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an analytichem company

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CERTIFICATE OF ANALYSIS FOR

CERTIFIED REFERENCE MATERIAL

OREAS 913

Volcanogenic Massive Sulphide (VMS) Au-Cu-Ag-Zn Ore

Newfoundland & Labrador, Canada

Table 1. Certified Values, Uncertainty & Tolerance Intervals in OREAS 913.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Pb Fire Assay					
Au, Gold (ppm)	2.06	2.05	2.08	2.05*	2.08*
Aqua Regia Digestion (sample weights 15-50g)					
Au, Gold (ppm)	1.94	1.84	2.04	1.93*	1.96*
Infrared Combustion					
S, Sulphur (wt.%)	24.37	23.91	24.83	24.13	24.61
Borate / Peroxide Fusion ICP					
Al, Aluminium (wt.%)	4.01	3.91	4.11	3.94	4.08
As, Arsenic (ppm)	1014	962	1067	983	1045
Ba, Barium (ppm)	125	117	132	121	128
Be, Beryllium (ppm)	< 1	IND	IND	IND	IND
Bi, Bismuth (ppm)	6.16	5.84	6.48	5.97	6.36
Ca, Calcium (wt.%)	1.14	1.08	1.19	1.10	1.17
Cd, Cadmium (ppm)	55	50	59	52	57
Ce, Cerium (ppm)	8.99	8.40	9.58	8.75	9.23
Co, Cobalt (ppm)	85	79	91	82	88
Cr, Chromium (ppm)	100	85	115	95	105
Cs, Caesium (ppm)	0.58	0.39	0.78	0.49	0.67
Cu, Copper (wt.%)	1.49	1.46	1.52	1.47	1.51
Dy, Dysprosium (ppm)	1.06	0.91	1.21	0.98	1.13
Er, Erbium (ppm)	0.61	0.49	0.74	0.56	0.67
Eu, Europium (ppm)	0.32	0.26	0.38	0.29	0.36
Fe, Iron (wt.%)	23.07	22.38	23.76	22.57	23.57
Ga, Gallium (ppm)	12.3	11.2	13.4	11.7	12.9
Gd, Gadolinium (ppm)	1.06	0.94	1.18	0.98	1.15
Ge, Germanium (ppm)	4.38	3.54	5.22	3.92	4.85
Ho, Holmium (ppm)	0.21	0.18	0.24	0.19	0.23
In, Indium (ppm)	1.46	1.33	1.59	IND	IND
K, Potassium (wt.%)	1.25	1.18	1.32	1.22	1.28
La, Lanthanum (ppm)	4.05	3.68	4.41	3.88	4.21
Lu, Lutetium (ppm)	0.10	0.08	0.12	IND	IND
Mg, Magnesium (wt.%)	0.800	0.773	0.826	0.786	0.813
Mn, Manganese (wt.%)	0.026	0.024	0.027	0.025	0.026
Mo, Molybdenum (ppm)	62	56	68	59	65
Nb, Niobium (ppm)	2.10	1.55	2.64	IND	IND
Nd, Neodymium (ppm)	4.59	4.00	5.18	4.27	4.91
Ni, Nickel (ppm)	54	46	62	47	61
Pb, Lead (ppm)	1401	1350	1453	1367	1436
Pr, Praseodymium (ppm)	1.07	1.00	1.14	1.00	1.14

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

*Gold Tolerance Limits for typical 30 g fire assay and 25 g aqua regia digestion methods are determined from 20 x 85 mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973).

Note: intervals may appear asymmetric due to rounding.

