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CERTIFICATE OF ANALYSIS FOR

PORPHYRY COPPER-GOLD ORE

(Ridgeway/Northparkes Mines, New South Wales, Australia)

CERTIFIED REFERENCE MATERIAL

OREAS 501d

Summary Statistics for ^Key Analytes.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Pb Fire Assay						
Au, Gold (ppm)	0.232	0.010	0.228	0.235	0.230*	0.233*
Aqua Regia Digestion (sample weights 10-50g)						
Au, Gold (ppm)	0.230	0.011	0.228	0.237	0.231*	0.234*
Infrared Combustion						
S, Sulphur (wt.%)	0.375	0.016	0.367	0.383	0.366	0.385
4-Acid Digestion						
Ag, Silver (ppm)	0.664	0.053	0.635	0.693	0.644	0.684
Cu, Copper (wt.%)	0.272	0.009	0.268	0.276	0.269	0.276
Mo, Molybdenum (ppm)	95	6.9	92	98	93	97

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

^See Table 1 below for complete list of certified analytes;

*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).

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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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	0.232	0.011	0.210	0.253	0.200	0.264	4.61%	9.22%	13.83%	0.220	0.243
Aqua Regia Digestion (sample weights 10-50g)											
Au, ppm	0.232	0.010	0.213	0.252	0.204	0.261	4.10%	8.19%	12.29%	0.221	0.244
Infrared Combustion											
S, wt.%	0.375	0.016	0.344	0.407	0.328	0.423	4.21%	8.41%	12.62%	0.357	0.394
4-Acid Digestion											
Ag, ppm	0.664	0.053	0.559	0.769	0.506	0.822	7.93%	15.85%	23.78%	0.631	0.697
Al, wt.%	7.69	0.247	7.20	8.18	6.95	8.43	3.21%	6.43%	9.64%	7.31	8.07
As, ppm	15.1	2.0	11.1	19.1	9.1	21.1	13.18%	26.36%	39.54%	14.3	15.9
Ba, ppm	1032	36	961	1103	925	1139	3.45%	6.91%	10.36%	981	1084
Be, ppm	2.65	0.29	2.07	3.23	1.78	3.52	10.92%	21.85%	32.77%	2.52	2.79
Bi, ppm	1.26	0.14	0.98	1.53	0.85	1.66	10.82%	21.64%	32.46%	1.19	1.32
Ca, wt.%	1.85	0.050	1.75	1.95	1.70	2.00	2.70%	5.40%	8.10%	1.76	1.95
Cd, ppm	0.30	0.03	0.24	0.36	0.21	0.39	10.07%	20.14%	30.20%	0.28	0.31
Ce, ppm	73	5.6	62	84	56	90	7.68%	15.36%	23.03%	70	77
Co, ppm	9.57	0.636	8.30	10.84	7.66	11.48	6.65%	13.30%	19.95%	9.09	10.05
Cr, ppm	45.4	5.5	34.4	56.3	28.9	61.8	12.07%	24.13%	36.20%	43.1	47.6
Cs, ppm	10.7	0.93	8.9	12.6	7.9	13.5	8.66%	17.32%	25.98%	10.2	11.3
Cu, wt.%	0.272	0.009	0.255	0.290	0.246	0.299	3.22%	6.44%	9.66%	0.259	0.286
Dy, ppm	3.76	0.315	3.13	4.39	2.82	4.71	8.37%	16.74%	25.12%	3.57	3.95
Er, ppm	1.49	0.19	1.11	1.88	0.92	2.07	12.86%	25.72%	38.58%	1.42	1.57
Eu, ppm	1.44	0.101	1.23	1.64	1.13	1.74	7.03%	14.06%	21.09%	1.36	1.51
Fe, wt.%	3.37	0.123	3.13	3.62	3.00	3.74	3.66%	7.32%	10.98%	3.20	3.54
Ga, ppm	20.8	1.09	18.6	22.9	17.5	24.0	5.23%	10.46%	15.68%	19.7	21.8
Gd, ppm	5.89	0.444	5.00	6.78	4.56	7.22	7.54%	15.08%	22.63%	5.60	6.19
Hf, ppm	2.00	0.31	1.38	2.63	1.07	2.94	15.55%	31.10%	46.66%	1.90	2.10
Ho, ppm	0.62	0.059	0.50	0.74	0.45	0.80	9.43%	18.85%	28.28%	0.59	0.65
In, ppm	0.086	0.007	0.072	0.100	0.065	0.107	8.09%	16.18%	24.26%	0.081	0.090
K, wt.%	3.01	0.103	2.80	3.21	2.70	3.32	3.43%	6.86%	10.28%	2.86	3.16
La, ppm	34.8	2.83	29.1	40.4	26.3	43.3	8.15%	16.30%	24.45%	33.0	36.5
Li, ppm	51	2.8	46	57	43	60	5.49%	10.97%	16.46%	49	54
Lu, ppm	0.19	0.018	0.15	0.22	0.13	0.24	9.54%	19.08%	28.62%	0.18	0.19
Mg, wt.%	0.827	0.028	0.771	0.883	0.743	0.911	3.40%	6.79%	10.19%	0.786	0.868
Mn, wt.%	0.037	0.001	0.035	0.039	0.034	0.040	2.75%	5.49%	8.24%	0.035	0.039
Mo, ppm	95	6.9	81	109	74	115	7.30%	14.60%	21.90%	90	99
Na, wt.%	2.07	0.056	1.96	2.19	1.91	2.24	2.70%	5.39%	8.09%	1.97	2.18
Nb, ppm	12.2	0.52	11.1	13.2	10.6	13.7	4.30%	8.60%	12.90%	11.6	12.8
Nd, ppm	32.6	2.87	26.8	38.3	24.0	41.2	8.80%	17.60%	26.40%	30.9	34.2
Ni, wt.%	0.002	0.000	0.002	0.002	0.002	0.003	8.09%	16.19%	24.28%	0.002	0.002
P, wt.%	0.087	0.004	0.078	0.095	0.074	0.099	5.00%	10.00%	15.01%	0.082	0.091

