ORE RESEARCH & EXPLORATION P/L ABN 28 006 859 856
37A Hosie Street · Bayswater North · VIC 3153 · AUSTRALIA
61 3 9729 0333 61 3 9729 8338
info@ore.com.au www.ore.com.au

CERTIFICATE OF ANALYSIS FOR

PORPHYRY COPPER-GOLD ORE

(Northparkes, New South Wales, Australia)

CERTIFIED REFERENCE MATERIAL

OREAS 505

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)	0.555	0.014	0.550	0.560	0.551*	0.559*
Aqua Regia Digestion (sample weights 10-50g)						
Au, Gold (ppm)	0.552	0.023	0.540	0.564	0.548*	0.556*
4-Acid Digestion						
Ag, Silver (ppm)	1.53	0.072	1.50	1.57	1.47	1.60
Cu, Copper (wt.%)	0.321	0.008	0.319	0.324	0.316	0.327
Mo, Molybdenum (ppm)	66	2.1	66	67	65	68

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

*Gold Tolerance Limits for typical 30g fire assay and 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.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Table 1. Certified Values, SDs, 95% Confidence & Tolerance Limits for OREAS 505.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Pb Fire Assay						
Au, Gold (ppm)	0.555	0.014	0.550	0.560	0.551*	0.559*
Aqua Regia Digestion (sample weights 10-50g)						
Au, Gold (ppm)	0.552	0.023	0.540	0.564	0.548*	0.556*
4-Acid Digestion						
Ag, Silver (ppm)	1.53	0.072	1.50	1.57	1.47	1.60
Al, Aluminium (wt.%)	7.45	0.422	7.27	7.62	7.30	7.59
As, Arsenic (ppm)	30.4	1.57	29.8	31.0	28.9	31.9
Ba, Barium (ppm)	1011	45	993	1029	990	1032
Be, Beryllium (ppm)	2.42	0.237	2.32	2.52	2.27	2.56
Bi, Bismuth (ppm)	2.52	0.152	2.44	2.59	2.39	2.64
Ca, Calcium (wt.%)	1.78	0.092	1.75	1.82	1.74	1.82
Cd, Cadmium (ppm)	0.30	0.04	0.28	0.31	0.27	0.32
Ce, Cerium (ppm)	67	4.7	65	69	65	70
Co, Cobalt (ppm)	8.39	0.263	8.29	8.49	8.12	8.67
Cr, Chromium (ppm)	42.4	6.4	39.7	45.0	40.7	44.0
Cs, Cesium (ppm)	9.70	0.431	9.49	9.91	9.38	10.02
Cu, Copper (wt.%)	0.321	0.008	0.319	0.324	0.316	0.327
Dy, Dysprosium (ppm)	3.74	0.122	3.67	3.80	3.57	3.90
Er, Erbium (ppm)	1.43	0.118	1.33	1.53	1.28	1.57
Eu, Europium (ppm)	1.20	0.111	1.09	1.31	1.08	1.33
Fe, Iron (wt.%)	3.34	0.095	3.30	3.37	3.27	3.40
Ga, Gallium (ppm)	19.6	0.73	19.4	19.9	19.0	20.2
Gd, Gadolinium (ppm)	5.63	0.364	5.31	5.96	5.42	5.85
Hf, Hafnium (ppm)	1.93	0.140	1.87	1.99	1.84	2.02
Ho, Holmium (ppm)	0.61	0.019	0.60	0.61	0.55	0.66
In, Indium (ppm)	0.10	0.009	0.10	0.11	0.10	0.11
K, Potassium (wt.%)	3.15	0.139	3.10	3.20	3.09	3.21
La, Lanthanum (ppm)	32.2	2.77	31.0	33.3	30.6	33.7
Li, Lithium (ppm)	46.5	2.21	45.7	47.2	44.8	48.1
Lu, Lutetium (ppm)	0.18	0.009	0.17	0.19	IND	IND
Mg, Magnesium (wt.%)	0.771	0.030	0.758	0.784	0.754	0.788
Mn, Manganese (wt.%)	0.036	0.001	0.035	0.036	0.035	0.037
Mo, Molybdenum (ppm)	66	2.1	66	67	65	68
Na, Sodium (wt.%)	2.14	0.069	2.11	2.17	2.10	2.18
Nb, Niobium (ppm)	11.7	0.55	11.4	12.0	11.4	12.0

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

*Gold Tolerance Limits for typical 30g fire assay and 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.

Table 1 continued.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
4-Acid Digestion continued						
Nd, Neodymium (ppm)	31.2	1.51	30.2	32.3	30.1	32.4
Ni, Nickel (ppm)	16.5	0.79	16.2	16.7	15.7	17.2
P, Phosphorus (wt.%)	0.086	0.003	0.085	0.087	0.083	0.088
Pb, Lead (ppm)	26.7	2.7	25.5	27.8	25.1	28.3
Pr, Praseodymium (ppm)	8.14	0.374	7.90	8.37	7.77	8.51
Rb, Rubidium (ppm)	152	8	148	155	147	156
Re, Rhenium (ppb)	54.2	4.2	52.9	55.6	48.9	59.5
S, Sulphur (wt.%)	0.446	0.019	0.439	0.452	0.434	0.458
Sb, Antimony (ppm)	3.50	0.147	3.44	3.56	3.35	3.65
Sc, Scandium (ppm)	8.81	0.500	8.57	9.04	8.49	9.12
Se, Selenium (ppm)	4.39	0.57	4.18	4.61	4.08	4.71
Sm, Samarium (ppm)	6.56	0.328	6.32	6.79	6.20	6.92
Sn, Tin (ppm)	4.94	0.253	4.83	5.04	4.75	5.12
Sr, Strontium (ppm)	253	10	249	256	246	259
Ta, Tantalum (ppm)	1.02	0.101	0.97	1.07	0.97	1.07
Tb, Terbium (ppm)	0.75	0.041	0.72	0.79	0.71	0.80
Te, Tellurium (ppm)	0.57	0.06	0.54	0.60	0.50	0.63
Th, Thorium (ppm)	12.9	0.84	12.6	13.3	12.2	13.7
Ti, Titanium (wt.%)	0.340	0.012	0.335	0.345	0.331	0.348
Tl, Thallium (ppm)	0.86	0.047	0.84	0.88	0.82	0.89
Tm, Thulium (ppm)	0.20	0.009	0.19	0.20	IND	IND
U, Uranium (ppm)	3.66	0.37	3.55	3.77	3.28	4.04
V, Vanadium (ppm)	72	2.5	71	73	70	74
W, Tungsten (ppm)	8.49	0.754	8.24	8.75	7.96	9.03
Y, Yttrium (ppm)	15.1	0.68	14.9	15.4	14.7	15.6
Yb, Ytterbium (ppm)	1.17	0.12	1.10	1.25	1.14	1.21
Zn, Zinc (ppm)	88	4.4	86	89	85	90
Zr, Zirconium (ppm)	63	4.7	61	65	61	65
Aqua Regia Digestion						
Ag, Silver (ppm)	1.53	0.110	1.47	1.59	1.47	1.59
Al, Aluminium (wt.%)	1.88	0.119	1.83	1.93	1.84	1.91
As, Arsenic (ppm)	29.8	1.81	29.1	30.4	28.9	30.6
Ba, Barium (ppm)	495	18	487	503	481	509
Be, Beryllium (ppm)	1.41	0.19	1.32	1.50	1.34	1.47
Bi, Bismuth (ppm)	2.60	0.181	2.52	2.68	2.51	2.69
Ca, Calcium (wt.%)	0.714	0.043	0.696	0.732	0.699	0.729