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

Table 1 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Borate / Peroxide Fusion ICP continued					
Rb, Rubidium (ppm)	24.7	22.9	26.4	23.6	25.7
S, Sulphur (wt.%)	24.30	23.73	24.87	23.84	24.76
Sb, Antimony (ppm)	107	103	111	103	111
Sc, Scandium (ppm)	12.0	10.3	13.7	IND	IND
Se, Selenium (ppm)	58	44	71	52	63
SiO_2, Silicon dioxide (wt.%)	34.48	33.17	35.79	33.95	35.01
Sm, Samarium (ppm)	1.04	0.82	1.26	1.01	1.07
Sn, Tin (ppm)	13.0	10.8	15.1	IND	IND
Sr, Strontium (ppm)	51	48	54	48	53
Tb, Terbium (ppm)	0.17	0.15	0.19	IND	IND
Te, Tellurium (ppm)	4.94	4.02	5.86	IND	IND
Th, Thorium (ppm)	1.10	0.98	1.22	1.04	1.17
Ti, Titanium (wt.%)	0.178	0.171	0.185	0.174	0.182
Tl, Thallium (ppm)	9.16	8.43	9.89	8.83	9.49
Tm, Thulium (ppm)	0.093	0.075	0.111	IND	IND
U, Uranium (ppm)	4.59	4.27	4.92	4.37	4.82
V, Vanadium (ppm)	96	90	101	94	98
W, Tungsten (ppm)	5.32	4.11	6.54	4.60	6.05
Y, Yttrium (ppm)	5.72	5.16	6.27	5.46	5.97
Yb, Ytterbium (ppm)	0.64	0.52	0.77	0.60	0.68
Zn, Zinc (wt.%)	1.22	1.17	1.27	1.20	1.24
Zr, Zirconium (ppm)	44.8	39.6	50.0	42.3	47.2
4-Acid Digestion					
Ag, Silver (ppm)	13.1	12.6	13.6	12.9	13.4
Al, Aluminium (wt.%)	3.89	3.74	4.03	3.79	3.98
As, Arsenic (ppm)	968	929	1008	946	990
Ba, Barium (ppm)	115	105	126	112	118
Be, Beryllium (ppm)	0.21	0.19	0.23	0.19	0.23
Bi, Bismuth (ppm)	6.12	5.80	6.43	5.95	6.28
Ca, Calcium (wt.%)	1.11	1.07	1.15	1.09	1.13
Cd, Cadmium (ppm)	57	54	59	55	58
Ce, Cerium (ppm)	9.13	8.55	9.70	8.81	9.44
Co, Cobalt (ppm)	87	84	89	85	89
Cr, Chromium (ppm)	99	91	106	96	101
Cs, Caesium (ppm)	0.51	0.47	0.55	0.49	0.54
Cu, Copper (wt.%)	1.51	1.47	1.54	1.48	1.53
Dy, Dysprosium (ppm)	1.03	0.95	1.12	0.98	1.09
Er, Erbium (ppm)	0.61	0.54	0.67	0.57	0.65
Eu, Europium (ppm)	0.32	0.29	0.35	0.30	0.34
Fe, Iron (wt.%)	22.36	21.64	23.08	21.93	22.79
Ga, Gallium (ppm)	12.5	11.8	13.3	12.1	12.9

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
Note: intervals may appear asymmetric due to rounding.
IND = indeterminate (due to limited reading resolution of the methods employed).