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											
Pb, ppm	25.2	0.75	23.7	26.7	22.9	27.5	2.99%	5.99%	8.98%	23.9	26.5
Pr, ppm	8.37	0.804	6.76	9.98	5.96	10.78	9.60%	19.21%	28.81%	7.95	8.79
Rb, ppm	164	5	154	174	149	178	2.97%	5.95%	8.92%	156	172
Re, ppm	0.049	0.003	0.042	0.055	0.039	0.058	6.52%	13.03%	19.55%	0.046	0.051
S, wt.%	0.380	0.022	0.336	0.425	0.314	0.447	5.85%	11.71%	17.56%	0.361	0.399
Sb, ppm	2.25	0.193	1.86	2.63	1.67	2.83	8.59%	17.18%	25.78%	2.14	2.36
Sc, ppm	9.47	0.598	8.28	10.67	7.68	11.27	6.32%	12.63%	18.95%	9.00	9.95
Sm, ppm	6.79	0.517	5.75	7.82	5.24	8.34	7.62%	15.23%	22.85%	6.45	7.13
Sn, ppm	4.86	0.282	4.30	5.43	4.01	5.71	5.80%	11.61%	17.41%	4.62	5.10
Sr, ppm	212	7	198	226	191	233	3.31%	6.63%	9.94%	201	223
Ta, ppm	1.09	0.058	0.97	1.20	0.91	1.26	5.33%	10.66%	16.00%	1.03	1.14
Tb, ppm	0.76	0.08	0.61	0.92	0.53	1.00	10.15%	20.30%	30.46%	0.73	0.80
Th, ppm	14.0	1.13	11.7	16.2	10.6	17.4	8.06%	16.11%	24.17%	13.3	14.7
Ti, wt.%	0.359	0.012	0.335	0.383	0.323	0.395	3.32%	6.64%	9.96%	0.341	0.377
Tl, ppm	0.91	0.040	0.84	0.99	0.80	1.03	4.33%	8.67%	13.00%	0.87	0.96
Tm, ppm	0.19	0.02	0.15	0.24	0.13	0.26	10.65%	21.30%	31.94%	0.19	0.20
U, ppm	3.88	0.48	2.91	4.84	2.43	5.32	12.43%	24.87%	37.30%	3.68	4.07
V, ppm	71	1.3	69	74	67	75	1.84%	3.69%	5.53%	68	75
W, ppm	8.56	0.773	7.01	10.10	6.24	10.87	9.03%	18.07%	27.10%	8.13	8.98
Y, ppm	15.7	1.38	13.0	18.5	11.6	19.9	8.78%	17.55%	26.33%	15.0	16.5
Yb, ppm	1.22	0.120	0.98	1.46	0.85	1.58	9.89%	19.78%	29.67%	1.15	1.28
Zn, ppm	90	3.3	84	97	80	100	3.69%	7.38%	11.07%	86	95
Zr, ppm	62	9	44	80	35	89	14.53%	29.06%	43.59%	59	65
Pb, ppm	25.2	0.75	23.7	26.7	22.9	27.5	2.99%	5.99%	8.98%	23.9	26.5
Aqua Regia Digestion											
Ag, ppm	0.649	0.045	0.560	0.739	0.515	0.784	6.92%	13.83%	20.75%	0.617	0.682
Al, wt.%	1.96	0.145	1.67	2.25	1.53	2.40	7.38%	14.76%	22.15%	1.87	2.06
As, ppm	14.1	0.92	12.3	16.0	11.4	16.9	6.47%	12.94%	19.40%	13.4	14.9
B, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Ba, ppm	468	41	385	551	344	593	8.86%	17.73%	26.59%	445	492
Be, ppm	1.46	0.17	1.11	1.81	0.94	1.98	11.89%	23.78%	35.68%	1.39	1.53
Bi, ppm	1.30	0.113	1.08	1.53	0.96	1.64	8.66%	17.32%	25.98%	1.24	1.37
Ca, wt.%	0.580	0.050	0.479	0.681	0.428	0.731	8.71%	17.41%	26.12%	0.551	0.609
Cd, ppm	0.18	0.02	0.13	0.22	0.11	0.24	12.83%	25.65%	38.48%	0.17	0.18
Ce, ppm	29.1	5.4	18.3	39.9	12.9	45.4	18.59%	37.19%	55.78%	27.7	30.6
Co, ppm	9.28	0.551	8.18	10.39	7.63	10.94	5.94%	11.87%	17.81%	8.82	9.75
Cr, ppm	48.5	1.57	45.4	51.7	43.8	53.2	3.23%	6.47%	9.70%	46.1	51.0
Cs, ppm	8.35	0.740	6.87	9.83	6.13	10.57	8.86%	17.72%	26.59%	7.93	8.77
Cu, wt.%	0.270	0.006	0.259	0.281	0.253	0.287	2.08%	4.16%	6.23%	0.257	0.284
Dy, ppm	2.31	0.179	1.95	2.67	1.77	2.85	7.76%	15.53%	23.29%	2.19	2.42

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											
Er, ppm	0.89	0.059	0.77	1.00	0.71	1.06	6.66%	13.33%	19.99%	0.84	0.93
Eu, ppm	0.32	0.05	0.22	0.42	0.18	0.46	15.06%	30.11%	45.17%	0.30	0.34
Fe, wt.%	3.24	0.150	2.94	3.54	2.79	3.69	4.63%	9.26%	13.89%	3.08	3.40
Ga, ppm	9.21	0.523	8.17	10.26	7.64	10.78	5.68%	11.35%	17.03%	8.75	9.67
Gd, ppm	3.02	0.33	2.36	3.68	2.03	4.01	10.93%	21.86%	32.80%	2.87	3.17
Hf, ppm	0.29	0.016	0.26	0.33	0.25	0.34	5.37%	10.74%	16.11%	0.28	0.31
Ho, ppm	0.39	0.05	0.28	0.50	0.23	0.55	13.86%	27.73%	41.59%	0.37	0.41
In, ppm	0.074	0.007	0.061	0.088	0.054	0.095	9.12%	18.24%	27.35%	0.071	0.078
K, wt.%	0.938	0.065	0.809	1.067	0.744	1.132	6.89%	13.78%	20.67%	0.891	0.985
La, ppm	13.6	2.5	8.5	18.6	5.9	21.2	18.76%	37.51%	56.27%	12.9	14.2
Li, ppm	40.8	4.1	32.6	48.9	28.5	53.0	10.02%	20.04%	30.07%	38.7	42.8
Mg, wt.%	0.761	0.024	0.713	0.808	0.689	0.832	3.13%	6.27%	9.40%	0.723	0.799
Mn, wt.%	0.031	0.001	0.028	0.034	0.027	0.035	4.43%	8.86%	13.30%	0.030	0.033
Mo, ppm	93	5.2	83	104	78	109	5.56%	11.12%	16.67%	89	98
Na, wt.%	0.146	0.017	0.112	0.180	0.095	0.197	11.70%	23.40%	35.11%	0.139	0.153
Nb, ppm	0.75	0.25	0.25	1.26	0.00	1.51	33.48%	66.97%	100.45 %	0.72	0.79
Ni, wt.%	0.002	0.000	0.002	0.002	0.002	0.002	4.69%	9.37%	14.06%	0.002	0.002
P, wt.%	0.066	0.003	0.061	0.072	0.058	0.075	4.16%	8.32%	12.49%	0.063	0.070
Pb, ppm	7.08	0.609	5.86	8.30	5.25	8.91	8.61%	17.22%	25.83%	6.73	7.43
Pr, ppm	3.30	0.72	1.85	4.75	1.12	5.47	21.98%	43.96%	65.95%	3.13	3.46
Pt, ppb	< 5	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Rb, ppm	94	7.9	79	110	71	118	8.42%	16.83%	25.25%	90	99
Re, ppm	0.047	0.003	0.041	0.054	0.038	0.057	6.74%	13.49%	20.23%	0.045	0.050
S, wt.%	0.383	0.026	0.331	0.435	0.305	0.461	6.76%	13.53%	20.29%	0.364	0.402
Sb, ppm	1.58	0.26	1.05	2.10	0.79	2.36	16.65%	33.29%	49.94%	1.50	1.65
Sc, ppm	8.00	0.528	6.94	9.05	6.41	9.58	6.60%	13.20%	19.80%	7.60	8.40
Sm, ppm	3.13	0.59	1.95	4.31	1.36	4.90	18.87%	37.75%	56.62%	2.97	3.29
Sn, ppm	3.47	0.228	3.01	3.92	2.78	4.15	6.59%	13.18%	19.77%	3.29	3.64
Sr, ppm	40.8	2.72	35.4	46.2	32.7	48.9	6.66%	13.31%	19.97%	38.8	42.8
Tb, ppm	0.45	0.06	0.34	0.56	0.28	0.62	12.43%	24.87%	37.30%	0.43	0.47
Te, ppm	0.20	0.03	0.15	0.25	0.12	0.27	12.75%	25.50%	38.25%	0.19	0.21
Ti, wt.%	0.265	0.013	0.240	0.290	0.227	0.303	4.76%	9.52%	14.28%	0.252	0.278
Tl, ppm	0.60	0.036	0.52	0.67	0.49	0.71	6.11%	12.22%	18.32%	0.57	0.63
Tm, ppm	0.13	0.02	0.08	0.18	0.06	0.20	18.75%	37.49%	56.24%	0.12	0.13
U, ppm	3.32	0.249	2.82	3.81	2.57	4.06	7.50%	15.00%	22.50%	3.15	3.48
V, ppm	65	3.6	58	72	54	76	5.49%	10.97%	16.46%	62	68
W, ppm	5.36	0.450	4.46	6.26	4.01	6.71	8.40%	16.80%	25.20%	5.09	5.62
Y, ppm	10.2	0.72	8.8	11.7	8.1	12.4	7.03%	14.06%	21.09%	9.7	10.8
Yb, ppm	0.75	0.047	0.65	0.84	0.61	0.89	6.30%	12.61%	18.91%	0.71	0.79
Zn, ppm	86	2.6	80	91	78	93	3.02%	6.03%	9.05%	81	90

