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CERTIFICATE OF ANALYSIS FOR

CERTIFIED REFERENCE MATERIAL

OREAS 503e

PORPHYRY COPPER-GOLD-MOLYBDENUM

(Cadia Valley Operations, New South Wales, Australia)



Document: COA-1599-OREAS503e-R1

(Template: BUP-70-10-01 Rev: 2.0)

1-September-2023

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Table 1. Certified Values and Performance Gates for OREAS 503e.

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	0.709	0.018	0.673	0.746	0.655	0.764	2.58%	5.16%	7.74%	0.674	0.745
Aqua Regia Digestion (sample weights 10-50g)											
Au, ppm	0.706	0.035	0.636	0.777	0.600	0.812	5.00%	10.00%	14.99%	0.671	0.741
4-Acid Digestion											
Ag, ppm	1.52	0.134	1.25	1.79	1.12	1.92	8.81%	17.62%	26.43%	1.44	1.59
Al, wt. %	7.55	0.242	7.06	8.03	6.82	8.27	3.20%	6.40%	9.60%	7.17	7.92
As, ppm	28.8	1.96	24.8	32.7	22.9	34.6	6.83%	13.65%	20.48%	27.3	30.2
Ba, ppm	926	35	856	996	821	1031	3.79%	7.57%	11.36%	880	973
Be, ppm	2.34	0.135	2.07	2.61	1.93	2.74	5.79%	11.58%	17.37%	2.22	2.46
Bi, ppm	1.86	0.142	1.58	2.15	1.44	2.29	7.64%	15.28%	22.93%	1.77	1.96
Ca, wt. %	1.95	0.054	1.84	2.05	1.79	2.11	2.76%	5.53%	8.29%	1.85	2.04
Cd, ppm	0.75	0.09	0.57	0.94	0.48	1.03	12.24%	24.48%	36.72%	0.71	0.79
Ce, ppm	67	5.4	56	78	51	83	8.10%	16.20%	24.29%	64	70
Co, ppm	16.3	0.80	14.7	17.9	13.9	18.7	4.90%	9.81%	14.71%	15.5	17.1
Cr, ppm	45.9	4.26	37.4	54.4	33.1	58.7	9.28%	18.55%	27.83%	43.6	48.2
Cs, ppm	9.33	0.384	8.57	10.10	8.18	10.49	4.11%	8.23%	12.34%	8.87	9.80
Cu, wt. %	0.531	0.016	0.498	0.564	0.482	0.581	3.09%	6.19%	9.28%	0.505	0.558
Dy, ppm	3.50	0.298	2.91	4.10	2.61	4.40	8.52%	17.03%	25.55%	3.33	3.68
Er, ppm	1.44	0.18	1.09	1.80	0.91	1.97	12.24%	24.48%	36.72%	1.37	1.52
Eu, ppm	1.29	0.099	1.09	1.48	0.99	1.58	7.68%	15.37%	23.05%	1.22	1.35
Fe, wt. %	4.11	0.117	3.87	4.34	3.76	4.46	2.84%	5.69%	8.53%	3.90	4.31
Ga, ppm	19.4	0.68	18.1	20.8	17.4	21.5	3.51%	7.03%	10.54%	18.4	20.4
Gd, ppm	5.50	0.59	4.31	6.68	3.72	7.27	10.77%	21.53%	32.30%	5.22	5.77
Ge, ppm	0.18	0.05	0.08	0.28	0.03	0.33	28.44%	56.88%	85.32%	0.17	0.19
Hf, ppm	1.83	0.109	1.61	2.05	1.50	2.16	5.94%	11.89%	17.83%	1.74	1.92
Ho, ppm	0.58	0.040	0.50	0.66	0.46	0.70	6.98%	13.96%	20.94%	0.55	0.61
In, ppm	0.38	0.020	0.35	0.42	0.33	0.44	5.15%	10.30%	15.46%	0.37	0.40
K, wt. %	2.95	0.082	2.78	3.11	2.70	3.19	2.78%	5.56%	8.34%	2.80	3.09
La, ppm	33.3	2.48	28.3	38.2	25.8	40.7	7.46%	14.92%	22.38%	31.6	34.9
Li, ppm	46.3	1.58	43.2	49.5	41.6	51.1	3.41%	6.82%	10.22%	44.0	48.6
Lu, ppm	0.19	0.014	0.16	0.21	0.14	0.23	7.42%	14.84%	22.27%	0.18	0.20
Mg, wt. %	0.917	0.043	0.831	1.002	0.789	1.045	4.65%	9.30%	13.96%	0.871	0.963
Mn, wt. %	0.043	0.001	0.041	0.045	0.040	0.047	2.44%	4.87%	7.31%	0.041	0.046
Mo, ppm	343	13	317	368	304	381	3.77%	7.54%	11.31%	325	360
Na, wt. %	2.01	0.098	1.82	2.21	1.72	2.30	4.86%	9.72%	14.58%	1.91	2.11
Nb, ppm	11.0	0.65	9.7	12.3	9.1	13.0	5.90%	11.79%	17.69%	10.5	11.6
Nd, ppm	31.0	2.86	25.3	36.8	22.5	39.6	9.21%	18.42%	27.63%	29.5	32.6
Ni, ppm	47.6	1.65	44.3	50.9	42.6	52.5	3.47%	6.95%	10.42%	45.2	49.9
P, wt. %	0.088	0.004	0.081	0.095	0.078	0.099	3.98%	7.96%	11.94%	0.084	0.092
Pb, ppm	78	3.0	72	84	69	87	3.90%	7.81%	11.71%	74	82
Pr, ppm	7.83	0.731	6.37	9.29	5.64	10.03	9.34%	18.67%	28.01%	7.44	8.22
Rb, ppm	146	9	128	163	119	172	6.06%	12.11%	18.17%	138	153
Re, ppm	0.016	0.002	0.013	0.020	0.011	0.022	10.63%	21.25%	31.88%	0.016	0.017

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

Note 1: intervals may appear asymmetric due to rounding.