Table 1 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion continued					
Gd, Gadolinium (ppm)	1.07	0.94	1.20	1.01	1.13
Ge, Germanium (ppm)	0.34	0.24	0.44	0.30	0.39
Hf, Hafnium (ppm)	0.77	0.69	0.86	0.72	0.82
Ho, Holmium (ppm)	0.20	0.17	0.23	0.18	0.22
In, Indium (ppm)	1.48	1.40	1.55	1.42	1.53
K, Potassium (wt.%)	1.19	1.15	1.24	1.17	1.22
La, Lanthanum (ppm)	4.01	3.75	4.27	3.87	4.15
Li, Lithium (ppm)	5.57	5.18	5.96	5.31	5.83
Lu, Lutetium (ppm)	0.094	0.077	0.111	IND	IND
Mg, Magnesium (wt.%)	0.737	0.706	0.767	0.723	0.750
Mn, Manganese (wt.%)	0.025	0.025	0.026	0.025	0.026
Mo, Molybdenum (ppm)	59	56	61	57	60
Na, Sodium (wt.%)	0.394	0.378	0.411	0.386	0.402
Nb, Niobium (ppm)	1.53	1.39	1.67	1.44	1.62
Nd, Neodymium (ppm)	4.56	4.22	4.90	4.34	4.78
Ni, Nickel (ppm)	49.3	47.2	51.3	47.7	50.9
P, Phosphorus (wt.%)	0.013	0.012	0.014	0.012	0.014
Pb, Lead (ppm)	1365	1313	1417	1341	1389
Pr, Praseodymium (ppm)	1.09	1.00	1.19	1.05	1.14
Rb, Rubidium (ppm)	24.3	22.9	25.7	23.4	25.2
Re, Rhenium (ppm)	0.017	0.013	0.021	IND	IND
S, Sulphur (wt.%)	23.55	22.74	24.36	23.26	23.84
Sb, Antimony (ppm)	102	97	107	99	104
Sc, Scandium (ppm)	12.5	11.9	13.2	12.1	12.9
Se, Selenium (ppm)	59	55	64	57	62
Sm, Samarium (ppm)	1.05	0.89	1.22	1.00	1.11
Sn, Tin (ppm)	12.0	11.2	12.8	11.2	12.7
Sr, Strontium (ppm)	48.6	46.5	50.7	47.3	50.0
Ta, Tantalum (ppm)	0.11	0.10	0.12	IND	IND
Tb, Terbium (ppm)	0.16	0.14	0.18	IND	IND
Te, Tellurium (ppm)	4.98	4.61	5.34	4.76	5.19
Th, Thorium (ppm)	1.09	1.02	1.16	1.06	1.12
Ti, Titanium (wt.%)	0.135	0.127	0.143	0.131	0.139
Tl, Thallium (ppm)	9.29	8.80	9.77	9.07	9.50
Tm, Thulium (ppm)	0.080	0.062	0.097	IND	IND
U, Uranium (ppm)	4.64	4.45	4.83	4.49	4.79
V, Vanadium (ppm)	92	89	96	90	95
W, Tungsten (ppm)	4.99	4.69	5.29	4.84	5.14
Y, Yttrium (ppm)	5.55	5.23	5.86	5.35	5.74
Yb, Ytterbium (ppm)	0.59	0.52	0.67	0.57	0.62
Zn, Zinc (wt.%)	1.23	1.19	1.26	1.21	1.25

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
Note: intervals may appear asymmetric due to rounding.
IND = indeterminate (due to limited reading resolution of the methods employed).