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.

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 presents the 116 certified values together with their associated 1SD's, 95% confidence and tolerance limits. Table 2 shows 16 indicative values for major and trace element composition. Table 4 provides some indicative physical properties and Table 5 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 501d-DataPack.1.0.210512_111756.xlsx**).

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

SOURCE MATERIAL

OREAS 501d 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 Ridgeway 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.

Mineralisations in the Northparkes and Ridgeway regions are quite similar and hosted by a sequence of late Ordovician to Early Silurian volcanics, intrusives and sediments that occur within the Bogan Gate Synclinorial 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) ± 10%.

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

Table 2. Indicative Values for OREAS 501d.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Infrared Combustion								
C	wt.%	*0.105*						
4-Acid Digestion								
B	ppm	*22.8*	Hg	ppm	*0.16*	Te	ppm	*0.24*
Ge	ppm	*0.89*	Se	ppm	*2.18*			
Aqua Regia Digestion								
Ge	ppm	*0.11*	Pd	ppb	*< 10*	Ta	ppm	*< 0.01*
Hg	ppm	*0.023*	Ru	ppm	*< 0.005*	Th	ppm	*5.97*
Lu	ppm	*0.099*	Se	ppm	*2.00*	Zr	ppm	*7.66*
Nd	ppm	*13.1*	Si	wt.%	*0.034*			

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.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 501d was prepared in the following manner:

- Drying of ores 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 ore, granodiorite and concentrate in appropriate proportions to achieve target grades;
- Homogenisation;
- Packaging into 10 and 60g units in laminated foil pouches and 500g units in plastic jars.

PHYSICAL PROPERTIES

OREAS 501d 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 501d.

Bulk Density (g/L)	Moisture%	Munsell Notation‡	Munsell Color‡
605	0.7	5Y 6/1	Light OliveGray

‡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

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

- Gold by instrumental neutron activation analysis (INAA) on 20 x 85mg subsamples to confirm homogeneity (1 laboratory only: ANSTO, Lucas Heights, Australia);
- Gold via 25-40g fire assay with AAS finish (10 laboratories), ICP-OES or ICP-MS (10 laboratories) finish;
- Gold via 15-50g aqua regia digestion with ICP OES or MS finish (10 laboratories) and AAS (3 laboratories) finish;
- Total Sulphur by infrared combustion furnace (19 laboratories);
- 4-Acid digestion for full elemental suite ICP-OES/MS finish (up to 20 laboratories depending on the element);
- Aqua regia digestion for full elemental suite ICP-OES/MS and AAS finish (up to 20 laboratories depending on the element).

For the round robin program ten 1.5kg test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire prepared batch. Six 120g pulp samples were submitted to each laboratory for analysis received by each laboratory were obtained by taking two 120g samples from each of three separate 1.5kg 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.

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

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

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 501d (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.

Table 4. 95% Confidence & Tolerance Limits for OREAS 501d.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
Pb Fire Assay					
Au, Gold (ppm)	0.232	0.228	0.235	0.230*	0.233*
Aqua Regia Digestion (sample weights 10-50g)					
Au, Gold (ppm)	0.232	0.228	0.237	0.231*	0.234*
Infrared Combustion					
S, Sulphur (wt.%)	0.375	0.367	0.383	0.366	0.385
4-Acid Digestion					
Ag, Silver (ppm)	0.664	0.635	0.693	0.644	0.684
Al, Aluminium (wt.%)	7.69	7.58	7.81	7.53	7.86
As, Arsenic (ppm)	15.1	13.8	16.4	14.5	15.7
Ba, Barium (ppm)	1032	1015	1049	1012	1052
Be, Beryllium (ppm)	2.65	2.52	2.79	2.51	2.80
Bi, Bismuth (ppm)	1.26	1.19	1.32	1.15	1.37
Ca, Calcium (wt.%)	1.85	1.83	1.88	1.82	1.89
Cd, Cadmium (ppm)	0.30	0.28	0.31	0.27	0.32
Ce, Cerium (ppm)	73	70	76	70	76
Co, Cobalt (ppm)	9.57	9.23	9.91	9.24	9.90
Cr, Chromium (ppm)	45.4	42.8	48.0	43.6	47.2
Cs, Caesium (ppm)	10.7	10.2	11.2	10.5	11.0
Cu, Copper (wt.%)	0.272	0.268	0.276	0.269	0.276
Dy, Dysprosium (ppm)	3.76	3.53	3.99	3.60	3.92
Er, Erbium (ppm)	1.49	1.34	1.64	1.41	1.58
Eu, Europium (ppm)	1.44	1.33	1.55	1.37	1.51
Fe, Iron (wt.%)	3.37	3.31	3.43	3.32	3.43
Ga, Gallium (ppm)	20.8	20.2	21.3	20.2	21.4
Gd, Gadolinium (ppm)	5.89	5.56	6.23	5.63	6.16
Hf, Hafnium (ppm)	2.00	1.86	2.15	1.92	2.08
Ho, Holmium (ppm)	0.62	0.56	0.68	0.59	0.66
In, Indium (ppm)	0.086	0.082	0.089	0.078	0.094
K, Potassium (wt.%)	3.01	2.96	3.06	2.93	3.09
La, Lanthanum (ppm)	34.8	33.3	36.2	33.2	36.3