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	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Aqua Regia Digestion continued						
Cd, Cadmium (ppm)	0.20	0.03	0.19	0.22	0.18	0.22
Ce, Cerium (ppm)	31.6	5.0	28.9	34.4	30.8	32.5
Co, Cobalt (ppm)	8.14	0.531	7.89	8.39	7.95	8.33
Cr, Chromium (ppm)	51	3.5	50	52	49	53
Cs, Cesium (ppm)	8.30	0.233	8.18	8.42	8.13	8.46
Cu, Copper (wt.%)	0.323	0.010	0.319	0.327	0.318	0.327
Dy, Dysprosium (ppm)	2.49	0.31	2.21	2.77	2.43	2.55
Er, Erbium (ppm)	0.98	0.079	0.91	1.04	0.93	1.02
Eu, Europium (ppm)	0.32	0.020	0.30	0.34	0.30	0.33
Fe, Iron (wt.%)	3.27	0.122	3.22	3.31	3.21	3.32
Ga, Gallium (ppm)	8.91	0.641	8.60	9.22	8.59	9.23
Gd, Gadolinium (ppm)	3.44	0.89	2.66	4.23	3.33	3.55
Ge, Germanium (ppm)	0.12	0.02	0.09	0.14	IND	IND
Hf, Hafnium (ppm)	0.30	0.019	0.29	0.31	0.28	0.31
Ho, Holmium (ppm)	0.39	0.04	0.35	0.42	0.37	0.40
In, Indium (ppm)	0.097	0.006	0.094	0.101	0.093	0.102
K, Potassium (wt.%)	0.933	0.041	0.915	0.950	0.914	0.951
La, Lanthanum (ppm)	15.4	2.5	14.2	16.6	14.8	16.0
Li, Lithium (ppm)	38.9	3.30	37.5	40.4	37.7	40.2
Lu, Lutetium (ppm)	0.10	0.008	0.10	0.11	IND	IND
Mg, Magnesium (wt.%)	0.733	0.022	0.724	0.742	0.720	0.746
Mn, Manganese (wt.%)	0.032	0.001	0.031	0.032	0.031	0.032
Mo, Molybdenum (ppm)	65	1.8	64	65	63	66
Na, Sodium (wt.%)	0.154	0.020	0.145	0.163	0.147	0.162
Nb, Niobium (ppm)	0.90	0.17	0.78	1.02	0.81	0.99
Nd, Neodymium (ppm)	18.2	4.1	13.6	22.9	17.4	19.1
Ni, Nickel (ppm)	16.3	0.63	16.0	16.5	15.8	16.7
P, Phosphorus (wt.%)	0.068	0.004	0.067	0.070	0.066	0.070
Pb, Lead (ppm)	10.1	0.73	9.7	10.4	9.5	10.6
Rb, Rubidium (ppm)	92	5.0	89	95	90	94
Re, Rhenium (ppb)	52.4	2.7	51.4	53.5	48.9	56.0
S, Sulphur (wt.%)	0.442	0.021	0.433	0.450	0.432	0.451
Sb, Antimony (ppm)	2.45	0.26	2.31	2.59	2.34	2.56
Sc, Scandium (ppm)	7.61	0.419	7.40	7.83	7.38	7.85
Se, Selenium (ppm)	3.94	0.43	3.77	4.11	3.68	4.20
Sm, Samarium (ppm)	3.55	1.04	2.63	4.46	3.37	3.72

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	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Aqua Regia Digestion continued						
Sn, Tin (ppm)	3.63	0.156	3.55	3.71	3.49	3.77
Sr, Strontium (ppm)	76	6.6	73	79	74	78
Tb, Terbium (ppm)	0.49	0.08	0.43	0.54	0.47	0.51
Te, Tellurium (ppm)	0.54	0.047	0.51	0.56	0.51	0.57
Th, Thorium (ppm)	6.15	0.64	5.76	6.54	5.94	6.36
Ti, Titanium (wt.%)	0.248	0.015	0.241	0.254	0.242	0.253
Tl, Thallium (ppm)	0.60	0.037	0.58	0.62	0.58	0.62
Tm, Thulium (ppm)	0.12	0.005	0.12	0.13	IND	IND
U, Uranium (ppm)	3.07	0.250	2.98	3.16	2.90	3.24
V, Vanadium (ppm)	65	2.9	63	66	63	66
W, Tungsten (ppm)	5.43	0.372	5.24	5.62	5.06	5.81
Y, Yttrium (ppm)	10.3	0.90	9.9	10.7	10.1	10.5
Yb, Ytterbium (ppm)	0.74	0.043	0.72	0.76	0.71	0.77
Zn, Zinc (ppm)	84	4.3	82	86	82	85
Zr, Zirconium (ppm)	7.52	0.741	7.15	7.89	7.24	7.81

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 2. Indicative Values for OREAS 505.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Pb Fire Assay								
Pd	ppb	*4.17*	Pt	ppb	*< 5*			
4-Acid Digestion								
Ge	ppm	*0.20*	Hg	ppm	*< 2*			
Aqua Regia Digestion								
B	ppm	*< 10*	Pr	ppm	*3.90*	Ta	ppm	*0.008*
Hg	ppm	*0.024*	Pt	ppb	*< 1*			
Pd	ppb	*9.50*	Si	wt.%	*0.091*			
Borate Fusion XRF								
Al_2O_3	wt.%	*14.84*	MgO	wt.%	*1.34*	SiO_2	wt.%	*66.78*
CaO	wt.%	*2.53*	MnO	wt.%	*0.050*	SO_3	wt.%	*1.09*
Fe_2O_3	wt.%	*4.85*	Na_2O	wt.%	*2.89*	TiO_2	wt.%	*0.590*
K_2O	wt.%	*3.91*	P_2O_5	wt.%	*0.199*			
Thermogravimetry								
LOI^{1000}	wt.%	*1.24*						
Infrared Combustion								
C	wt.%	*0.163*	S	wt.%	*0.422*			

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.

Table 2 continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Laser Ablation ICP-MS								
Ag	ppm	*1.65*	Hf	ppm	*6.07*	Sm	ppm	*6.84*
As	ppm	*29.6*	Ho	ppm	*1.00*	Sn	ppm	*5.40*
Ba	ppm	*1005*	In	ppm	*0.10*	Sr	ppm	*248*
Be	ppm	*2.60*	La	ppm	*34.4*	Ta	ppm	*1.05*
Bi	ppm	*2.75*	Lu	ppm	*0.37*	Tb	ppm	*0.95*
Cd	ppm	*0.30*	Mn	wt.%	*0.036*	Te	ppm	*0.50*
Ce	ppm	*68*	Mo	ppm	*65*	Th	ppm	*13.4*
Co	ppm	*8.80*	Nb	ppm	*12.0*	Ti	wt.%	*0.365*
Cr	ppm	*56*	Nd	ppm	*32.8*	Tl	ppm	*0.90*
Cs	ppm	*10.0*	Ni	ppm	*15.0*	Tm	ppm	*0.41*
Cu	wt.%	*0.312*	Pb	ppm	*27.5*	U	ppm	*4.22*
Dy	ppm	*5.31*	Pr	ppm	*8.23*	V	ppm	*74*
Er	ppm	*2.81*	Rb	ppm	*157*	W	ppm	*8.00*
Eu	ppm	*1.31*	Re	ppb	*80.0*	Y	ppm	*27.5*
Ga	ppm	*19.4*	Sb	ppm	*3.75*	Yb	ppm	*2.53*
Gd	ppm	*6.10*	Sc	ppm	*9.25*	Zn	ppm	*85*
Ge	ppm	*1.55*	Se	ppm	*< 5*	Zr	ppm	*220*

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

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

INTRODUCTION

OREAS reference materials are intended to provide a low cost method of evaluating and improving the quality of analysis of geological samples. To the geologist they provide a means of implementing quality control in analytical data sets generated in exploration from the grass roots level through to prospect evaluation, and in grade control at mining operations. To the analyst they provide an effective means of calibrating analytical equipment, assessing new techniques and routinely monitoring in-house procedures.

OREAS reference materials enable users to successfully achieve process control of these tasks because the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself.