Table 1 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion continued					
Zr, Zirconium (ppm)	28.8	26.9	30.7	27.5	30.0
Aqua Regia Digestion					
Ag, Silver (ppm)	13.1	12.6	13.5	12.8	13.3
Al, Aluminium (wt.%)	1.02	0.97	1.07	0.99	1.05
As, Arsenic (ppm)	984	942	1027	965	1004
B, Boron (ppm)	< 10	IND	IND	IND	IND
Be, Beryllium (ppm)	< 0.05	IND	IND	IND	IND
Bi, Bismuth (ppm)	5.99	5.70	6.28	5.78	6.20
Ca, Calcium (wt.%)	0.624	0.593	0.654	0.608	0.639
Cd, Cadmium (ppm)	55	52	57	53	56
Ce, Cerium (ppm)	6.47	6.11	6.84	6.21	6.73
Co, Cobalt (ppm)	84	81	87	81	86
Cr, Chromium (ppm)	51	48	54	49	52
Cs, Caesium (ppm)	0.20	0.18	0.22	0.18	0.21
Cu, Copper (wt.%)	1.48	1.46	1.51	1.47	1.50
Dy, Dysprosium (ppm)	0.71	0.58	0.84	0.67	0.75
Er, Erbium (ppm)	0.41	0.34	0.48	0.37	0.45
Eu, Europium (ppm)	0.20	0.16	0.24	0.18	0.23
Fe, Iron (wt.%)	21.64	20.93	22.35	21.26	22.01
Ga, Gallium (ppm)	4.66	4.37	4.95	4.48	4.83
Gd, Gadolinium (ppm)	0.73	0.56	0.91	0.69	0.78
Ge, Germanium (ppm)	0.34	0.28	0.40	0.31	0.37
Hf, Hafnium (ppm)	0.31	0.27	0.36	0.30	0.33
Hg, Mercury (ppm)	3.43	3.14	3.72	3.26	3.60
Ho, Holmium (ppm)	0.12	0.10	0.15	IND	IND
In, Indium (ppm)	1.48	1.36	1.59	1.42	1.54
K, Potassium (wt.%)	0.241	0.226	0.255	0.232	0.249
La, Lanthanum (ppm)	3.09	2.90	3.27	2.96	3.22
Li, Lithium (ppm)	3.52	3.31	3.72	3.36	3.68
Lu, Lutetium (ppm)	0.054	0.029	0.078	IND	IND
Mg, Magnesium (wt.%)	0.567	0.545	0.589	0.555	0.579
Mn, Manganese (wt.%)	0.020	0.019	0.021	0.019	0.020
Mo, Molybdenum (ppm)	44.2	37.5	51.0	42.5	46.0
Na, Sodium (wt.%)	0.052	0.048	0.057	0.049	0.056
Nb, Niobium (ppm)	0.18	0.13	0.22	IND	IND
Nd, Neodymium (ppm)	3.13	2.60	3.66	3.01	3.26
Ni, Nickel (ppm)	47.5	45.0	50.0	46.1	48.9
P, Phosphorus (wt.%)	0.013	0.012	0.014	0.013	0.014
Pb, Lead (ppm)	1332	1277	1386	1306	1357
Pr, Praseodymium (ppm)	0.80	0.69	0.91	0.74	0.86

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

Note: intervals may appear asymmetric due to rounding.

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

Table 1 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Aqua Regia Digestion continued					
Rb, Rubidium (ppm)	5.17	4.78	5.56	4.90	5.43
S, Sulphur (wt.%)	23.08	22.31	23.86	22.82	23.35
Sb, Antimony (ppm)	75	68	81	72	78
Sc, Scandium (ppm)	3.76	3.41	4.10	3.58	3.93
Se, Selenium (ppm)	62	56	68	60	65
Sm, Samarium (ppm)	0.70	0.57	0.83	0.65	0.75
Sn, Tin (ppm)	8.51	8.04	8.98	8.16	8.86
Sr, Strontium (ppm)	11.7	10.5	12.9	11.0	12.3
Ta, Tantalum (ppm)	< 0.01	IND	IND	IND	IND
Tb, Terbium (ppm)	0.10	0.09	0.12	IND	IND
Te, Tellurium (ppm)	5.17	4.70	5.65	4.95	5.40
Th, Thorium (ppm)	0.99	0.89	1.09	0.93	1.05
Ti, Titanium (wt.%)	0.032	0.026	0.037	0.030	0.033
Tl, Thallium (ppm)	2.77	2.63	2.91	2.62	2.92
U, Uranium (ppm)	4.29	4.12	4.47	4.15	4.43
V, Vanadium (ppm)	34.9	31.9	37.9	33.6	36.2
W, Tungsten (ppm)	2.85	2.73	2.96	2.74	2.96
Y, Yttrium (ppm)	3.28	3.03	3.52	3.12	3.43
Yb, Ytterbium (ppm)	0.38	0.32	0.45	0.36	0.41
Zn, Zinc (wt.%)	1.19	1.16	1.22	1.18	1.21
Zr, Zirconium (ppm)	12.4	10.9	13.9	11.6	13.1

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

Note: intervals may appear asymmetric due to rounding.