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

Table 1 continued.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
4-Acid Digestion continued											
S, wt. %	0.875	0.037	0.801	0.949	0.764	0.986	4.23%	8.46%	12.68%	0.831	0.919
Sb, ppm	236	9	219	253	210	262	3.64%	7.28%	10.92%	224	248
Sc, ppm	9.66	0.603	8.45	10.86	7.85	11.47	6.24%	12.48%	18.72%	9.17	10.14
Se, ppm	6.03	0.83	4.37	7.69	3.54	8.51	13.75%	27.49%	41.24%	5.73	6.33
Sm, ppm	6.21	0.544	5.12	7.29	4.58	7.84	8.76%	17.52%	26.28%	5.90	6.52
Sn, ppm	4.51	0.257	3.99	5.02	3.73	5.28	5.71%	11.43%	17.14%	4.28	4.73
Sr, ppm	229	14	201	257	187	271	6.10%	12.21%	18.31%	218	241
Ta, ppm	0.97	0.066	0.84	1.10	0.77	1.17	6.77%	13.54%	20.30%	0.92	1.02
Tb, ppm	0.69	0.063	0.57	0.82	0.51	0.88	9.10%	18.20%	27.30%	0.66	0.73
Te, ppm	0.85	0.063	0.72	0.97	0.66	1.04	7.44%	14.87%	22.31%	0.81	0.89
Th, ppm	12.3	1.01	10.3	14.3	9.3	15.4	8.15%	16.30%	24.45%	11.7	13.0
Ti, wt. %	0.351	0.011	0.329	0.372	0.319	0.383	3.07%	6.14%	9.22%	0.333	0.368
Tl, ppm	0.82	0.045	0.73	0.91	0.69	0.96	5.48%	10.96%	16.44%	0.78	0.86
Tm, ppm	0.20	0.008	0.19	0.22	0.18	0.23	3.99%	7.98%	11.97%	0.19	0.21
U, ppm	3.47	0.334	2.80	4.14	2.47	4.47	9.62%	19.24%	28.86%	3.30	3.64
V, ppm	79	3.0	73	85	71	88	3.72%	7.43%	11.15%	75	83
W, ppm	10.6	0.96	8.7	12.5	7.7	13.5	9.07%	18.14%	27.22%	10.1	11.1
Y, ppm	14.9	1.18	12.5	17.2	11.3	18.4	7.95%	15.91%	23.86%	14.1	15.6
Yb, ppm	1.18	0.13	0.91	1.45	0.77	1.58	11.44%	22.88%	34.32%	1.12	1.24
Zn, ppm	261	9	244	279	235	287	3.35%	6.70%	10.05%	248	274
Zr, ppm	57	4.3	48	65	44	69	7.55%	15.09%	22.64%	54	59
Aqua Regia Digestion											
Ag, ppm	1.49	0.071	1.35	1.64	1.28	1.71	4.78%	9.55%	14.33%	1.42	1.57
Al, wt. %	1.94	0.077	1.79	2.09	1.71	2.17	3.96%	7.92%	11.88%	1.84	2.04
As, ppm	28.6	1.20	26.2	31.0	25.0	32.2	4.19%	8.39%	12.58%	27.2	30.0
B, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Ba, ppm	362	73	215	508	142	582	20.27%	40.54%	60.81%	344	380
Be, ppm	1.41	0.077	1.25	1.56	1.18	1.64	5.49%	10.98%	16.48%	1.34	1.48
Bi, ppm	1.97	0.163	1.64	2.30	1.48	2.46	8.27%	16.54%	24.80%	1.87	2.07
Ca, wt. %	0.764	0.026	0.711	0.816	0.685	0.843	3.44%	6.87%	10.31%	0.726	0.802
Cd, ppm	0.68	0.11	0.46	0.91	0.35	1.02	16.21%	32.42%	48.63%	0.65	0.72
Ce, ppm	29.6	4.0	21.6	37.7	17.6	41.7	13.52%	27.04%	40.56%	28.2	31.1
Co, ppm	16.1	0.56	15.0	17.2	14.4	17.8	3.47%	6.95%	10.42%	15.3	16.9
Cr, ppm	50.0	2.52	44.9	55.0	42.4	57.5	5.05%	10.09%	15.14%	47.5	52.5
Cs, ppm	8.00	0.370	7.26	8.74	6.89	9.11	4.63%	9.25%	13.88%	7.60	8.40
Cu, wt. %	0.530	0.014	0.502	0.558	0.488	0.572	2.62%	5.25%	7.87%	0.504	0.557
Fe, wt. %	3.94	0.089	3.76	4.12	3.67	4.21	2.26%	4.52%	6.78%	3.74	4.14
Ga, ppm	9.44	0.649	8.14	10.74	7.49	11.39	6.88%	13.75%	20.63%	8.97	9.91
Ge, ppm	0.11	0.02	0.08	0.14	0.06	0.16	14.26%	28.53%	42.79%	0.11	0.12
Hf, ppm	0.32	0.024	0.27	0.37	0.25	0.40	7.51%	15.02%	22.53%	0.31	0.34
Hg, ppm	0.065	0.009	0.048	0.082	0.039	0.090	13.12%	26.24%	39.35%	0.062	0.068
In, ppm	0.38	0.014	0.35	0.41	0.34	0.42	3.65%	7.29%	10.94%	0.36	0.40
K, wt. %	0.841	0.023	0.794	0.888	0.771	0.912	2.79%	5.58%	8.38%	0.799	0.884

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

Note 1: intervals may appear asymmetric due to rounding; IND = indeterminate.

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

Table 1 continued.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
Aqua Regia Digestion continued											
La, ppm	14.3	2.1	10.1	18.5	8.0	20.6	14.76%	29.51%	44.27%	13.6	15.0
Li, ppm	38.1	2.03	34.1	42.2	32.0	44.2	5.32%	10.64%	15.96%	36.2	40.0
Mg, wt. %	0.830	0.024	0.782	0.877	0.758	0.901	2.88%	5.76%	8.64%	0.788	0.871
Mn, wt. %	0.037	0.001	0.035	0.040	0.033	0.041	3.26%	6.51%	9.77%	0.035	0.039
Mo, ppm	333	14	304	362	290	377	4.33%	8.66%	12.99%	317	350
Na, wt. %	0.135	0.012	0.111	0.158	0.099	0.170	8.75%	17.51%	26.26%	0.128	0.141
Nb, ppm	0.87	0.26	0.35	1.39	0.08	1.66	30.13%	60.26%	90.39%	0.83	0.91
Ni, ppm	46.4	1.53	43.3	49.4	41.8	51.0	3.31%	6.61%	9.92%	44.0	48.7
P, wt. %	0.069	0.002	0.064	0.074	0.062	0.076	3.35%	6.70%	10.05%	0.066	0.072
Pb, ppm	62	2.3	57	67	55	69	3.67%	7.34%	11.01%	59	65
Rb, ppm	86	5.5	75	97	70	103	6.42%	12.83%	19.25%	82	91
Re, ppm	0.016	0.002	0.013	0.019	0.011	0.020	9.97%	19.94%	29.91%	0.015	0.016
S, wt. %	0.863	0.035	0.793	0.934	0.757	0.969	4.10%	8.19%	12.29%	0.820	0.907
Sb, ppm	186	22	141	231	119	253	11.98%	23.96%	35.94%	177	195
Sc, ppm	7.95	0.379	7.20	8.71	6.82	9.09	4.77%	9.54%	14.30%	7.56	8.35
Se, ppm	5.79	0.430	4.93	6.65	4.50	7.08	7.43%	14.86%	22.28%	5.50	6.08
Sn, ppm	3.30	0.234	2.83	3.76	2.60	4.00	7.09%	14.18%	21.27%	3.13	3.46
Sr, ppm	50	2.4	45	55	43	58	4.88%	9.75%	14.63%	48	53
Ta, ppm	< 0.01	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Tb, ppm	0.43	0.034	0.37	0.50	0.33	0.53	7.73%	15.45%	23.18%	0.41	0.46
Te, ppm	0.79	0.056	0.68	0.90	0.62	0.96	7.12%	14.24%	21.35%	0.75	0.83
Th, ppm	5.16	0.71	3.74	6.58	3.03	7.29	13.79%	27.58%	41.37%	4.90	5.42
Ti, wt. %	0.248	0.009	0.230	0.267	0.221	0.276	3.71%	7.42%	11.14%	0.236	0.261
Tl, ppm	0.56	0.024	0.51	0.61	0.49	0.63	4.28%	8.57%	12.85%	0.53	0.59
U, ppm	3.02	0.294	2.43	3.61	2.14	3.90	9.73%	19.45%	29.18%	2.87	3.17
V, ppm	71	2.7	66	77	63	79	3.83%	7.67%	11.50%	68	75
W, ppm	5.93	1.09	3.76	8.10	2.67	9.19	18.31%	36.62%	54.92%	5.64	6.23
Y, ppm	10.2	0.43	9.4	11.1	9.0	11.5	4.19%	8.38%	12.58%	9.7	10.8
Yb, ppm	0.75	0.047	0.66	0.85	0.61	0.89	6.29%	12.59%	18.88%	0.71	0.79
Zn, ppm	255	8	238	271	230	279	3.20%	6.41%	9.61%	242	267
Zr, ppm	8.21	0.91	6.38	10.04	5.47	10.95	11.14%	22.28%	33.41%	7.80	8.62

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

Note 1: intervals may appear asymmetric due to rounding; IND = indeterminate.