SOURCE MATERIAL

OREAS 505 was prepared from a blend of porphyry copper-gold ores, barren granodiorite and a minor quantity of Mo concentrate. The ores were sourced from both the Northparkes Mine and Ridgeway 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.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 505 was prepared in the following manner:

- Drying of ores and barren granodiorite to constant mass at 105°C;
- Drying of 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 505 was tested at ORE Research & Exploration Pty Ltd's onsite laboratory for various physical properties. Table 3 presents these findings which should be used for informational purposes only.

Table 3. Physical properties of OREAS 505.

CRM Name	Bulk Density (g/L)	Moisture%	Munsell Notation‡	Munsell Color‡
OREAS 505	704.3	0.44	N8	Very Light Gray

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

ANALYTICAL PROGRAM

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

- Gold via 15-50g fire assay with AAS finish (14 laboratories) and ICP-OES (12 laboratories) finish;
- Gold via 15-50g aqua regia digestion with ICP-MS finish (11 laboratories), AAS (4 laboratories) and ICP-OES (1 laboratory) finish;
- Aqua regia digestion for full elemental suite ICP-OES/MS and AAS finish (up to 26 laboratories depending on the element);
- 4-Acid digestion for full elemental suite ICP-OES/MS finish (up to 25 laboratories depending on the element);
- Gold by instrumental neutron activation analysis (INAA) on 20 x 85mg subsamples to confirm homogeneity (1 laboratory only: ANSTO, Lucas Heights, Australia);
- Major and trace elements determined by borate fusion XRF (Al_2O_3 to TiO_2), laser ablation with ICP-MS (Ag to Zr), LOI at 1000°C and C+S by infrared combustion furnace (1 laboratory only: Bureau Veritas Geoanalytical, Perth, Australia).

It is important to note that in the analytical industry there is no standardisation of the aqua regia digestion process. Aqua regia is a partial empirical digest and differences in recoveries for various analytes are commonplace. These are caused by variations in the digest conditions which 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.

For the round robin program twenty 1kg test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire prepared batch. Six 100g pulp samples were submitted to each laboratory for analysis received by each laboratory were obtained by taking two 100g samples from each of three separate 1kg 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.

Table 1 presents the 119 certified values together with their associated 1SD's, 95% confidence and tolerance limits. Table 2 shows 76 indicative values for major and trace element composition and Table 3 provides indicative physical properties information. Gold homogeneity has been evaluated and confirmed by instrumental neutron activation analysis (INAA) on twenty ~85mg sample portions (see Table 4) and by a nested ANOVA program for both fire assay and aqua regia digestion (see '**nested ANOVA**' section).

Table 5 provides performance gate intervals for the certified values based on their pooled 1SDs. Tabulated results of all elements together with uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of lab means from the corrected mean of means (PDM[3]) are presented in the detailed certification data for this CRM (**OREAS 505 DataPack-1.0.190408_170255.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.

STATISTICAL ANALYSIS

Certified Values, Confidence Limits, Standard Deviations and Tolerance Limits (Table 1) 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 4) 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 505.

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 are provided in Table 2. Additional indicative values by other analytical methods are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where inter-laboratory consensus is poor.

Standard Deviation values (1SDs) are reported in Table 1. They 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.**

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-lab 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.

Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) shown in Table 1 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 0.316 and 0.327 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 4 below shows the INAA data determined on 20 x 85mg subsamples of OREAS 505. An equivalent scaled version of the results is also provided to demonstrate an appreciation of what this data means 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 and measurement error becomes negligible. In this instance a subsample weight of 85 milligrams was employed and the 1RSD of 0.223% was calculated for a 30g fire assay or aqua regia sample (4.18% at 85mg weights). These confirm the high level of gold homogeneity in OREAS 505.

Table 4. Neutron Activation Analysis of Au (in ppm) on 20 x 85mg subsamples showing the equivalent results scaled to a typical fire assay (30g sample mass) method.

Replicate No	Au 85mg actual	Au 30g equivalent*
1	0.531	0.559
2	0.544	0.560
3	0.616	0.564
4	0.599	0.563
5	0.601	0.563
6	0.533	0.559
7	0.554	0.560
8	0.579	0.562
9	0.563	0.561
10	0.558	0.561
11	0.539	0.560
12	0.562	0.561
13	0.549	0.560
14	0.557	0.561
15	0.566	0.561
16	0.534	0.559
17	0.575	0.562
18	0.546	0.560
19	0.565	0.561
20	0.545	0.560
Mean	0.561	0.561
Median	0.558	0.561
Std Dev.	0.023	0.001
Rel.Std.Dev.	**4.18%**	**0.223%**

*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 505 has also been evaluated in a **nested ANOVA** of the round robin program. Each of the twenty-five 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 505. The test was performed using the following parameters:

- Gold fire assay – 156 samples (26 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 102 samples (17 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 0.75 for Au by fire assay and 0.70 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 505 and whether the variance between two subsamples from the same unit is statistically distinguishable to the variance from two subsamples taken from any two separate units. A reference material therefore, can possess poor absolute homogeneity yet still pass a relative homogeneity 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 505 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

Performance Gates

Table 5 shows 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. 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 5. Performance Gates for OREAS 505.

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	0.555	0.014	0.527	0.582	0.514	0.596	2.46%	4.91%	7.37%	0.527	0.582
Aqua Regia Digestion (sample weights 10-50g)											
Au, ppm	0.552	0.023	0.505	0.599	0.481	0.622	4.25%	8.50%	12.75%	0.524	0.579