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, 25g aqua regia digestion and 200g cyanide leach 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					
Li, Lithium (ppm)	51	50	53	50	53
Lu, Lutetium (ppm)	0.19	0.17	0.20	IND	IND
Mg, Magnesium (wt.%)	0.827	0.815	0.839	0.814	0.840
Mn, Manganese (wt.%)	0.037	0.037	0.038	0.036	0.038
Mo, Molybdenum (ppm)	95	92	98	93	97
Na, Sodium (wt.%)	2.07	2.05	2.10	2.04	2.11
Nb, Niobium (ppm)	12.2	11.9	12.4	11.9	12.5
Nd, Neodymium (ppm)	32.6	30.5	34.6	31.1	34.0
Ni, Nickel (wt.%)	0.002	0.002	0.002	0.002	0.002
P, Phosphorus (wt.%)	0.087	0.084	0.089	0.084	0.089
Pb, Lead (ppm)	25.2	24.9	25.5	24.6	25.8
Pr, Praseodymium (ppm)	8.37	7.79	8.95	7.91	8.83
Rb, Rubidium (ppm)	164	161	166	160	168
Re, Rhenium (ppm)	0.049	0.048	0.050	0.045	0.052
S, Sulphur (wt.%)	0.380	0.370	0.391	0.370	0.391
Sb, Antimony (ppm)	2.25	2.15	2.34	2.11	2.39
Sc, Scandium (ppm)	9.47	9.15	9.79	9.02	9.93
Sm, Samarium (ppm)	6.79	6.42	7.15	6.44	7.14
Sn, Tin (ppm)	4.86	4.73	4.99	4.68	5.04
Sr, Strontium (ppm)	212	209	215	208	216
Ta, Tantalum (ppm)	1.09	1.05	1.12	1.05	1.12
Tb, Terbium (ppm)	0.76	0.69	0.84	0.72	0.80
Th, Thorium (ppm)	14.0	13.4	14.6	13.5	14.5
Ti, Titanium (wt.%)	0.359	0.354	0.365	0.352	0.366
Tl, Thallium (ppm)	0.91	0.89	0.93	0.89	0.94
Tm, Thulium (ppm)	0.19	0.17	0.22	0.17	0.22
U, Uranium (ppm)	3.88	3.68	4.08	3.63	4.12
V, Vanadium (ppm)	71	71	72	70	73
W, Tungsten (ppm)	8.56	8.25	8.87	7.92	9.19
Y, Yttrium (ppm)	15.7	15.0	16.5	15.1	16.4
Yb, Ytterbium (ppm)	1.22	1.12	1.32	1.18	1.25
Zn, Zinc (ppm)	90	89	92	88	93
Zr, Zirconium (ppm)	62	58	66	60	65
Aqua Regia Digestion					
Ag, Silver (ppm)	0.649	0.626	0.673	0.625	0.674
Al, Aluminium (wt.%)	1.96	1.89	2.03	1.92	2.01
As, Arsenic (ppm)	14.1	13.5	14.8	13.6	14.7
B, Boron (ppm)	< 10	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; IND = indeterminate.

Table 4 continued.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
Aqua Regia Digestion continued					
Ba, Barium (ppm)	468	445	491	454	483
Be, Beryllium (ppm)	1.46	1.38	1.54	1.38	1.54
Bi, Bismuth (ppm)	1.30	1.25	1.35	1.22	1.38
Ca, Calcium (wt.%)	0.580	0.556	0.604	0.567	0.593
Cd, Cadmium (ppm)	0.18	0.17	0.19	0.15	0.20
Ce, Cerium (ppm)	29.1	25.8	32.5	28.1	30.2
Co, Cobalt (ppm)	9.28	9.00	9.57	9.02	9.55
Cr, Chromium (ppm)	48.5	47.8	49.2	47.1	50.0
Cs, Caesium (ppm)	8.35	7.96	8.74	8.14	8.56
Cu, Copper (wt.%)	0.270	0.268	0.272	0.266	0.275
Dy, Dysprosium (ppm)	2.31	2.11	2.51	2.26	2.36
Er, Erbium (ppm)	0.89	0.81	0.96	0.86	0.91
Eu, Europium (ppm)	0.32	0.27	0.37	0.32	0.32
Fe, Iron (wt.%)	3.24	3.17	3.31	3.18	3.31
Ga, Gallium (ppm)	9.21	8.92	9.50	8.95	9.48
Gd, Gadolinium (ppm)	3.02	2.64	3.40	2.92	3.12
Hf, Hafnium (ppm)	0.29	0.29	0.30	0.27	0.32
Ho, Holmium (ppm)	0.39	0.33	0.45	0.37	0.40
In, Indium (ppm)	0.074	0.071	0.077	0.068	0.081
K, Potassium (wt.%)	0.938	0.907	0.969	0.920	0.956
La, Lanthanum (ppm)	13.6	12.1	15.0	13.3	13.9
Li, Lithium (ppm)	40.8	38.7	42.8	39.6	41.9
Mg, Magnesium (wt.%)	0.761	0.750	0.771	0.745	0.776
Mn, Manganese (wt.%)	0.031	0.031	0.032	0.030	0.032
Mo, Molybdenum (ppm)	93	91	96	92	95
Na, Sodium (wt.%)	0.146	0.138	0.154	0.141	0.152
Nb, Niobium (ppm)	0.75	0.57	0.94	0.71	0.80
Ni, Nickel (wt.%)	0.002	0.002	0.002	0.002	0.002
P, Phosphorus (wt.%)	0.066	0.065	0.068	0.065	0.068
Pb, Lead (ppm)	7.08	6.75	7.41	6.79	7.37
Pr, Praseodymium (ppm)	3.30	2.48	4.11	3.20	3.40
Pt, Platinum (ppb)	< 5	IND	IND	IND	IND
Rb, Rubidium (ppm)	94	90	99	92	97
Re, Rhenium (ppm)	0.047	0.046	0.049	0.045	0.050
S, Sulphur (wt.%)	0.383	0.370	0.397	0.373	0.394
Sb, Antimony (ppm)	1.58	1.44	1.71	1.52	1.63
Sc, Scandium (ppm)	8.00	7.72	8.27	7.61	8.38
Sm, Samarium (ppm)	3.13	2.47	3.79	3.03	3.23

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; IND = indeterminate.