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

Table 2. Indicative Values for OREAS 503e.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
4-Acid Digestion								
B	ppm	33.7	Hg	ppm	< 2			
Aqua Regia Digestion								
Dy	ppm	2.30	Ho	ppm	0.40	Pr	ppm	3.34
Er	ppm	0.96	Lu	ppm	0.094	Pt	ppb	10.4
Eu	ppm	0.37	Nd	ppm	13.2	Sm	ppm	3.07
Gd	ppm	3.01	Pd	ppb	203	Tm	ppm	0.11
Dy	ppm	2.30	Ho	ppm	0.40	Pr	ppm	3.34
Borate Fusion XRF								
Al ₂ O ₃	wt. %	14.46	MgO	wt. %	1.60	SiO ₂	wt. %	65.22
CaO	wt. %	2.71	MnO	wt. %	0.055	SO ₃	wt. %	2.18
Fe ₂ O ₃	wt. %	5.98	Na ₂ O	wt. %	2.79	TiO ₂	wt. %	0.600
K ₂ O	wt. %	3.54	P ₂ O ₅	wt. %	0.200			
Thermogravimetry								
LOI ¹⁰⁰⁰	wt. %	1.70						
Infrared Combustion								
C	wt. %	0.115	S	wt. %	0.820			
Laser Ablation ICP-MS								
Ag	ppm	1.65	Hf	ppm	6.18	Sm	ppm	6.74
As	ppm	28.8	Ho	ppm	1.05	Sn	ppm	5.60
Ba	ppm	923	In	ppm	0.38	Sr	ppm	223
Be	ppm	2.60	La	ppm	35.2	Ta	ppm	1.03
Bi	ppm	2.14	Lu	ppm	0.36	Tb	ppm	0.97
Cd	ppm	0.95	Mn	wt. %	0.046	Te	ppm	1.00
Ce	ppm	70	Mo	ppm	339	Th	ppm	12.8
Co	ppm	16.1	Nb	ppm	11.7	Ti	wt. %	0.368
Cr	ppm	61	Nd	ppm	32.4	Tl	ppm	0.60
Cs	ppm	9.81	Ni	ppm	61	Tm	ppm	0.43
Cu	ppm	5565	Pb	ppm	83	U	ppm	3.98
Dy	ppm	5.29	Pr	ppm	8.43	V	ppm	83
Er	ppm	2.78	Rb	ppm	149	W	ppm	11.8
Eu	ppm	1.32	Re	ppm	0.025	Y	ppm	29.0
Ga	ppm	19.2	Sb	ppm	245	Yb	ppm	2.62
Gd	ppm	6.22	Sc	ppm	9.95	Zn	ppm	265
Ge	ppm	1.43	Se	ppm	< 5	Zr	ppm	215

SI unit equivalents: ppb (parts per billion; 1×10^{-9}) \equiv $\mu\text{g}/\text{kg}$; ppm (parts per million; 1×10^{-6}) \equiv mg/kg ; wt. % (weight per cent) \equiv % (mass fraction).

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

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 (based on multiples of the SD) for the certified values, Table 2 shows indicative values including major and trace element characterisation, Table 3 provides some indicative physical properties, Table 4 provides indicative mineralogy based on semi-quantitative XRD analysis, Table 5 presents the 95% expanded uncertainty and tolerance limits for all certified values and Table 6 shows gold homogeneity data determined by INAA. Tabulated results of all analytes together with uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of lab means from the corrected mean of means (PDM³) are presented in the detailed certification data for this CRM (**OREAS 503e-DataPack.1.1.230214_142446.xlsx**).

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

SOURCE MATERIAL

OREAS 503e was prepared from a blend of porphyry copper-gold ores, barren granodiorite and a minor quantity of Cu-Mo concentrate. The ores were sourced from both the Cadia Mine and Northparkes Mine. Both mines are located in the Central West of New South Wales, Australia. The barren granodiorite was sourced from the mafic, S-Type, Late Devonian Bulla Granodiorite complex located in northern Melbourne, Australia.

Mineralisation in the CVO region is hosted by a sequence of late Ordovician to Early Silurian volcanics, intrusives and sediments that occur within the Bogan Gate Synclinal Zone of the Lachlan Fold Belt. The western portion of this zone is dominated by volcanics and host to the Late Ordovician Goonumbla porphyry copper-gold deposits. These volcanics are interpreted to have erupted from shallow water to partly emergent volcanic centres and show a broad range in composition from shoshonite through to latite to trachyte. Coeval sub-volcanic quartz monzonite porphyries (and attendant mineralisation) have intruded the volcanics. They are generally small, sub-vertical, pipe-like intrusives. Typically, the mineralised porphyries contain plagioclase and quartz phenocrysts in a matrix of fine-grained potassium feldspar and quartz with minor biotite and hornblende.

Copper-gold mineralisation occurs as stockwork quartz veins and disseminations associated with potassic alteration. This alteration is intimately associated spatially and temporally with the small finger-like quartz monzonite porphyries that intrude the Goonumbla

Volcanics. Sulphides are zoned laterally from the centres of mineralisation. The central portions are bornite-rich with minor chalcopyrite, zoning outward through equal concentrations of bornite and chalcopyrite, to an outermost chalcopyrite-rich zone. Pyrite increases outward at the expense of bornite.

PERFORMANCE GATES

Table 1 above shows intervals calculated for two and three standard deviations. As a guide these intervals may be regarded as warning or rejection for multiple 2SD outliers, or rejection for individual 3SD outliers in QC monitoring, although their precise application should be at the discretion of the QC manager concerned (also see 'Intended Use' section below). Westgard Rules extend the basics of single-rule QC monitoring using multi-rules (for more information visit www.westgard.com/mltirule.htm). A second method utilises a 5% window calculated directly from the certified value.

Standard deviation is also shown in relative percent for one, two and three relative standard deviations (1RSD, 2RSD and 3RSD) to facilitate an appreciation of the magnitude of these numbers and a comparison with the 5% window. Caution should be exercised when concentration levels approach lower limits of detection of the analytical methods employed as performance gates calculated from standard deviations tend to be excessively wide whereas those determined by the 5% method are too narrow. One approach used at commercial laboratories is to set the acceptance criteria at twice the detection level (DL) \pm 10%.

i.e., Certified Value \pm 10% \pm 2DL [1].

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 503e was prepared in the following manner:

- Drying of ore and barren granodiorite to constant mass at 105°C;
- Drying of Cu-Mo concentrate to constant mass at 85°C;
- Multi-stage milling of ore and concentrate to 100% minus 30 microns;
- Milling of barren granodiorite to 98% minus 75 microns;
- Combining ores, granodiorite and concentrate in appropriate proportions to achieve target grades;
- Homogenisation using OREAS' novel processing technologies;
- Packaging into 10 and 60g units in laminated foil pouches and 500g units in plastic jars.

PHYSICAL PROPERTIES

OREAS 503e 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 503e.

Bulk Density (g/L)	Moisture%	Munsell Notation [‡]	Munsell Color [‡]
710	0.62	N7	Light 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.

MINERALOGY

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

Table 4. Indicative mineralogy of OREAS 503e based on semi-quantitative XRD analysis.

Mineral / Mineral Group	% (mass ratio)
Zeolite	0
*Clay minerals	< 1
Kaolinite	1
Chlorite	2
Annite - biotite - phlogopite	36
Muscovite	2
Calcic amphibole	1
Cordierite	< 1
Plagioclase	22
K-feldspar	15
Quartz	20
Gypsum	0
Calcite	< 1
Pyrite	1
**Molybdenite	< 1

*Most likely smectite and vermiculite.

**This phase is associated with a larger than usual uncertainty in regard to the quantity of the phase reported; for some of the minor and trace phases it may also indicate an uncertainty in regard to the presence of the phase itself.

ANALYTICAL PROGRAM

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

- Gold by 15-50g fire assay with AAS (17 laboratories) or ICP-OES (4 laboratories) finish;
- Gold by 10-50g aqua regia digestion with ICP-MS finish (10 laboratories) and AAS (5 laboratories) finish;
- 4-acid digestion for full elemental suite ICP-OES/MS finish (up to 19 laboratories depending on the element)
- Aqua regia digestion for full elemental suite ICP-OES/MS and AAS finish (up to 21 laboratories depending on the element);
- Gold by instrumental neutron activation analysis (INAA) on 20 x 85mg subsamples to confirm homogeneity (undertaken at ANSTO, Lucas Heights, Australia).