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 5 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											
Ag, ppm	1.53	0.072	1.39	1.68	1.32	1.75	4.70%	9.39%	14.09%	1.46	1.61
Al, wt.%	7.45	0.422	6.60	8.29	6.18	8.71	5.67%	11.34%	17.01%	7.07	7.82
As, ppm	30.4	1.57	27.2	33.5	25.7	35.1	5.18%	10.35%	15.53%	28.9	31.9
Ba, ppm	1011	45	921	1101	876	1146	4.44%	8.89%	13.33%	961	1062
Be, ppm	2.42	0.237	1.95	2.89	1.71	3.13	9.79%	19.58%	29.37%	2.30	2.54
Bi, ppm	2.52	0.152	2.21	2.82	2.06	2.97	6.06%	12.11%	18.17%	2.39	2.64
Ca, wt.%	1.78	0.092	1.60	1.97	1.51	2.06	5.14%	10.27%	15.41%	1.70	1.87
Cd, ppm	0.30	0.04	0.22	0.37	0.19	0.41	12.44%	24.88%	37.32%	0.28	0.31
Ce, ppm	67	4.7	58	77	53	81	6.96%	13.92%	20.88%	64	71
Co, ppm	8.39	0.263	7.87	8.92	7.60	9.18	3.13%	6.26%	9.38%	7.97	8.81
Cr, ppm	42.4	6.4	29.5	55.2	23.1	61.7	15.16%	30.33%	45.49%	40.3	44.5
Cs, ppm	9.70	0.431	8.84	10.56	8.41	10.99	4.44%	8.89%	13.33%	9.22	10.19
Cu, wt.%	0.321	0.008	0.305	0.338	0.296	0.347	2.62%	5.25%	7.87%	0.305	0.337
Dy, ppm	3.74	0.122	3.49	3.98	3.37	4.10	3.27%	6.54%	9.81%	3.55	3.92
Er, ppm	1.43	0.118	1.19	1.67	1.07	1.79	8.29%	16.57%	24.86%	1.36	1.50
Eu, ppm	1.20	0.111	0.98	1.43	0.87	1.54	9.24%	18.48%	27.72%	1.14	1.26
Fe, wt.%	3.34	0.095	3.15	3.53	3.05	3.62	2.85%	5.71%	8.56%	3.17	3.50
Ga, ppm	19.6	0.73	18.2	21.1	17.4	21.8	3.72%	7.44%	11.16%	18.6	20.6
Gd, ppm	5.63	0.364	4.90	6.36	4.54	6.72	6.47%	12.93%	19.40%	5.35	5.91
Hf, ppm	1.93	0.140	1.65	2.21	1.51	2.35	7.23%	14.46%	21.69%	1.83	2.03
Ho, ppm	0.61	0.019	0.57	0.65	0.55	0.67	3.13%	6.25%	9.38%	0.58	0.64
In, ppm	0.10	0.009	0.09	0.12	0.08	0.13	8.55%	17.09%	25.64%	0.10	0.11
K, wt.%	3.15	0.139	2.87	3.43	2.73	3.57	4.41%	8.82%	13.22%	2.99	3.31
La, ppm	32.2	2.77	26.6	37.7	23.9	40.5	8.61%	17.21%	25.82%	30.6	33.8
Li, ppm	46.5	2.21	42.0	50.9	39.8	53.1	4.75%	9.50%	14.25%	44.1	48.8
Lu, ppm	0.18	0.009	0.16	0.20	0.15	0.21	5.15%	10.31%	15.46%	0.17	0.19
Mg, wt.%	0.771	0.030	0.710	0.832	0.680	0.862	3.95%	7.89%	11.84%	0.732	0.809
Mn, wt.%	0.036	0.001	0.034	0.038	0.033	0.039	3.07%	6.14%	9.21%	0.034	0.038
Mo, ppm	66	2.1	62	71	60	73	3.20%	6.39%	9.59%	63	70
Na, wt.%	2.14	0.069	2.00	2.28	1.93	2.35	3.24%	6.49%	9.73%	2.03	2.25
Nb, ppm	11.7	0.55	10.6	12.8	10.1	13.3	4.67%	9.34%	14.00%	11.1	12.3
Nd, ppm	31.2	1.51	28.2	34.2	26.7	35.7	4.83%	9.65%	14.48%	29.7	32.8
Ni, ppm	16.5	0.79	14.9	18.0	14.1	18.8	4.78%	9.56%	14.35%	15.6	17.3
P, wt.%	0.086	0.003	0.079	0.093	0.076	0.096	3.98%	7.97%	11.95%	0.082	0.090
Pb, ppm	26.7	2.7	21.2	32.1	18.5	34.8	10.21%	20.42%	30.63%	25.3	28.0
Pr, ppm	8.14	0.374	7.39	8.89	7.01	9.26	4.60%	9.20%	13.81%	7.73	8.54
Rb, ppm	152	8	136	168	128	176	5.25%	10.51%	15.76%	144	159
Re, ppb	54.2	4.2	45.8	62.7	41.5	66.9	7.80%	15.59%	23.39%	51.5	56.9
S, wt.%	0.446	0.019	0.407	0.484	0.388	0.504	4.33%	8.66%	12.98%	0.424	0.468
Sb, ppm	3.50	0.147	3.21	3.79	3.06	3.94	4.19%	8.38%	12.56%	3.32	3.67

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 5 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											
Sc, ppm	8.81	0.500	7.81	9.81	7.31	10.31	5.68%	11.35%	17.03%	8.37	9.25
Se, ppm	4.39	0.57	3.25	5.54	2.68	6.11	13.00%	25.99%	38.99%	4.18	4.61
Sm, ppm	6.56	0.328	5.90	7.21	5.58	7.54	5.00%	9.99%	14.99%	6.23	6.89
Sn, ppm	4.94	0.253	4.43	5.44	4.18	5.69	5.12%	10.25%	15.37%	4.69	5.18
Sr, ppm	253	10	233	272	224	282	3.83%	7.66%	11.49%	240	265
Ta, ppm	1.02	0.101	0.82	1.22	0.72	1.32	9.95%	19.89%	29.84%	0.97	1.07
Tb, ppm	0.75	0.041	0.67	0.84	0.63	0.88	5.50%	11.01%	16.51%	0.72	0.79
Te, ppm	0.57	0.06	0.45	0.69	0.39	0.75	10.57%	21.15%	31.72%	0.54	0.59
Th, ppm	12.9	0.84	11.3	14.6	10.4	15.5	6.45%	12.90%	19.35%	12.3	13.6
Ti, wt.%	0.340	0.012	0.315	0.365	0.303	0.377	3.63%	7.26%	10.89%	0.323	0.357
Tl, ppm	0.86	0.047	0.76	0.95	0.72	1.00	5.49%	10.98%	16.46%	0.81	0.90
Tm, ppm	0.20	0.009	0.18	0.22	0.17	0.23	4.81%	9.62%	14.42%	0.19	0.21
U, ppm	3.66	0.37	2.92	4.39	2.56	4.76	10.04%	20.09%	30.13%	3.48	3.84
V, ppm	72	2.5	67	77	65	80	3.51%	7.01%	10.52%	69	76
W, ppm	8.49	0.754	6.99	10.00	6.23	10.76	8.87%	17.75%	26.62%	8.07	8.92
Y, ppm	15.1	0.68	13.8	16.5	13.1	17.2	4.46%	8.92%	13.38%	14.4	15.9
Yb, ppm	1.17	0.12	0.93	1.41	0.81	1.53	10.24%	20.49%	30.73%	1.11	1.23
Zn, ppm	88	4.4	79	96	74	101	5.08%	10.15%	15.23%	83	92
Zr, ppm	63	4.7	54	72	49	77	7.50%	15.01%	22.51%	60	66
Aqua Regia Digestion											
Ag, ppm	1.53	0.110	1.31	1.75	1.20	1.86	7.21%	14.42%	21.63%	1.46	1.61
Al, wt.%	1.88	0.119	1.64	2.11	1.52	2.23	6.35%	12.70%	19.05%	1.78	1.97
As, ppm	29.8	1.81	26.1	33.4	24.3	35.2	6.07%	12.13%	18.20%	28.3	31.2
Ba, ppm	495	18	459	531	441	549	3.66%	7.31%	10.97%	470	520
Be, ppm	1.41	0.19	1.03	1.78	0.84	1.97	13.31%	26.62%	39.93%	1.34	1.48
Bi, ppm	2.60	0.181	2.24	2.96	2.06	3.14	6.96%	13.93%	20.89%	2.47	2.73
Ca, wt.%	0.714	0.043	0.628	0.800	0.585	0.844	6.04%	12.09%	18.13%	0.678	0.750
Cd, ppm	0.20	0.03	0.15	0.25	0.13	0.28	12.70%	25.41%	38.11%	0.19	0.21
Ce, ppm	31.6	5.0	21.6	41.7	16.5	46.7	15.90%	31.81%	47.71%	30.1	33.2
Co, ppm	8.14	0.531	7.08	9.20	6.55	9.73	6.53%	13.05%	19.58%	7.73	8.55
Cr, ppm	51	3.5	44	58	40	61	6.96%	13.92%	20.88%	48	53
Cs, ppm	8.30	0.233	7.83	8.76	7.60	9.00	2.80%	5.61%	8.41%	7.88	8.71
Cu, wt.%	0.323	0.010	0.303	0.342	0.293	0.352	3.06%	6.12%	9.19%	0.307	0.339
Dy, ppm	2.49	0.31	1.86	3.12	1.55	3.43	12.62%	25.25%	37.87%	2.37	2.61
Er, ppm	0.98	0.079	0.82	1.13	0.74	1.21	8.05%	16.10%	24.15%	0.93	1.03
Eu, ppm	0.32	0.020	0.28	0.35	0.26	0.37	6.19%	12.37%	18.56%	0.30	0.33
Fe, wt.%	3.27	0.122	3.02	3.51	2.90	3.63	3.73%	7.45%	11.18%	3.10	3.43
Ga, ppm	8.91	0.641	7.63	10.19	6.99	10.83	7.19%	14.38%	21.56%	8.47	9.36
Gd, ppm	3.44	0.89	1.66	5.22	0.77	6.12	25.90%	51.79%	77.69%	3.27	3.61
Ge, ppm	0.12	0.02	0.07	0.16	0.05	0.18	19.28%	38.55%	57.83%	0.11	0.12