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

Table 2. Indicative Values for OREAS 913.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Infrared Combustion								
C	wt.%	*0.124*						
Borate / Peroxide Fusion ICP								
Ag	ppm	*13.7*	Li	ppm	*8.40*	Ta	ppm	*0.21*
B	ppm	*51*	P	wt.%	*0.014*			
Hf	ppm	*1.10*	Re	ppm	*< 0.1*			
4-Acid Digestion								
Hg	ppm	*2.61*						
Aqua Regia Digestion								
Ba	ppm	*19.2*	Pt	ppb	*< 5*	Tm	ppm	*0.052*
Pd	ppb	*< 10*	Re	ppm	*0.010*			

SI unit equivalents: ppb (parts per billion; 1 x 10^{-9}) ≡ µg/kg; ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

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

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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 handling and correct use' should be read carefully.

Table 1 presents the certified values together with their associated 95 % expanded uncertainty and tolerance intervals. Table 2 provides indicative values, including major and trace element characterisation, Table 3 lists indicative physical properties, while Table 4 reports indicative mineralogy determined by semi-quantitative XRD analysis, Gold homogeneity, assessed by INAA, is shown in Table 5 and is further demonstrated through a nested ANOVA (see *Homogeneity Evaluation* section). Finally, Table 6 presents the performance gate intervals for all certified values.

Tabulated results of all analytes together with uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of laboratory means from the corrected mean of means (PDM[3]) are presented in the detailed certification data for this CRM (**OREAS 913-DataPack.1.0.260401_151615.xlsx**). The certified values and uncertainties in this Certificate are the sole authoritative figures. Any additional significant figures in the DataPack are provided for reference only and do not affect the certified results.

Results are also presented in scatter plots for Au by Pb fire assay and Cu and Zn by 4-acid digestion in Figures 1 to 3 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.

INTENDED USE

OREAS 913 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 913 may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 913 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/ validation 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. When a value provided in this certificate is used to calibrate a measurement process, the uncertainty associated with that value should be appropriately propagated into the user's uncertainty calculation. Users can determine an approximation of the standard uncertainty by calculating one fourth of

the width of the Expanded Uncertainty interval given in this certificate (Expanded Uncertainty intervals are provided in Table 1).

SOURCE MATERIAL

OREAS 913 was prepared from volcanic-hosted massive sulphide (VMS) ore sourced from the Ming Lode, located in Newfoundland & Labrador, Canada. The Ming Lode is characterised by polymetallic sulphide assemblages containing copper, zinc, gold and silver, occurring as semi-massive to massive sulphide zones within volcanic host rocks. Sulphide mineralisation is dominated by pyrite and chalcopyrite hosted within a silica–sericite-altered rhyodacite matrix. The principal sulphide minerals, in approximate order of abundance, are pyrite, chalcopyrite, cubanite, sphalerite, pyrrhotite, arsenopyrite and galena.

MINIMUM SAMPLE SIZE

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

- Au by lead collection fire assay: ≥ 25 g;
- Au by aqua regia digestion ICP finish: ≥15 g;
- Total S by IR combustion furnace/CS analyser: ≥ 0.1 g;
- Borate fusion / Sodium peroxide with ICP-OES and/or MS finish: ≥0.2 g;
- 4-acid digestion with ICP-OES and/or MS finish: ≥ 0.25 g;
- Aqua regia digestion with ICP-OES and/or MS finish: ≥ 0.5 g.

INSTRUCTIONS FOR HANDLING, STORAGE & CORRECT USE

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

Pre-homogenisation of the CRM prior to subsampling and analysis is not necessary as there is no particle segregation under transport [12].

All certified values contained within this report refer to the concentration levels in the packaged state. There is no need for drying prior to weighing and analysis.

Single-use sachets sealed under nitrogen

OREAS 913 has a certified Total Sulphur content of 24.37 wt.%, determined by interlaboratory consensus using infrared combustion furnace analysis. As a precaution to mitigate oxidation, the material is packaged under a nitrogen atmosphere in robust laminated foil pouches. Following analysis, any remaining material should be discarded unless the sachet is promptly resealed under vacuum or under nitrogen. It is the user’s responsibility to prevent contamination and minimise exposure to air.