Table 2 shows indicative values including major and trace element characterisation by Bureau Veritas in Perth, Western Australia which includes:

- Major oxides by lithium borate fusion with X-ray fluorescence;
- LOI at 1000°C by thermogravimetric analyser;

- Total Carbon and Sulphur by infrared combustion furnace;
- Trace elements by laser ablation (on the fused bead) with ICP-MS finish.

For the round robin program twenty 2kg test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire prepared batch. Six 110g pulp samples were submitted to each laboratory for analysis received by each laboratory were obtained by taking two 110g samples from each of three separate 2kg test units. This format enabled nested ANOVA treatment of the results to evaluate homogeneity, i.e., to ascertain whether between-unit variance is greater than within-unit variance.

STATISTICAL ANALYSIS

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

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

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

Certified Values and their uncertainty intervals (Table 5) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration).

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

Certified Values are the means of accepted laboratory means after outlier filtering and are the present best estimate of the true value. The INAA data (see Table 6) is omitted from determination of the certified value for Au and is used solely for the calculation of Tolerance Limits and homogeneity evaluation (see 'Homogeneity Evaluation' section below).

95% Expanded Uncertainty provides a 95% probability that the true value of the analyte under consideration lies between the upper and lower limits and is calculated according to the method in the ISO Guides [6,16]. All known or suspected sources of bias have been investigated or taken into account.

The 95% Expanded Uncertainty should not be used as control limits for laboratory performance.

Table 5. 95% Uncertainty & Tolerance Limits for OREAS 503e.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Pb Fire Assay					
Au, Gold (ppm)	0.709	0.702	0.717	0.706*	0.713*
Aqua Regia Digestion (sample weights 10-50g)					
Au, Gold (ppm)	0.706	0.688	0.724	0.702*	0.710*
4-Acid Digestion					
Ag, Silver (ppm)	1.52	1.41	1.62	1.45	1.58
Al, Aluminium (wt.%)	7.55	7.24	7.85	7.37	7.72
As, Arsenic (ppm)	28.8	27.1	30.4	27.8	29.7
Ba, Barium (ppm)	926	893	960	904	949
Be, Beryllium (ppm)	2.34	2.19	2.49	2.24	2.44
Bi, Bismuth (ppm)	1.86	1.61	2.11	1.72	2.00
Ca, Calcium (wt.%)	1.95	1.88	2.02	1.91	1.99
Cd, Cadmium (ppm)	0.75	0.66	0.84	0.72	0.79
Ce, Cerium (ppm)	67	62	73	64	70
Co, Cobalt (ppm)	16.3	15.5	17.2	16.0	16.7
Cr, Chromium (ppm)	45.9	42.4	49.4	44.3	47.5
Cs, Caesium (ppm)	9.33	8.89	9.77	9.08	9.59
Cu, Copper (wt.%)	0.531	0.516	0.547	0.523	0.540
Dy, Dysprosium (ppm)	3.50	3.09	3.92	3.27	3.73
Er, Erbium (ppm)	1.44	1.22	1.66	IND	IND
Eu, Europium (ppm)	1.29	1.18	1.40	1.23	1.34
Fe, Iron (wt.%)	4.11	3.99	4.22	4.04	4.17
Ga, Gallium (ppm)	19.4	18.6	20.3	18.7	20.1
Gd, Gadolinium (ppm)	5.50	4.77	6.23	5.25	5.74
Ge, Germanium (ppm)	0.18	0.12	0.24	IND	IND
Hf, Hafnium (ppm)	1.83	1.70	1.96	1.76	1.90
Ho, Holmium (ppm)	0.58	0.52	0.63	IND	IND
In, Indium (ppm)	0.38	0.37	0.40	0.37	0.40
K, Potassium (wt.%)	2.95	2.86	3.03	2.89	3.00
La, Lanthanum (ppm)	33.3	30.6	35.9	32.2	34.3

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

*Gold Tolerance Limits for typical 30g fire assay and 25g aqua regia digestion 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 5 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion continued					
Li, Lithium (ppm)	46.3	44.4	48.2	45.1	47.5
Lu, Lutetium (ppm)	0.19	0.17	0.21	IND	IND
Mg, Magnesium (wt.%)	0.917	0.883	0.951	0.892	0.942
Mn, Manganese (wt.%)	0.043	0.042	0.045	0.043	0.044
Mo, Molybdenum (ppm)	343	332	353	336	349
Na, Sodium (wt.%)	2.01	1.94	2.08	1.98	2.04
Nb, Niobium (ppm)	11.0	10.5	11.6	10.6	11.4
Nd, Neodymium (ppm)	31.0	27.2	34.9	29.3	32.8
Ni, Nickel (ppm)	47.6	45.7	49.5	46.6	48.5
P, Phosphorus (wt.%)	0.088	0.085	0.091	0.086	0.090
Pb, Lead (ppm)	78	75	80	76	79
Pr, Praseodymium (ppm)	7.83	6.78	8.88	7.32	8.35
Rb, Rubidium (ppm)	146	139	153	142	150
Re, Rhenium (ppm)	0.016	0.013	0.019	IND	IND
S, Sulphur (wt.%)	0.875	0.843	0.907	0.855	0.895
Sb, Antimony (ppm)	236	228	243	231	241
Sc, Scandium (ppm)	9.66	9.21	10.10	9.38	9.93
Se, Selenium (ppm)	6.03	5.16	6.89	5.37	6.68
Sm, Samarium (ppm)	6.21	5.37	7.04	5.84	6.57
Sn, Tin (ppm)	4.51	4.22	4.79	4.31	4.70
Sr, Strontium (ppm)	229	219	240	225	234
Ta, Tantalum (ppm)	0.97	0.91	1.03	0.94	1.00
Tb, Terbium (ppm)	0.69	0.60	0.78	0.67	0.72
Te, Tellurium (ppm)	0.85	0.74	0.96	0.77	0.93
Th, Thorium (ppm)	12.3	11.3	13.4	11.8	12.9
Ti, Titanium (wt.%)	0.351	0.339	0.363	0.343	0.359
Tl, Thallium (ppm)	0.82	0.77	0.88	0.78	0.86
Tm, Thulium (ppm)	0.20	0.19	0.21	IND	IND
U, Uranium (ppm)	3.47	2.90	4.04	3.13	3.81
V, Vanadium (ppm)	79	77	82	78	81
W, Tungsten (ppm)	10.6	9.1	12.1	9.7	11.4
Y, Yttrium (ppm)	14.9	14.0	15.8	14.3	15.4
Yb, Ytterbium (ppm)	1.18	1.04	1.32	IND	IND
Zn, Zinc (ppm)	261	254	268	255	267
Zr, Zirconium (ppm)	57	53	61	55	58
Aqua Regia Digestion					
Ag, Silver (ppm)	1.49	1.42	1.57	1.43	1.56

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

Note: intervals may appear asymmetric due to rounding.