Table 4 continued.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
Aqua Regia Digestion continued					
Sn, Tin (ppm)	3.47	3.33	3.60	3.34	3.59
Sr, Strontium (ppm)	40.8	39.4	42.2	39.7	42.0
Tb, Terbium (ppm)	0.45	0.40	0.51	0.43	0.47
Te, Tellurium (ppm)	0.20	0.19	0.21	0.18	0.22
Ti, Titanium (wt.%)	0.265	0.258	0.271	0.259	0.271
Tl, Thallium (ppm)	0.60	0.58	0.62	0.58	0.62
Tm, Thulium (ppm)	0.13	0.10	0.16	IND	IND
U, Uranium (ppm)	3.32	3.22	3.42	3.15	3.49
V, Vanadium (ppm)	65	63	67	64	67
W, Tungsten (ppm)	5.36	5.10	5.62	5.06	5.65
Y, Yttrium (ppm)	10.2	9.9	10.6	10.0	10.5
Yb, Ytterbium (ppm)	0.75	0.70	0.80	0.68	0.81
Zn, Zinc (ppm)	86	84	87	84	87

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; IND = indeterminate.

Homogeneity Evaluation

For analytes other than gold the tolerance limits (ISO 16269:2014) shown in Table 4 were determined using an analysis of precision errors method and are considered a conservative estimate of true homogeneity. The meaning of tolerance limits may be illustrated for copper by 4-acid digestion, where 99% of the time (1-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 0.269 and 0.276 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 5 below shows the gold INAA data determined on 20 x 85mg subsamples of OREAS 501d. 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 0.21% was calculated for a 30g fire assay sample (3.94% at 85mg weights) and confirms the high level of gold homogeneity in OREAS 501d.

Table 5. Neutron Activation Analysis of Au (in ppm) on 20 x 85mg subsamples and showing the equivalent results scaled to a 30g sample mass typical of fire assay determination.

Replicate No	Au 85mg actual	Au 30g equivalent*
1	0.240	0.235
2	0.236	0.235
3	0.235	0.235
4	0.229	0.235
5	0.240	0.235
6	0.235	0.235
7	0.222	0.234
8	0.234	0.235
9	0.226	0.235
10	0.227	0.235
11	0.223	0.234
12	0.236	0.235
13	0.228	0.235
14	0.236	0.235
15	0.254	0.236
16	0.227	0.235
17	0.234	0.235
18	0.233	0.235
19	0.251	0.236
20	0.254	0.236
Mean	0.235	0.235
Median	0.235	0.235
Std Dev.	0.009	0.000
Rel.Std.Dev.	**3.94%**	**0.21%**

*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 501d 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 501d. The test was performed using the following parameters:

- Gold fire assay – 120 samples (20 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 78 samples (13 laboratories each providing analyses on 3 pairs of samples);
- Null Hypothesis, H_0: Between-unit variance is no greater than within-unit variance (reject H_0 if *p*-value < 0.05);
- Alternative Hypothesis, H_1: Between-unit variance is greater than within-unit variance.

P-values are a measure of probability where values less than 0.05 indicate a greater than 95% probability that the observed differences in within-unit and between-unit variances are real. The datasets were filtered for both individual and laboratory data set (batch) outliers prior to the calculation of the *p*-value. This process derived *p*-values of 0.99 for Au by fire assay, 0.99 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.

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 501d 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 501d is fit-for-purpose as a certified reference material (see ‘Intended Use’ below).

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. Actlabs, Ancaster, Ontario, Canada
3. AGAT Laboratories, Calgary, Alberta, Canada
4. ALS, Brisbane, QLD, Australia
5. ALS, Lima, Peru
6. ALS, Loughrea, Galway, Ireland
7. ALS, Perth, WA, Australia
8. ALS, Vancouver, BC, Canada
9. ALS, Vancouver, BC, Canada
10. American Assay Laboratories, Sparks, Nevada, USA
11. ANSTO, Lucas Heights, NSW, Australia
12. ARGETEST Mineral Processing, Ankara, Central Anatolia, Turkey
13. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
14. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
15. Intertek Genalysis, Adelaide, SA, Australia
16. Intertek Genalysis, Perth, WA, Australia
17. Intertek Testing Services, Townsville, QLD, Australia
18. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
19. Labtium Oy, Sodankyla, Finland
20. Labtium Oy, Sodankyla, Finland
21. MinAnalytical Services, Perth, WA, Australia

22. Nagrom, Perth, WA, Australia
23. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
24. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
25. SGS, Ankara, Anatolia, Turkey
26. SGS del Peru, Lima, Peru

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.

PREPARER AND SUPPLIER

Certified reference material OREAS 501d was prepared, certified and supplied by:

ORE Research & Exploration Pty Ltd
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AUSTRALIA

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Fax: +613-9729 8338
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Email: info@ore.com.au