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 5 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											
Hf, ppm	0.30	0.019	0.26	0.34	0.24	0.35	6.51%	13.02%	19.52%	0.28	0.31
Ho, ppm	0.39	0.04	0.30	0.47	0.26	0.51	11.02%	22.03%	33.05%	0.37	0.40
In, ppm	0.097	0.006	0.085	0.110	0.078	0.117	6.58%	13.16%	19.74%	0.093	0.102
K, wt.%	0.933	0.041	0.850	1.015	0.809	1.057	4.43%	8.86%	13.29%	0.886	0.979
La, ppm	15.4	2.5	10.4	20.4	7.9	22.9	16.25%	32.49%	48.74%	14.6	16.1
Li, ppm	38.9	3.30	32.4	45.5	29.1	48.8	8.46%	16.93%	25.39%	37.0	40.9
Lu, ppm	0.10	0.008	0.08	0.12	0.08	0.12	7.92%	15.83%	23.75%	0.10	0.11
Mg, wt.%	0.733	0.022	0.689	0.777	0.667	0.799	3.01%	6.02%	9.04%	0.696	0.770
Mn, wt.%	0.032	0.001	0.029	0.034	0.028	0.035	3.38%	6.75%	10.13%	0.030	0.033
Mo, ppm	65	1.8	61	68	59	70	2.83%	5.66%	8.49%	61	68
Na, wt.%	0.154	0.020	0.115	0.193	0.095	0.213	12.71%	25.41%	38.12%	0.146	0.162
Nb, ppm	0.90	0.17	0.56	1.24	0.39	1.41	18.94%	37.89%	56.83%	0.85	0.94
Nd, ppm	18.2	4.1	10.0	26.5	5.9	30.6	22.65%	45.29%	67.94%	17.3	19.2
Ni, ppm	16.3	0.63	15.0	17.5	14.4	18.2	3.87%	7.74%	11.61%	15.5	17.1
P, wt.%	0.068	0.004	0.061	0.076	0.057	0.079	5.31%	10.62%	15.93%	0.065	0.072
Pb, ppm	10.1	0.73	8.6	11.5	7.9	12.3	7.28%	14.56%	21.84%	9.6	10.6
Rb, ppm	92	5.0	82	102	77	107	5.42%	10.83%	16.25%	87	97
Re, ppb	52.4	2.7	47.0	57.8	44.3	60.5	5.16%	10.33%	15.49%	49.8	55.0
S, wt.%	0.442	0.021	0.399	0.484	0.378	0.505	4.81%	9.63%	14.44%	0.419	0.464
Sb, ppm	2.45	0.26	1.92	2.98	1.66	3.24	10.81%	21.62%	32.43%	2.33	2.57
Sc, ppm	7.61	0.419	6.78	8.45	6.36	8.87	5.51%	11.01%	16.52%	7.23	7.99
Se, ppm	3.94	0.43	3.08	4.80	2.65	5.23	10.94%	21.88%	32.82%	3.74	4.14
Sm, ppm	3.55	1.04	1.48	5.62	0.44	6.66	29.21%	58.42%	87.63%	3.37	3.72
Sn, ppm	3.63	0.156	3.32	3.94	3.16	4.10	4.29%	8.58%	12.87%	3.45	3.81
Sr, ppm	76	6.6	63	89	56	96	8.68%	17.35%	26.03%	72	80
Tb, ppm	0.49	0.08	0.32	0.65	0.24	0.73	16.70%	33.40%	50.11%	0.46	0.51
Te, ppm	0.54	0.047	0.44	0.63	0.40	0.68	8.75%	17.51%	26.26%	0.51	0.56
Th, ppm	6.15	0.64	4.87	7.43	4.23	8.07	10.41%	20.82%	31.22%	5.84	6.46
Ti, wt.%	0.248	0.015	0.217	0.278	0.202	0.293	6.10%	12.20%	18.30%	0.235	0.260
Tl, ppm	0.60	0.037	0.52	0.67	0.49	0.71	6.26%	12.51%	18.77%	0.57	0.63
Tm, ppm	0.12	0.005	0.11	0.13	0.11	0.14	3.77%	7.54%	11.31%	0.12	0.13
U, ppm	3.07	0.250	2.57	3.57	2.32	3.82	8.15%	16.30%	24.45%	2.91	3.22
V, ppm	65	2.9	59	71	56	73	4.54%	9.09%	13.63%	61	68
W, ppm	5.43	0.372	4.69	6.18	4.32	6.55	6.85%	13.70%	20.55%	5.16	5.71
Y, ppm	10.3	0.90	8.5	12.1	7.6	13.0	8.75%	17.49%	26.24%	9.8	10.8
Yb, ppm	0.74	0.043	0.66	0.83	0.61	0.87	5.77%	11.54%	17.31%	0.71	0.78
Zn, ppm	84	4.3	75	92	71	97	5.19%	10.38%	15.57%	80	88
Zr, ppm	7.52	0.741	6.04	9.01	5.30	9.75	9.86%	19.71%	29.57%	7.15	7.90

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.

PARTICIPATING LABORATORIES

1. Alex Stewart International, Mendoza, Argentina
2. ALS, Johannesburg, South Africa
3. ALS, Lima, Peru
4. ALS, Loughrea, Galway, Ireland
5. ALS, Perth, WA, Australia
6. ALS, Ulaanbaatar, Khan-Uul District, Mongolia
7. ALS, Vancouver, BC, Canada
8. ANSTO, Lucas Heights, NSW, Australia
9. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
10. Bureau Veritas Geoanalytical, Perth, WA, Australia
11. CERTIMIN, Lima, Peru
12. ESAN Istanbul, Istanbul, Turkey
13. Inspectorate (BV), Lima, Peru
14. Inspectorate America Corporation (BV), Sparks, Nevada, USA
15. Intertek Genalysis, Adelaide, SA, Australia
16. Intertek Genalysis, Perth, WA, Australia
17. Intertek Testing Services, Townsville, QLD, Australia
18. Nagrom, Perth, WA, Australia
19. Newcrest Laboratory Services, Orange, NSW, Australia
20. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
21. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
22. PT SGS Indo Assay Laboratories, Jakarta, Indonesia
23. SGS, Ankara, Anatolia, Turkey
24. SGS Canada Inc., Vancouver, BC, Canada
25. SGS del Peru, Lima, Peru
26. SGS Mongolia, Ulan Bator, Mongolia
27. Shiva Analyticals Ltd, Bangalore North, Karnataka, India

Please note: Above numbered alphabetical list of participating laboratories <u>does not</u> reflect the Lab ID numbering on the scatter plots below.