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

Table 5 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Aqua Regia Digestion					
Al, Aluminium (wt.%)	1.94	1.88	2.00	1.91	1.97
As, Arsenic (ppm)	28.6	27.3	29.9	27.6	29.6
B, Boron (ppm)	< 10	IND	IND	IND	IND
Ba, Barium (ppm)	362	322	401	349	374
Be, Beryllium (ppm)	1.41	1.31	1.50	1.35	1.47
Bi, Bismuth (ppm)	1.97	1.77	2.17	1.85	2.09
Ca, Calcium (wt.%)	0.764	0.738	0.789	0.749	0.779
Cd, Cadmium (ppm)	0.68	0.61	0.76	0.65	0.72
Ce, Cerium (ppm)	29.6	26.8	32.4	28.5	30.8
Co, Cobalt (ppm)	16.1	15.5	16.7	15.7	16.5
Cr, Chromium (ppm)	50.0	48.3	51.6	49.0	50.9
Cs, Caesium (ppm)	8.00	7.68	8.32	7.84	8.16
Cu, Copper (wt.%)	0.530	0.516	0.544	0.522	0.538
Fe, Iron (wt.%)	3.94	3.84	4.03	3.88	4.00
Ga, Gallium (ppm)	9.44	8.99	9.89	9.20	9.68
Ge, Germanium (ppm)	0.11	0.09	0.13	IND	IND
Hf, Hafnium (ppm)	0.32	0.30	0.35	0.31	0.34
Hg, Mercury (ppm)	0.065	0.051	0.079	IND	IND
In, Indium (ppm)	0.38	0.36	0.40	0.36	0.40
K, Potassium (wt.%)	0.841	0.818	0.865	0.824	0.859
La, Lanthanum (ppm)	14.3	12.9	15.6	13.8	14.8
Li, Lithium (ppm)	38.1	36.6	39.7	37.2	39.0
Mg, Magnesium (wt.%)	0.830	0.810	0.849	0.814	0.845
Mn, Manganese (wt.%)	0.037	0.036	0.038	0.037	0.038
Mo, Molybdenum (ppm)	333	323	344	328	339
Na, Sodium (wt.%)	0.135	0.125	0.144	0.131	0.138
Nb, Niobium (ppm)	0.87	0.69	1.05	0.81	0.93
Ni, Nickel (ppm)	46.4	44.8	47.9	45.3	47.4
P, Phosphorus (wt.%)	0.069	0.067	0.071	0.068	0.070
Pb, Lead (ppm)	62	59	65	61	63
Rb, Rubidium (ppm)	86	82	90	84	88
Re, Rhenium (ppm)	0.016	0.013	0.018	IND	IND
S, Sulphur (wt.%)	0.863	0.838	0.888	0.849	0.878
Sb, Antimony (ppm)	186	174	198	181	191
Sc, Scandium (ppm)	7.95	7.69	8.22	7.76	8.15
Se, Selenium (ppm)	5.79	5.09	6.48	5.38	6.20
Sn, Tin (ppm)	3.30	3.09	3.51	3.16	3.44

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

Note: intervals may appear asymmetric due to rounding.

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

Table 5 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Aqua Regia Digestion continued					
Sr, Strontium (ppm)	50	48	52	49	51
Ta, Tantalum (ppm)	< 0.01	IND	IND	IND	IND
Tb, Terbium (ppm)	0.43	0.39	0.48	IND	IND
Te, Tellurium (ppm)	0.79	0.74	0.85	0.75	0.84
Th, Thorium (ppm)	5.16	4.42	5.90	4.86	5.46
Ti, Titanium (wt.%)	0.248	0.240	0.257	0.243	0.254
Tl, Thallium (ppm)	0.56	0.53	0.59	0.54	0.58
U, Uranium (ppm)	3.02	2.57	3.47	2.82	3.22
V, Vanadium (ppm)	71	69	73	70	72
W, Tungsten (ppm)	5.93	5.22	6.64	5.49	6.37
Y, Yttrium (ppm)	10.2	9.8	10.7	10.0	10.5
Yb, Ytterbium (ppm)	0.75	0.65	0.86	IND	IND
Zn, Zinc (ppm)	255	248	261	250	260
Zr, Zirconium (ppm)	8.21	7.63	8.79	7.96	8.45

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

Note: intervals may appear asymmetric due to rounding.

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

Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) shown in Table 5 were determined using an analysis of precision errors method and are considered a conservative estimate of true homogeneity. The meaning of tolerance limits may be illustrated for copper by 4-acid digestion, where 99% of the time ($1-\alpha=0.99$) at least 95% of subsamples ($\rho=0.95$) will have concentrations lying between 0.523 and 0.540 wt.%. Put more precisely, this means that if the same number of subsamples were taken and analysed in the same manner repeatedly, 99% of the tolerance intervals so constructed would cover at least 95% of the total population, and 1% of the tolerance intervals would cover less than 95% of the total population (ISO Guide 35).

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

Table 6 below shows the gold INAA data determined on 20 x 85mg subsamples of OREAS 503e. An equivalent scaled version of the results is also provided to demonstrate an appreciation of what this data means if 30g fire assays were undertaken without the normal measurement error associated with this methodology. In this instance, the 1RSD of 0.15% calculated for a 30g fire assay sample (2.91% at 85mg weights) confirms the high level of gold homogeneity in OREAS 503e.

The homogeneity of gold has been determined by INAA at ANSTO using the reduced analytical subsample method which utilises the known relationship between standard deviation and analytical subsample weight (Ingamells and Switzer, 1973). In this approach the sample aliquot is substantially reduced to a point where most of the variability in replicate assays should be due to inhomogeneity of the reference material and measurement error becomes negligible.

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

Replicate No	Au 85mg actual	Au 30g equivalent*
1	0.692	0.694
2	0.678	0.693
3	0.670	0.693
4	0.679	0.693
5	0.665	0.692
6	0.702	0.694
7	0.700	0.694
8	0.704	0.694
9	0.688	0.693
10	0.721	0.695
11	0.739	0.696
12	0.676	0.693
13	0.687	0.693
14	0.691	0.694
15	0.676	0.693
16	0.681	0.693
17	0.728	0.696
18	0.684	0.693
19	0.721	0.695
20	0.696	0.694
Mean	0.694	0.694
Median	0.690	0.694
Std Dev.	0.020	0.001
Rel.Std.Dev.	2.91%	0.154%

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

The homogeneity of gold in OREAS 503e has also been evaluated in a nested Analysis of Variance (**ANOVA**) of the round robin program. Twenty-one 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 503e. The test was performed using the following parameters:

- Gold fire assay – 126 samples (21 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 90 samples (15 laboratories each providing analyses on 3 pairs of samples);
- Null Hypothesis, H_0 : Between-unit variance is no greater than within-unit variance (reject H_0 if p -value < 0.05);
- Alternative Hypothesis, H_1 : Between-unit variance is greater than within-unit variance.

P-values are a measure of probability where values less than 0.05 indicate a greater than 95% probability that the observed differences in within-unit and between-unit variances are real. The datasets were filtered for both individual and laboratory data set (batch) outliers prior to the calculation of *p*-values. This process derived *p*-values of 0.384 for Au by fire assay and 0.343 for Au by aqua regia digestion. Both *p*-values are insignificant and the Null Hypothesis is retained. Additionally, none of the other certified values showed significant *p*-values except for Sr by aqua regia 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.

Please note that only results for constituents present in concentrations well above the detection levels (i.e., >20 x Lower Limit of Detection) for the various methods undertaken were considered for the objective of evaluating homogeneity.

It is important to note that ANOVA is not an absolute measure of homogeneity. Rather, it establishes whether or not the analytes are distributed in a similar manner throughout the packaging run of OREAS 503e 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 ANOVA and the results of the interlaboratory certification program, it can be concluded that OREAS 503e is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PREPARER AND SUPPLIER

Certified reference material OREAS 503e was prepared and certified by:



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3. ALS, Johannesburg, South Africa
4. ALS, Lima, Peru
5. ALS, Loughrea, Galway, Ireland
6. ALS, Perth, WA, Australia
7. ALS, Ulaanbaatar, Khan-Uul District, Mongolia
8. ALS, Vancouver, BC, Canada
9. ANSTO, Lucas Heights, NSW, Australia
10. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada

11. CERTIMIN, Lima, Peru
12. ESAN Istanbul, Istanbul, Turkey
13. Inspectorate (BV), Lima, Peru
14. Intertek Genalysis, Perth, WA, Australia
15. Intertek Testing Services, Townsville, QLD, Australia
16. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
17. Laboratorio Tecnológico de Metalurgia LTM SA de CV, Hermosillo, Sonora, Mexico
18. Newcrest Laboratory Services, Orange, NSW, Australia
19. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
20. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
21. SGS, Ankara, Anatolia, Turkey
22. SGS Mongolia, Ulaanbaatar, Bayangol District, Mongolia