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)."*

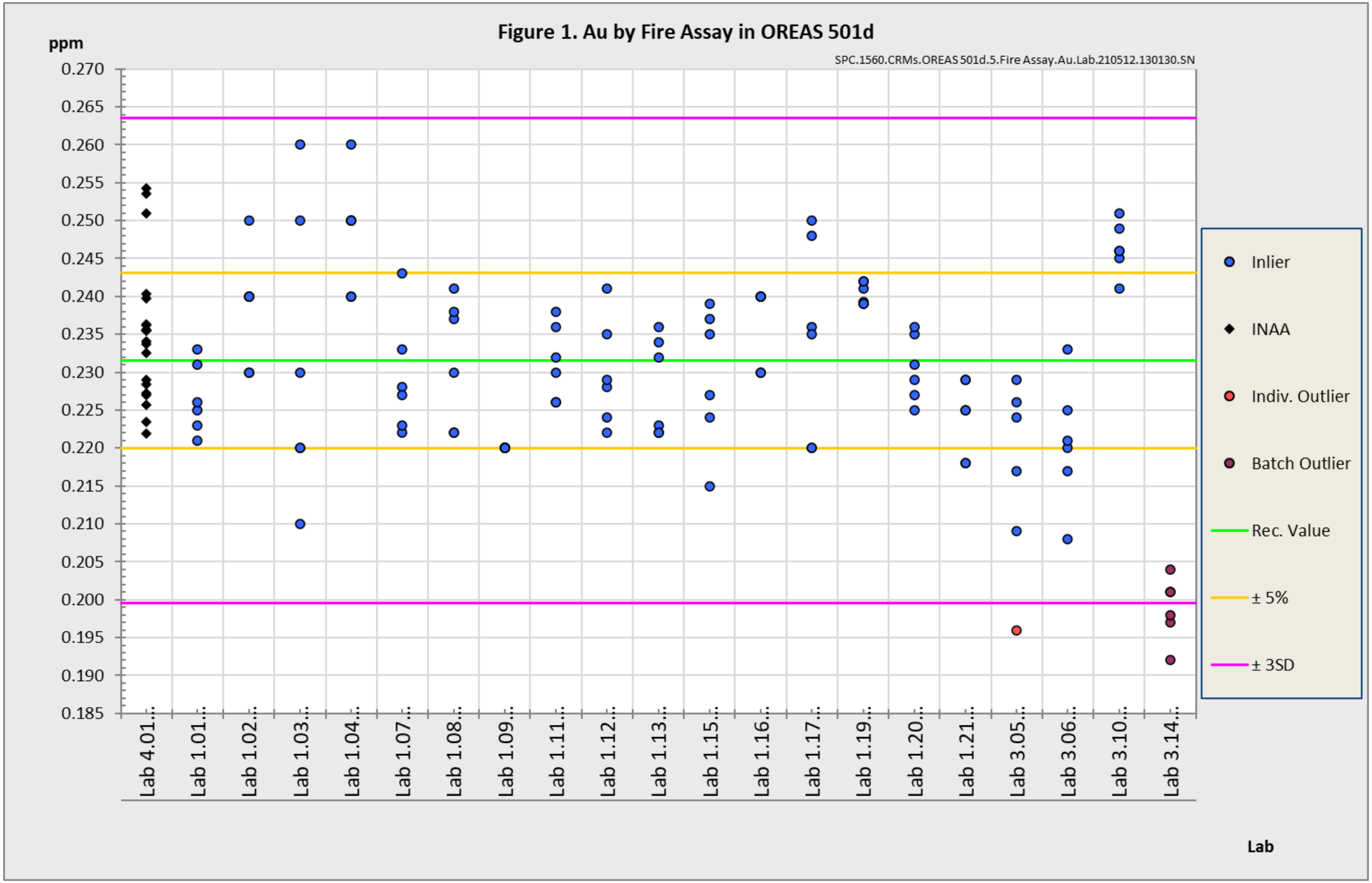

Figure 1. Au by Fire Assay in OREAS 501d

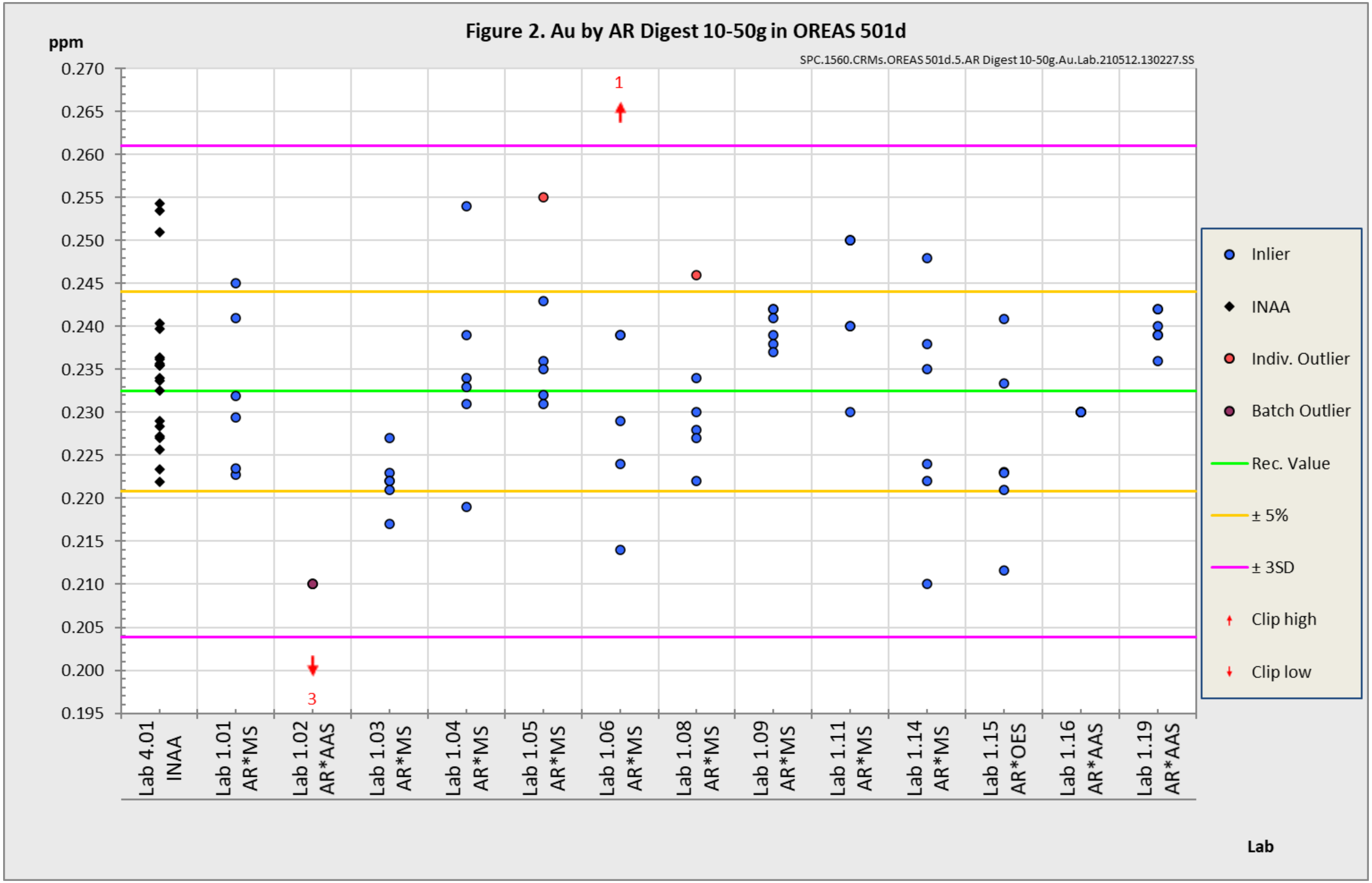

Figure 2. Au by AR Digest 10-50g in OREAS 501d

SPC.1560.CRMs.OREAS 501d.5.AR Digest 10-50g.Au.Lab.210512.130227.SS

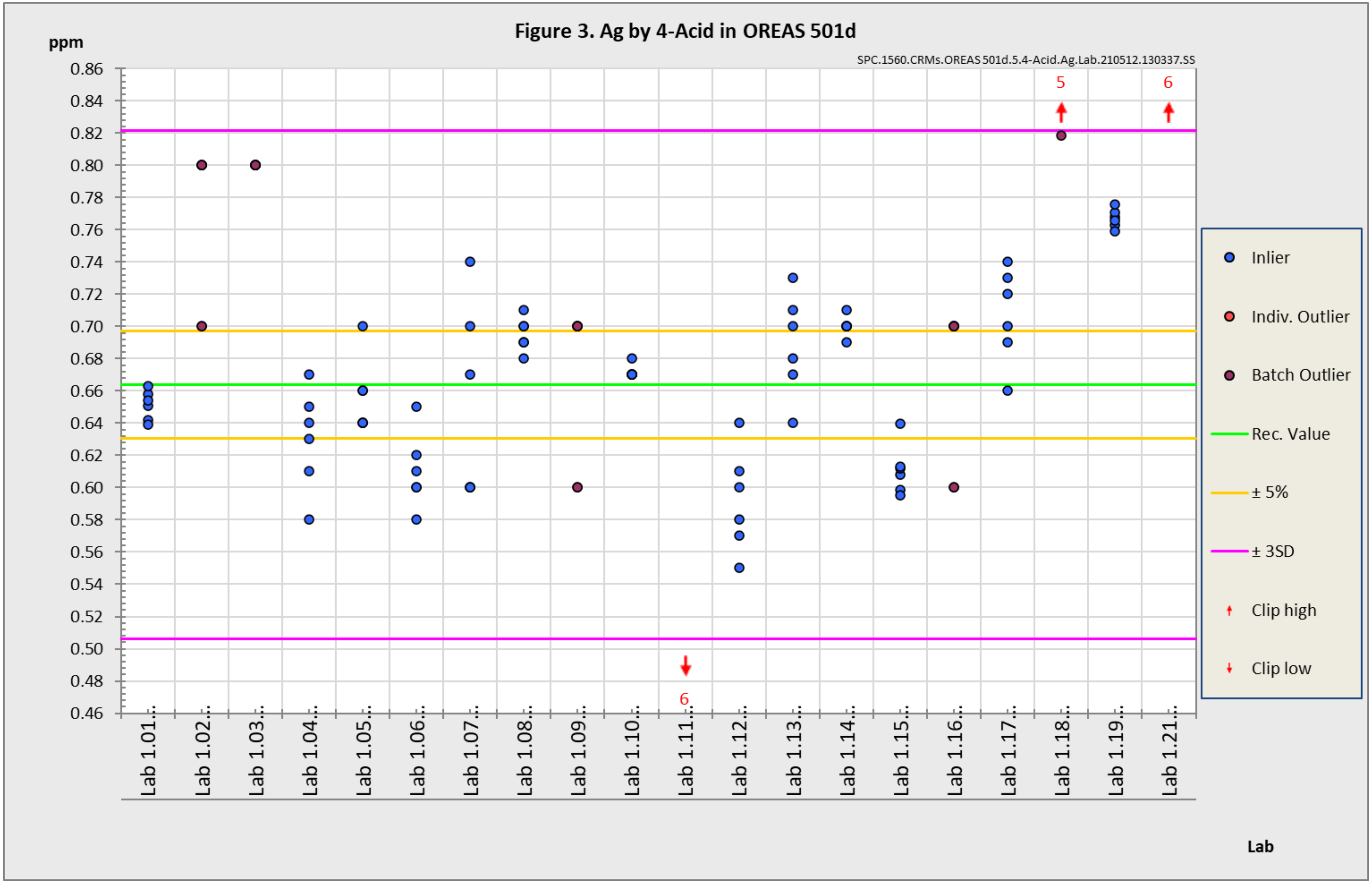

Figure 3. Ag by 4-Acid in OREAS 501d

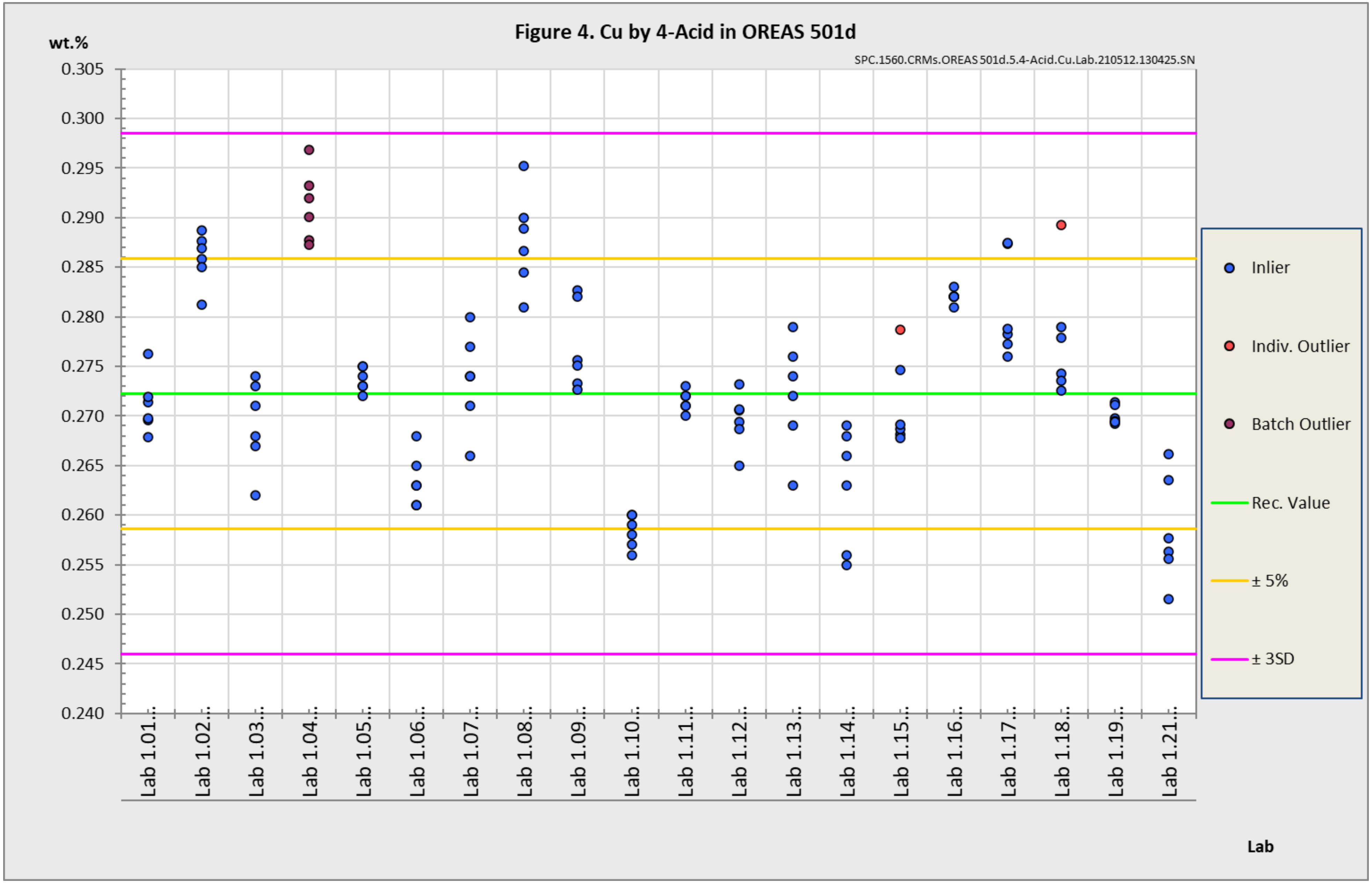

Figure 4. Cu by 4-Acid in OREAS 501d
SPC.1560.CRMs.OREAS 501d.5.4-Acid.Cu.Lab.210512.130425.SN
wt.%
0.305
0.300
0.295
0.290
0.285
0.280
0.275
0.270
0.265
0.260
0.255
0.250
0.245
0.240
Lab 1.01...
Lab 1.02...
Lab 1.03...
Lab 1.04...
Lab 1.05...
Lab 1.06...
Lab 1.07...
Lab 1.08...
Lab 1.09...
Lab 1.10...
Lab 1.11...
Lab 1.12...
Lab 1.13...
Lab 1.14...
Lab 1.15...
Lab 1.16...
Lab 1.17...
Lab 1.18...
Lab 1.19...
Lab 1.21...
Lab
Inlier
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD

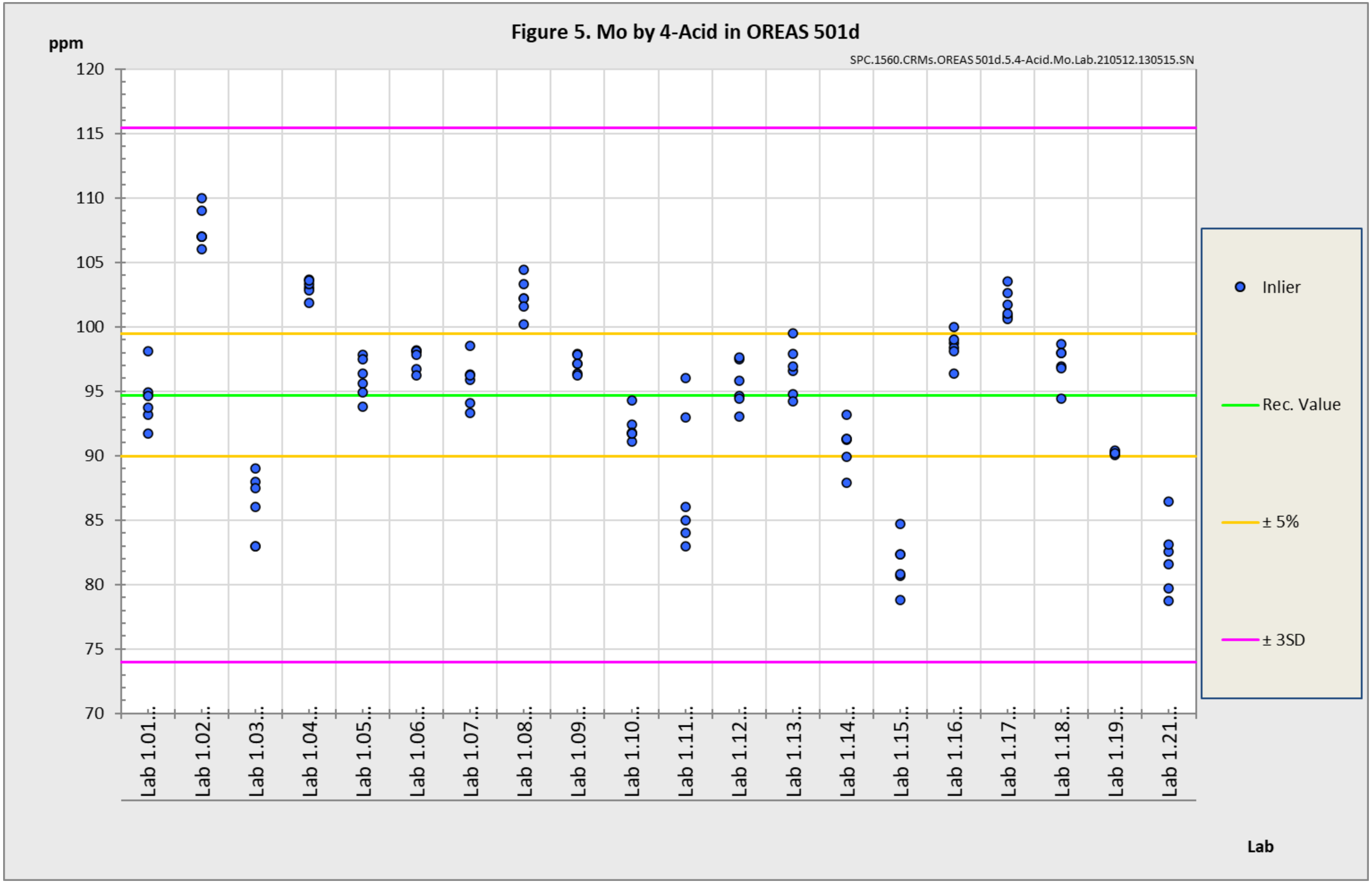
Figure 5. Mo by 4-Acid in OREAS 501d
ppm
SPC.1560.CRMs.OREAS 501d.5.4-Acid.Mo.Lab.210512.130515.SN