Authoritative Source of Information

This Certificate of Analysis constitutes the primary and authoritative document for the certified values, associated expanded uncertainties, and their correct use. While the accompanying DataPack provides supporting information, including raw data and uncertainty estimates with additional significant figures, these extended figures are provided solely for transparency, convenience and statistical reference. Users must rely exclusively on the values stated in this Certificate, rounded to an appropriate number of significant figures, for all metrological and analytical purposes. Any discrepancy between values presented in the DataPack and those in this Certificate shall be resolved in favour of the information provided herein.

Notice on Certificate Updates

The version of the Certificate of Analysis (COA) available on the OREAS website is considered the official and most current version. As COAs may be revised following periodic reviews, re-evaluation of data, or the availability of new information, users are strongly advised to refer to the latest online version prior to each use.

It is the user's responsibility to ensure that the most recent and applicable certificate is used to support the traceability, validity, and fitness-for-purpose of the certified reference material (CRM).

Any significant changes to the sections of this certificate will be clearly documented in the revised certificate.

QC monitoring using multiples of the Standard Deviation (SD)

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

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

The performance gates shown in Table 6 are intended only to be used as a preliminary guide as to what a laboratory may be able to achieve. Over a period of time monitoring your own laboratory's data for this CRM, SD's should be calculated directly from your own laboratory's process. This will enable you to establish more specific performance gates that are fit for purpose for your application as well as the ability to monitor bias. If your long-term trend analysis shows an average value that is within the 95 % expanded uncertainty then generally there is no cause for concern in regard to bias.

For use with the aqua regia digestion method

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

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

PERIOD OF VALIDITY

The certification of OREAS 913 remains valid, within the specified measurement uncertainties, until at least July 2040, provided the CRM is handled and stored in accordance with the instructions given below. This certification is nullified if the CRM is any way changed or contaminated.

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

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

COMMINUTION AND HOMOGENISATION PROCEDURES

The materials constituting OREAS 913 was prepared in the following manner:

- Drying of ore to constant mass at 85 °C;
- Crushing and multi-stage milling of the ore to 100 % minus 30 microns;
- Homogenisation using OREAS' novel processing technologies;
- Packaging in 60 g units sealed under nitrogen in laminated foil pouches.

PHYSICAL PROPERTIES

OREAS 913 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 913.

Bulk Density (kg/m^3)	Moisture (wt.%)	Munsell Notation‡	Munsell Color‡
775	0.85	N4	Medium Dark Gray

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

MINERALOGY

The semi-quantitative XRD results shown in Table 4 below were undertaken by ALS Metallurgy in Balcatta, Western Australia. The results have been normalised to 100 % and represent the relative proportion of crystalline material. Totals greater or less than 100 % are due to rounding errors.

Some amorphous material may be present. 'Clay minerals' appears to be mainly smectite and/or vermiculite. 'Kandite group' appears to be mainly kaolinite. 'K-feldspar and/or rutile' appears to be most likely K-feldspar. A trace of calcite may be present and, if present, is reported under chalcopyrite due to pattern overlap. Minor arsenopyrite and sphalerite is likely present, but this cannot be confirmed due to pattern overlap.

Table 4. Indicative mineralogy of OREAS 913 by semi-quantitative XRD analysis.