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

Figure 1. Au by Pb Fire Assay in OREAS 503e

SPC.1599.RR1.OREAS 503e.3.Fire Assay.Au.Lab.221104.200651.SN

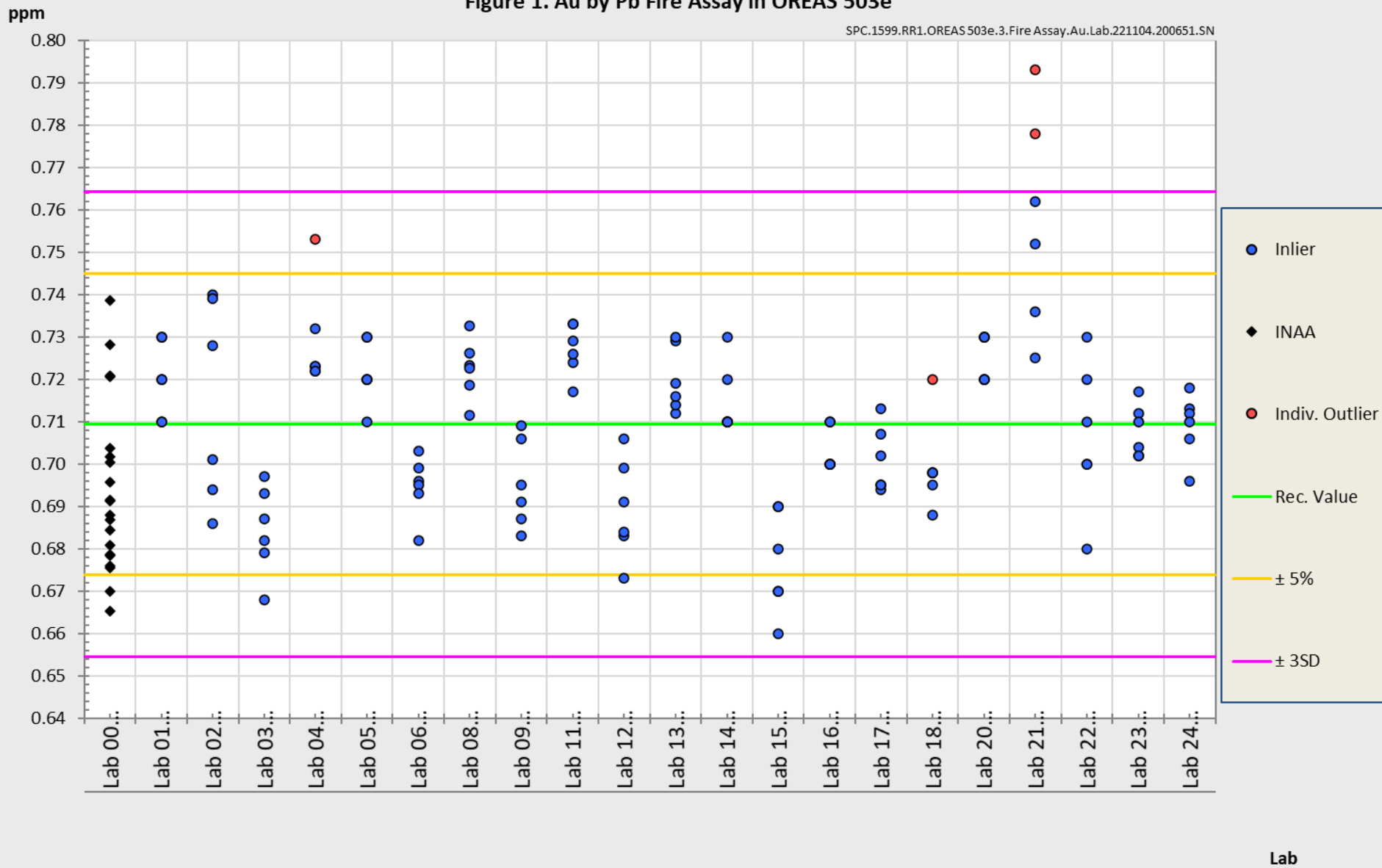


Figure 2. Au by Aqua Regia Digestion (sample weights 10-50g) in OREAS 503e

SPC.1599.RR1.OREAS 503e.3.AR Digest 10-50g.Au.Lab.221104.200730.SN

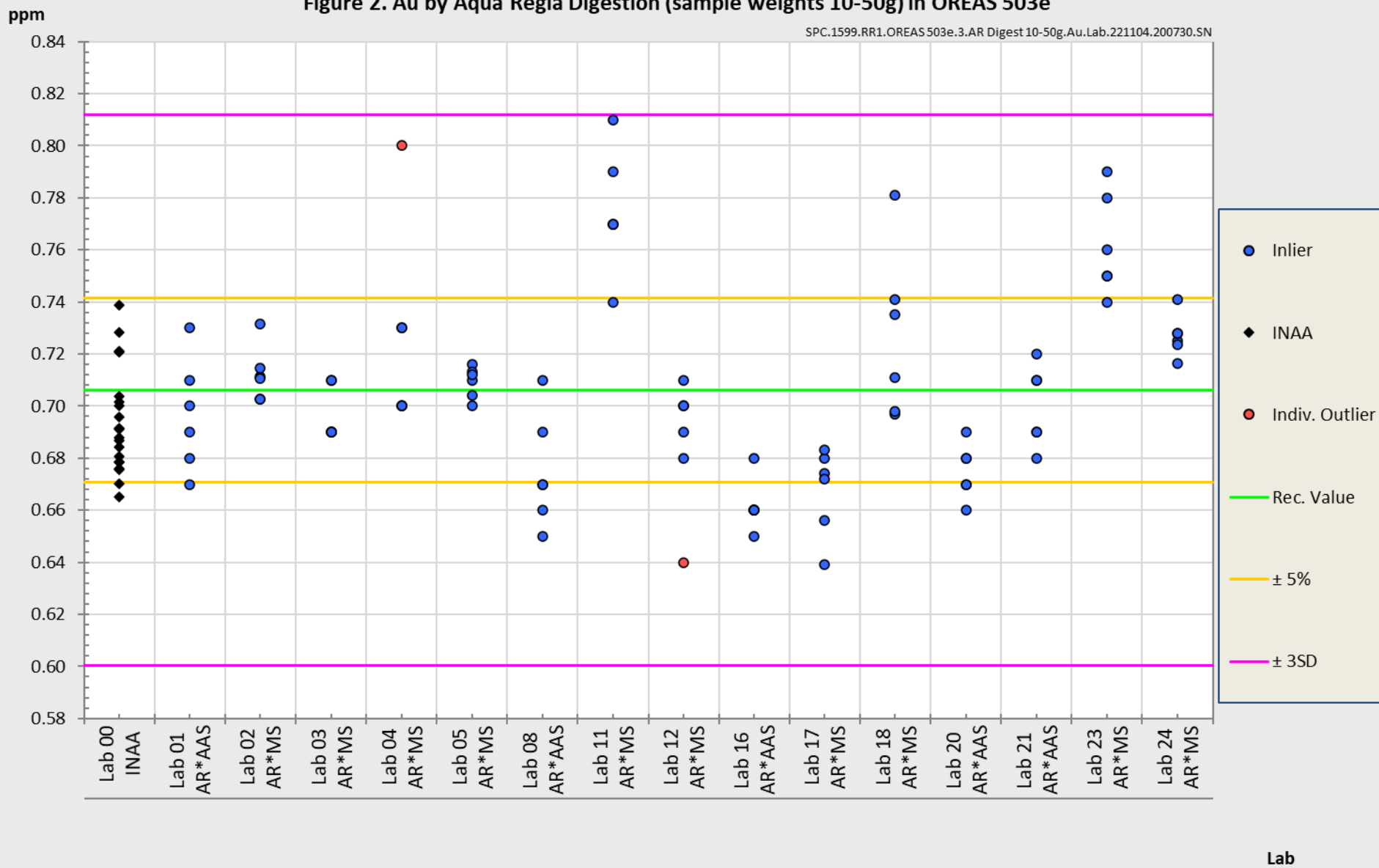


Figure 3. Cu by 4-Acid Digestion in OREAS 503e

SPC.1599.RR1.OREAS 503e.3.4-Acid.Cu.Lab.221104.200812.SN

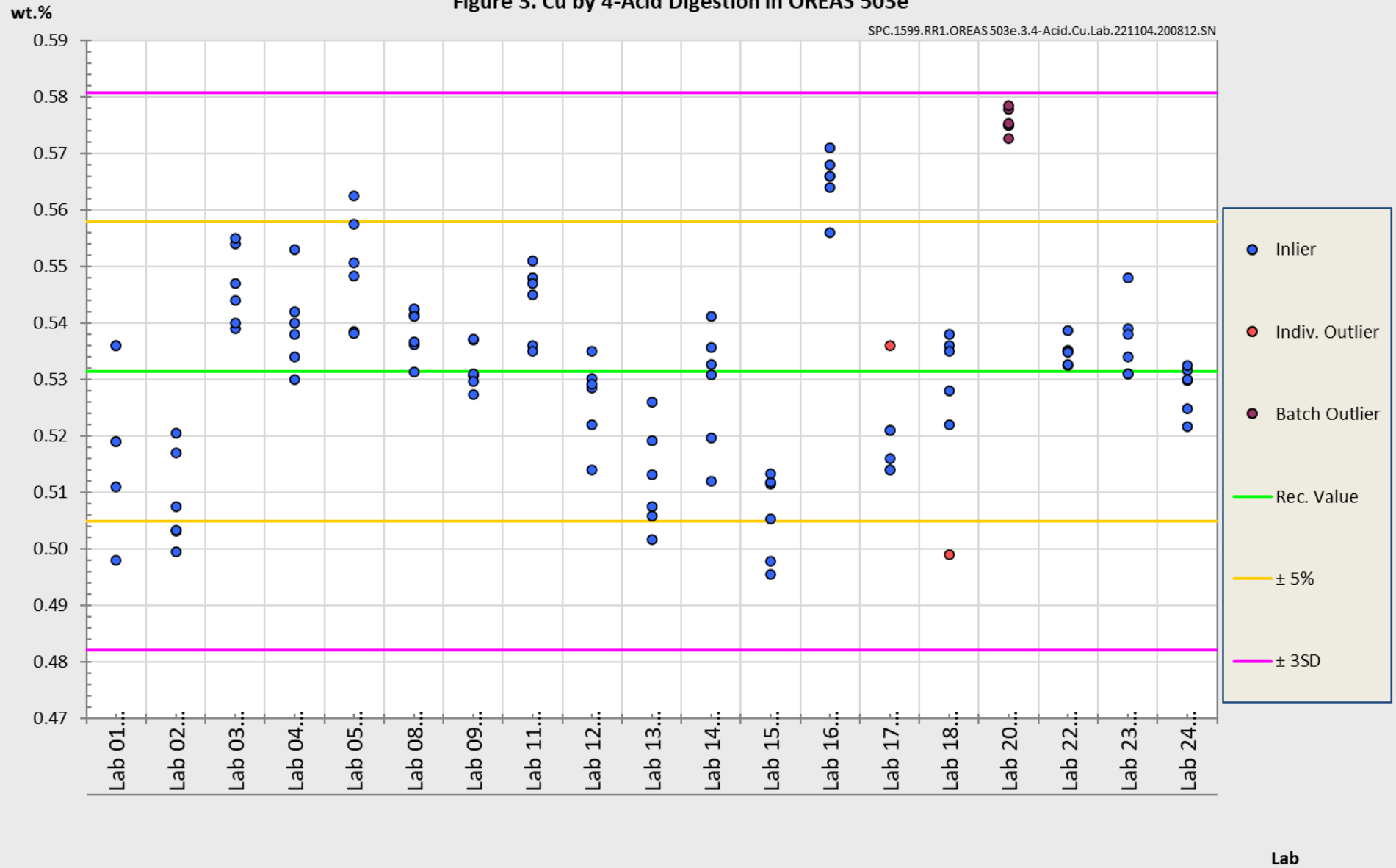
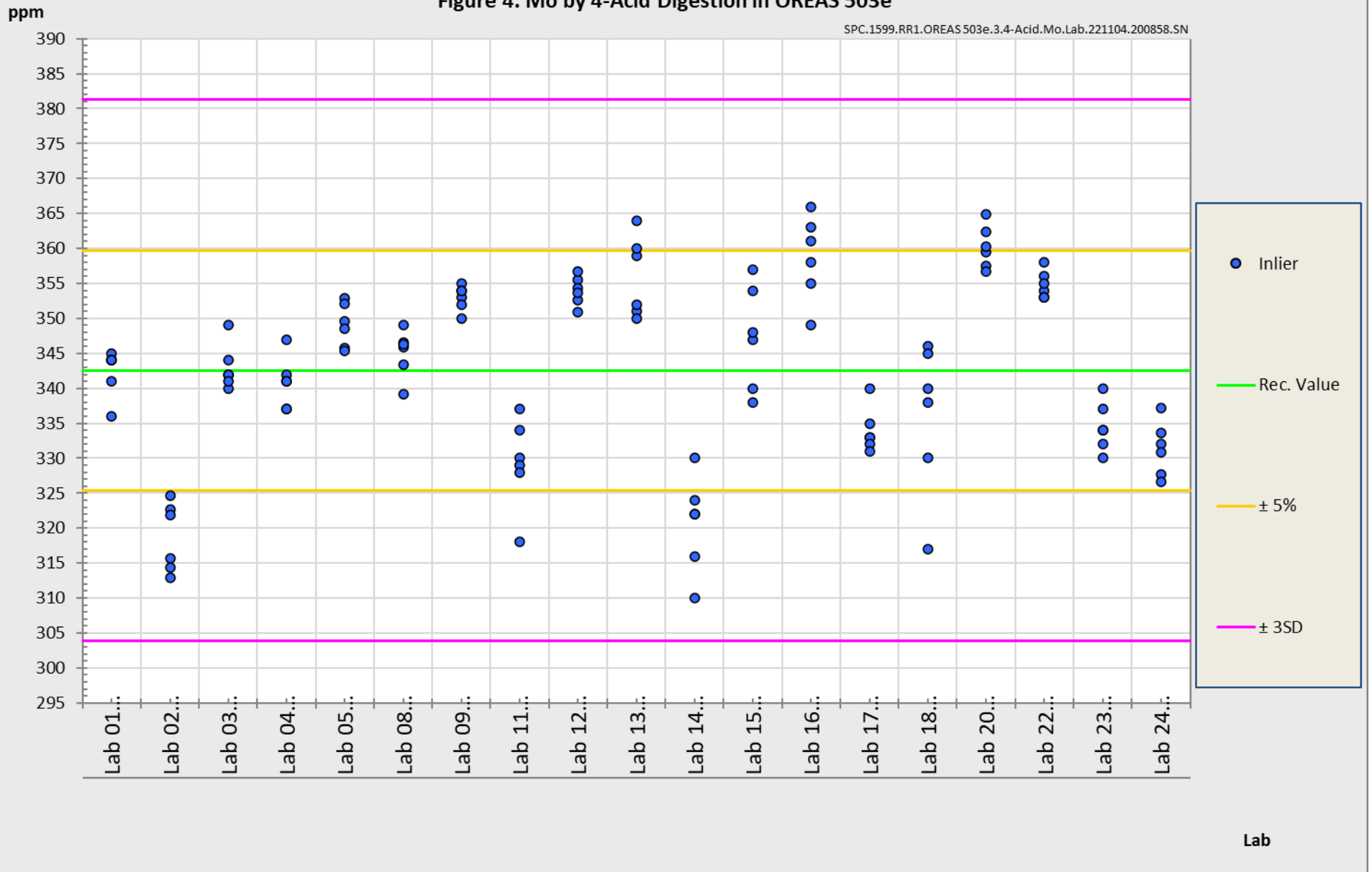


Figure 4. Mo by 4-Acid Digestion in OREAS 503e

SPC.1599.RR1.OREAS 503e.3.4-Acid.Mo.Lab.221104.200858.SN



METROLOGICAL TRACEABILITY

The interlaboratory results that underpin the certified values are metrologically traceable to the international measurement scale (SI) of mass (either as a % mass fraction, as milligrams per kilogram (mg/kg) or micrograms per kilogram ($\mu\text{g}/\text{kg}$)). In line with popular use, all data within tables in this certificate are expressed as the mass fraction in either weight percent (wt.%) or parts per million (ppm).