120
115
110
105
100
95
90
85
80
75
70
Lab 1.01...
Lab 1.02...
Lab 1.03...
Lab 1.04...
Lab 1.05...
Lab 1.06...
Lab 1.07...
Lab 1.08...
Lab 1.09...
Lab 1.10...
Lab 1.11...
Lab 1.12...
Lab 1.13...
Lab 1.14...
Lab 1.15...
Lab 1.16...
Lab 1.17...
Lab 1.18...
Lab 1.19...
Lab 1.21...
Inlier
Rec. Value
± 5%
± 3SD
Lab

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 501d 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 501d may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 501d 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 501d is low in reactive sulphide (0.38% 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.

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., 500g 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 501d given its low sulphur concentration (0.38 wt.% S).

Hygroscopic change is the amount of absorbed moisture (weakly held H_2O- molecules on the surface of exposed material) following exposure to the local atmosphere. Usually, equilibration of material to the local atmosphere will only occur if the material is spread into a thin (~2mm thick) layer and left exposed for a period of 2 hours. OREAS 501d 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 501d refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis. 500g jars permit repeated sampling as long as the lid is promptly re-secured to prevent airborne contamination.

Minimum sample size

As a practical guide, the minimum mass of sample used should match the typical mass that the laboratories used in the interlaboratory (round robin) certification program. This means that different sample masses should be used depending on the operationally defined methodology.

- Au by fire assay: ≥30g;
- Au by aqua regia digestion: ≥25g;
- S by infrared combustion furnace/CS analyser: ≥0.1g;
- 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	12th May, 2021	First publication.

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.

CERTIFYING OFFICER

12th May, 2021

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

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