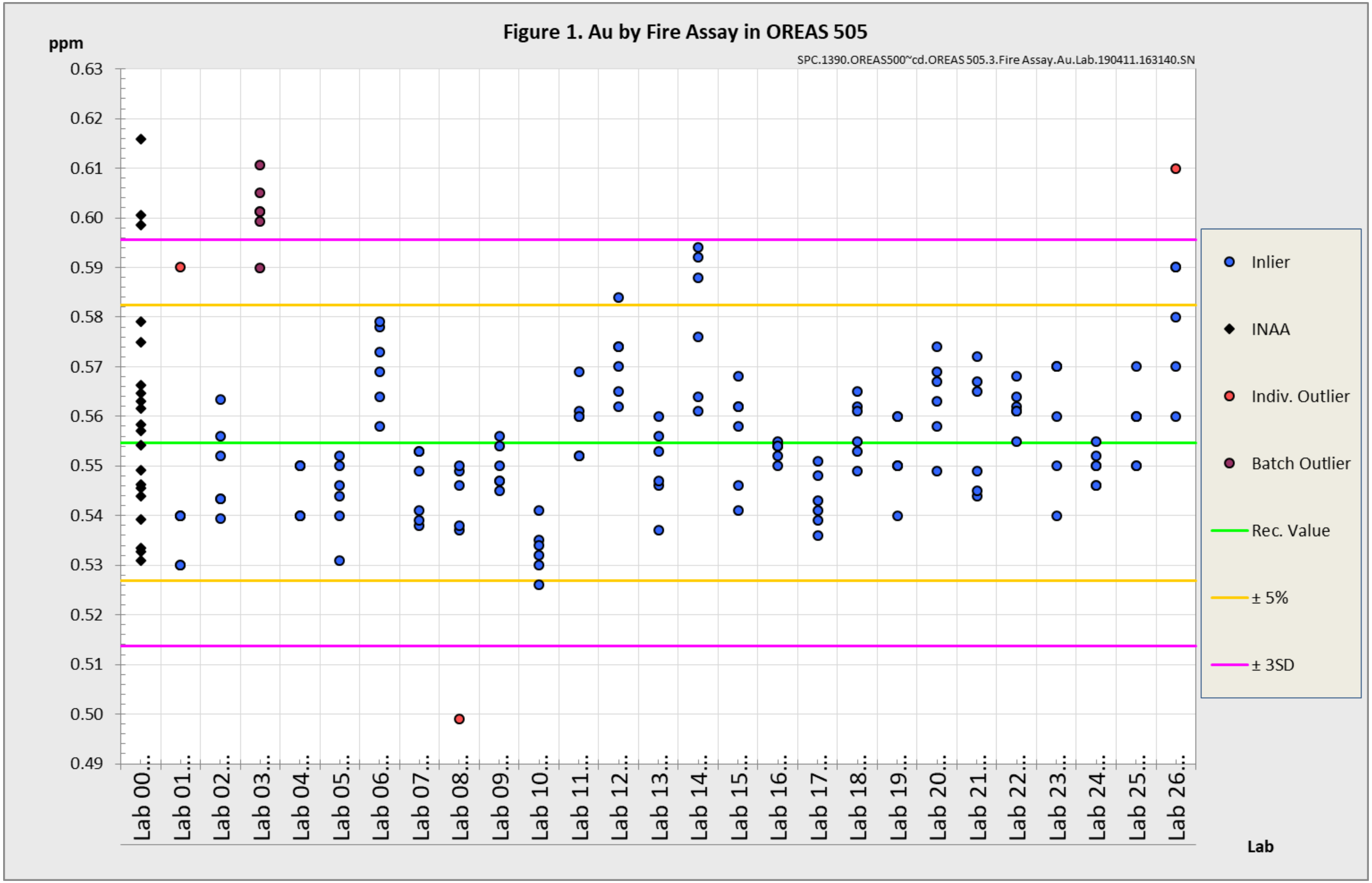

Figure 1. Au by Fire Assay in OREAS 505
SPC.1390.OREAS500~cd.OREAS 505.3.Fire Assay.Au.Lab.190411.163140.SN
ppm
0.63
0.62
0.61
0.60
0.59
0.58
0.57
0.56
0.55
0.54
0.53
0.52
0.51
0.50
0.49
Lab 00...
Lab 01...
Lab 02...
Lab 03...
Lab 04...
Lab 05...
Lab 06...
Lab 07...
Lab 08...
Lab 09...
Lab 10...
Lab 11...
Lab 12...
Lab 13...
Lab 14...
Lab 15...
Lab 16...
Lab 17...
Lab 18...
Lab 19...
Lab 20...
Lab 21...
Lab 22...
Lab 23...
Lab 24...
Lab 25...
Lab 26...
Lab
Inlier
INAA
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD

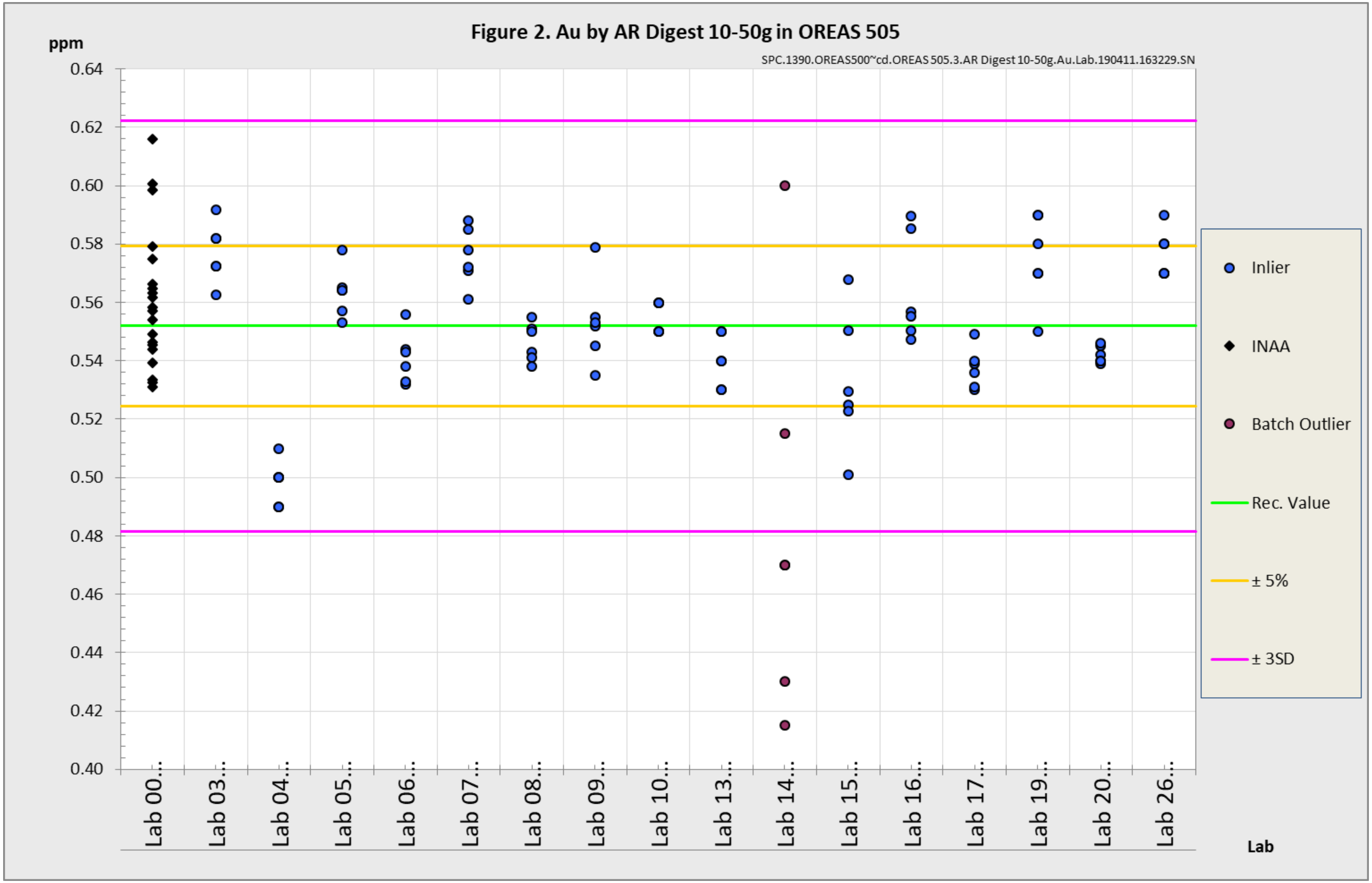
Figure 2. Au by AR Digest 10-50g in OREAS 505
ppm
SPC.1390.OREAS500~cd.OREAS 505.3.AR Digest 10-50g.Au.Lab.190411.163229.SN
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
Lab 00...
Lab 03...
Lab 04...
Lab 05...
Lab 06...
Lab 07...
Lab 08...
Lab 09...
Lab 10...
Lab 13...
Lab 14...
Lab 15...
Lab 16...
Lab 17...
Lab 19...
Lab 20...
Lab 26...
Lab
Inlier
INAA
Batch Outlier
Rec. Value
± 5%
± 3SD