The analytical samples were selected in a manner to represent the entire batch of prepared CRM. This 'representivity' was maintained in each submitted laboratory sample batch and ensures the user that the data is traceable from sample selection through to the analytical results that underlie the consensus values. Each analytical data set has been validated by its assayer through the inclusion of internal reference materials and QC checks during analysis.

The laboratories were chosen on the basis of their competence (from past performance in inter-laboratory programs undertaken by ORE Pty Ltd) for a particular analytical method, analyte or analyte suite, and sample matrix. Most of these laboratories have and maintain ISO 17025 accreditation. The certified values presented in this report are calculated from the means of accepted data following robust statistical treatment as detailed in this report.

Guide ISO/TR 16476:2016, section 5.3.1 describes metrological traceability in reference materials as it pertains to the transformation of the measurand. In this section it states, *"Although the determination of the property value itself can be made traceable to appropriate units through, for example, calibration of the measurement equipment used, steps like the transformation of the sample from one physical (chemical) state to another cannot. Such transformations may only be compared with a reference (when available), or among themselves. For some transformations, reference methods have been defined and may be used in certification projects to evaluate the uncertainty associated with such a transformation. **In other cases, only a comparison among different laboratories using the same procedure is possible. In this case, it is impossible to demonstrate absence of method bias; therefore, the result is an operationally defined measurand (ISO Guide 35:2017, 9.2.4c).**"* Certification takes place on the basis of agreement among operationally defined, independent measurement results.

COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving pre-treatment (digestion/fusion) of the sample. This served to reduce the sample to a simple and well understood form permitting calibration using simple solutions of the CRM. Due to these methods being well understood and highly effective, commutability is not an issue for this CRM. Being matrix-matched, OREAS 503e will display similar behaviour in the relevant measurement process to the routine 'process' samples for which OREAS 503e is designated to monitor. To maintain commutability, care should be taken to always ensure 'matrix matching' as close as practically achievable. The matrix 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 503e 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 503e may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution. OREAS 503e is intended for the following uses:

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

MINIMUM SAMPLE SIZE

To relate analytical determinations to the values in this certificate, the minimum mass of sample used should match the typical mass that the laboratories used in the interlaboratory (round robin) certification program. This means that different minimum sample masses should be used depending on the operationally defined methodology as follows:

- Au by fire assay: $\geq 10\text{g}$;
- Au by aqua regia digestion ICP finish: $\geq 1\text{g}$.;
- 4-acid digestion with ICP-OES and/or MS finish: $\geq 0.25\text{g}$;
- Aqua regia digestion with ICP-OES and/or MS finish: $\geq 0.5\text{g}$.

PERIOD OF VALIDITY & STORAGE INSTRUCTIONS

The certification of OREAS 503e remains valid, within the specified measurement uncertainties, until October 2037, provided the CRM is handled and stored in accordance with the instructions given below. This certification is nullified if the CRM is any way changed or contaminated.

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

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

Single-use sachets

OREAS 503e has been prepared from a blend of porphyry copper-gold ore, barren granodiorite and a minor quantity of Cu-Mo concentrate. It is low in reactive sulphide (0.88 wt.% S). In its unopened state and under normal conditions of storage it has a shelf life beyond ten years. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

Repeat-use packaging (e.g., 500g plastic jars)

After taking a subsample, users should replace the lid of the jar promptly and securely to prevent accidental spills and airborne contamination. OREAS 503e contains a non-hygroscopic* matrix with an indicative value for moisture provided to enable users to check

for changes to stored material by determining moisture in the user's laboratory and comparing the result to the value in Table 3 in this certificate.

The stability of the CRM in regard to oxidation from the breakdown of sulphide minerals to sulphates is negligible given its low sulphur concentration (0.88 wt.% S).

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

INSTRUCTIONS FOR HANDLING & CORRECT USE

Pre-homogenisation of the CRM prior to subsampling and analysis is not necessary as there is no particle segregation under transport [13].

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

QC monitoring using multiples of the Standard Deviation (SD)

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

The majority of data generated in the round robin program was produced by a selection of world class laboratories. The SD's thus generated are more constrained than those that would be produced across a randomly selected group of laboratories. To produce more generally achievable SD's the 'pooled' SD's provided in this report include interlaboratory bias. This 'one size fits all' approach may require revision at the discretion of the QC manager concerned following careful scrutiny of QC control charts.

The performance gates shown in Table 1 are intended only to be used as a preliminary 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, SD's should be calculated directly from your own laboratory's process. This will enable you to establish more specific performance gates that are fit for purpose for your application as well as the ability to monitor bias. If your long-term trend analysis shows an average value that is within the 95% expanded uncertainty then generally there is no cause for concern in regard to bias.

For use with the aqua regia digestion method

It is important to note that in the analytical industry there is no standardisation of the aqua regia digestion process. This method is a partial empirical digest and differences in recoveries for various analytes are commonplace. These are caused by variations in the digest conditions and can include the ratio of nitric to hydrochloric acids, acid strength, temperatures, leach times and secondary digestions. Recoveries for sulphide-hosted base metal sulphides approach total values, however, other analytes, in particular the lithophile elements, show greater sensitivity to method parameters. This can result in lack of consensus in an inter-laboratory certification program for these elements.

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

LEGAL NOTICE

Ore Research & Exploration Pty Ltd has prepared and statistically evaluated the property values of this reference material to the best of its ability. The Purchaser by receipt hereof releases and indemnifies Ore Research & Exploration Pty Ltd from and against all liability and costs arising from the use of this material and information.

DOCUMENT HISTORY

Revision No.	Date	Changes applied
1	1 st September, 2023	Added M&T and Minerology data.
0	7 th November, 2022	First publication.

QMS ACCREDITATION

ORE Pty Ltd is accredited for compliance with ISO 17034.



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



CERTIFYING OFFICER



1st September, 2023

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

REFERENCES

- [1] Govett, G.J.S. (1983). Handbook of Exploration Geochemistry, Volume 2: Statistics and Data Analysis in Geochemical Prospecting (Variations of accuracy and precision).
- [2] Ingamells, C. O. and Switzer, P. (1973). A Proposed Sampling Constant for Use in Geochemical Analysis, Talanta 20, 547-568.
- [3] ISO Guide 30:2015. Terms and definitions used in connection with reference materials.
- [4] ISO Guide 31:2015. Reference materials – Contents of certificates and labels.
- [5] ISO Guide 35:2017. Certification of reference materials - General and statistical principals.
- [6] ISO Guide 98-3:2008. Guide to the expression of uncertainty in measurement (GUM:1995).
- [7] ISO 16269:2014. Statistical interpretation of data – Part 6: Determination of statistical tolerance intervals.
- [8] ISO/TR 16476:2016, Reference Materials – Establishing and expressing metrological traceability of quantity values assigned to reference materials.
- [9] ISO 17025:2017, General requirements for the competence of testing and calibration laboratories.
- [10] ISO Guide 17034:2016. General requirements for the competence of reference material producers.
- [11] Munsell Rock Color Book (2014). Rock-Color Chart Committee, Geological Society of America (GSA), 4300 44th Street SE, Grand Rapids, MI 49512.
- [12] OREAS-BUP-70-09-11: Statistical Analysis - OREAS Evaluation Method.
- [13] OREAS-TN-04-1498: Stability under transport; an experimental study of OREAS CRMs.
- [14] OREAS-TN-05-1674: Long-term storage stability; an experimental study of OREAS CRMs.
- [15] Thompson, A.; Taylor, B.N.; Guide for the Use of the International System of Units (SI); NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (2008); available at: <https://physics.nist.gov/cuu/pdf/sp811.pdf> (accessed Nov 2021).
- [16] Van der Veen AMH and Pauwels, J. (2001), Accred Qual Assur 6: 290-294.