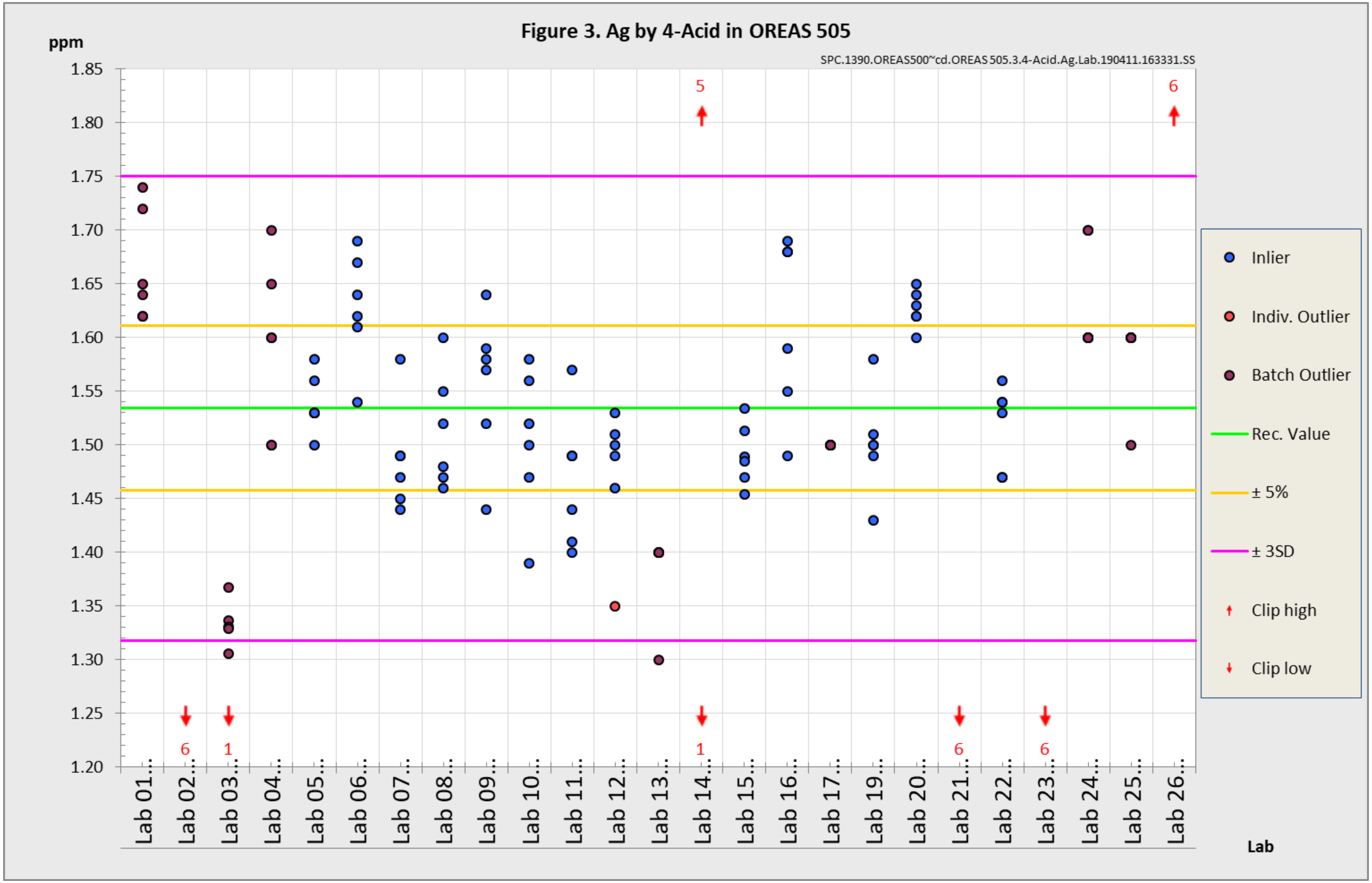
Figure 3. Ag by 4-Acid in OREAS 505
SPC.1390.OREAS500~cd.OREAS 505.3.4-Acid.Ag.Lab.190411.163331.SS
ppm
1.85
1.80
1.75
1.70
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
5
6
6
1
1
6
6
Lab 01...
Lab 02...
Lab 03...
Lab 04...
Lab 05...
Lab 06...
Lab 07...
Lab 08...
Lab 09...
Lab 10...
Lab 11...
Lab 12...
Lab 13...
Lab 14...
Lab 15...
Lab 16...
Lab 17...
Lab 19...
Lab 20...
Lab 21...
Lab 22...
Lab 23...
Lab 24...
Lab 25...
Lab 26...
Lab
Inlier
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD
Clip high
Clip low

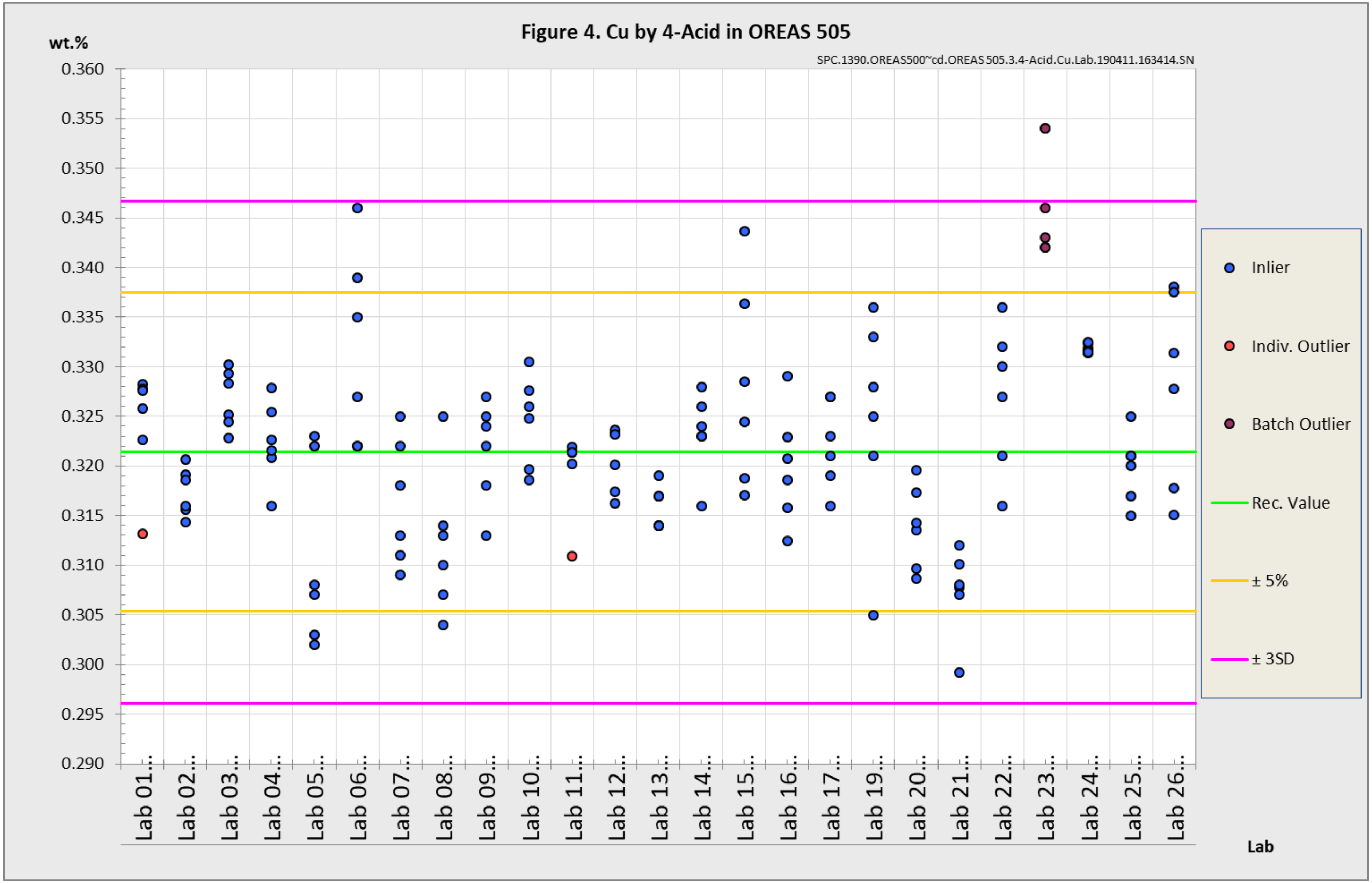
Figure 4. Cu by 4-Acid in OREAS 505
wt.%
SPC.1390.OREAS500~cd.OREAS 505.3.4-Acid.Cu.Lab.190411.163414.SN
0.360
0.355
0.350
0.345
0.340
0.335
0.330
0.325
0.320
0.315
0.310
0.305
0.300
0.295
0.290
Lab 01...
Lab 02...
Lab 03...
Lab 04...
Lab 05...
Lab 06...
Lab 07...
Lab 08...
Lab 09...
Lab 10...
Lab 11...
Lab 12...
Lab 13...
Lab 14...
Lab 15...
Lab 16...
Lab 17...
Lab 19...
Lab 20...
Lab 21...
Lab 22...
Lab 23...
Lab 24...
Lab 25...
Lab 26...
Lab
Inlier
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD

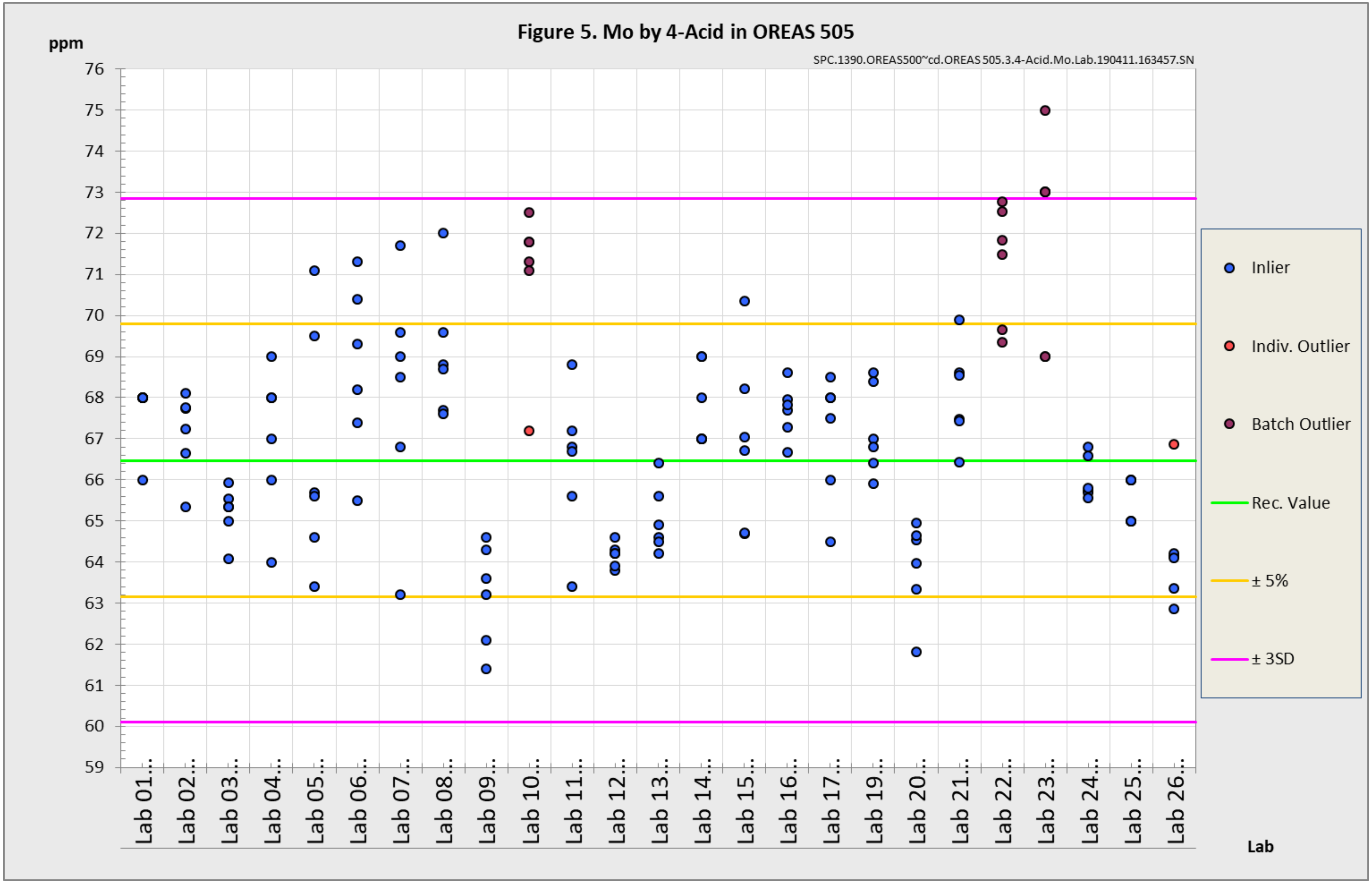

Figure 5. Mo by 4-Acid in OREAS 505
SPC.1390.OREAS500~cd.OREAS 505.3.4-Acid.Mo.Lab.190411.163457.SN
ppm
76
75
74
73
72
71
70
69
68
67
66
65
64
63
62
61
60
59
Lab 01...
Lab 02...
Lab 03...
Lab 04...
Lab 05...
Lab 06...
Lab 07...
Lab 08...
Lab 09...
Lab 10...
Lab 11...
Lab 12...
Lab 13...
Lab 14...
Lab 15...
Lab 16...
Lab 17...
Lab 19...
Lab 20...
Lab 21...
Lab 22...
Lab 23...
Lab 24...
Lab 25...
Lab 26...
Lab
Inlier
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD

PREPARER AND SUPPLIER

Certified reference material OREAS 505 was prepared, certified and supplied by:

ORE Research & Exploration Pty Ltd	Tel:	+613-9729 0333
37A Hosie Street	Fax:	+613-9729 8338
Bayswater North VIC 3153	Web:	www.ore.com.au
AUSTRALIA	Email:	info@ore.com.au

It is available in unit sizes of 10g and 60g (single-use laminated foil pouches) and 500g (plastic jars).

METROLOGICAL TRACEABILITY

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

COMMUTABILITY

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

INTENDED USE

OREAS 505 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 505 may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 505 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 505 has been prepared from a blend of porphyry copper-gold ore, barren granodiorite and a minor quantity of Mo concentrate. It is low in reactive sulphide (~0.45% 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.

INSTRUCTIONS FOR CORRECT USE

The certified values for OREAS 505 refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis.

HANDLING INSTRUCTIONS

Fine powders pose a risk to eyes and lungs and therefore standard precautions such as 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	11th April 2019	First publication.

QMS ACCREDITED

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

11th April, 2019

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

REFERENCES

Govett, G.J.S. (1983), ed. Handbook of Exploration Geochemistry, Volume 2: Statistics and Data Analysis in Geochemical Prospecting (Variations of accuracy and precision), P.O. Box 330, 1000 AH Amsterdam, The Netherlands.

Ingamells, C. O. and Switzer, P. (1973), Talanta 20, 547-568.

ISO Guide 30:2015, Terms and definitions used in connection with reference materials.

ISO Guide 31:2015, Reference materials – Contents of certificates and labels.

ISO Guide 35:2017, Certification of reference materials - General and statistical principals.

ISO 16269:2014, Statistical interpretation of data – Part 6: Determination of statistical tolerance intervals.

Munsell Rock Color Book (2014), Rock-Color Chart Committee, Geological Society of America (GSA), 4300 44th Street SE, Grand Rapids, MI 49512.