Mineral / Mineral Group	% (mass ratio)
Chalcopyrite	4
Pyrrhotite	1
Pyrite	42
Magnetite	< 1
Clay minerals	< 1
Chlorite	3
Annite - biotite - phlogopite	1
Muscovite - illite	14
Ca amphibole	5
Plagioclase	5
K-feldspar and/or rutile	< 1
Quartz	24
Garnet	< 1
Gypsum	< 1
Dolomite - ankerite	< 1

ANALYTICAL PROGRAM

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

- Instrumental neutron activation analysis (INAA) for Au on 20 x 85 mg subsamples to confirm homogeneity (1 laboratory);
- Gold by Pb collection fire assay (25-50g charge weight) with AAS (20 laboratories), ICP-OES or ICP-MS (6 laboratories) finish;
- Gold by 15-50g aqua regia digestion with ICP-MS (10 laboratories) or AAS (6 laboratories) finish;
- Total S by IR combustion furnace (23 laboratories);
- Full ICP-OES and ICP-MS elemental suites by sodium peroxide fusion (up to 18 laboratories depending on the element);
- Full ICP-OES and ICP-MS elemental suites by 4-acid (HNO_3-HF-$HClO_4$-HCl) digestion (up to 22 laboratories depending on the element);

- Full ICP-OES and ICP-MS elemental suites by aqua regia digestion (up to 22 laboratories depending on the element).

For the round robin program, twelve 2.5 kg test units were collected at predetermined intervals during the bagging stage, immediately after homogenisation. The samples received by each laboratory were obtained by taking a 160 g sample from six different 2.5 kg test units to maximise representation (i.e., from either the odd or even sampling (lot) intervals).

The 20 individual INAA results upon which much of the homogeneity evaluation is based, included paired 10 g samples taken from 10 different sampling units. This format enabled a nested ANOVA treatment of the INAA results to evaluate homogeneity (see ‘Homogeneity Evaluation’ section below).

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. AGAT Laboratories, Thunder Bay, Ontario, Canada
3. ALS, Brisbane, QLD, Australia
4. ALS, Lima, Peru
5. ALS, Loughrea, Galway, Ireland
6. ALS, Malaga, WA, Australia
7. ALS, Vancouver, BC, Canada
8. American Assay Laboratories, Sparks, Nevada, USA
9. ANSTO, Lucas Heights, NSW, Australia
10. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
11. Gekko Assay Labs, Ballarat, VIC, Australia
12. Inspectorate (BV), Lima, Peru
13. Intertek, Cupang, Muntinlupa, Philippines
14. Intertek, Perth, WA, Australia
15. Intertek, Townsville, QLD, Australia
16. Intertek Genalysis, Adelaide, SA, Australia
17. Intertek Minerals Ltd, Tarkwa, Western Region, Ghana
18. Lucid Laboratories Private Limited, Hyderabad, Telangana, India
19. On Site Laboratory Services, Bendigo, VIC, Australia
20. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
21. PT Indo Mineral Research, Bungursari, West Java, Indonesia
22. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
23. SGS Canada Inc., Vancouver, BC, Canada
24. SGS Geosol Laboratorios Ltda, Vespasiano, Minas Gerais, Brazil
25. SGS Tarkwa, Tarkwa, Western Region, Ghana
26. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
27. Skyline Assayers & Laboratories, Tucson, Arizona, USA
28. Stewart Assay & Environmental Laboratories LLC, Kara-Balta, Chüy, Kyrgyzstan

Please note: To maintain anonymity of participating laboratories, the alphabetical list above does not correspond to the Lab ID numbers shown in the scatter plots below.

STATISTICAL ANALYSIS

Certified Values and their uncertainty intervals (Table 1) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration). Outlier evaluation was conducted in accordance with ISO 17034:2017 and ISO 33405:2024. While formal statistical tests were applied, professional statistical judgment was also exercised in determining the validity of potential outliers. Assessment of systematic bias and performance using independent control materials (CRMs) was incorporated to ensure compliance with the referenced standards and to establish metrological traceability of the certified values.

95% Expanded Uncertainty provides a 95 % probability that the true value of the analyte under consideration lies between the upper and lower limits and is calculated according to the method outlined in [6] and [15]. All known or suspected sources of bias have been investigated or taken into account.

Indicative (uncertified) values (Table 2) are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where interlaboratory consensus is poor. This data is intended for 'informational purposes' only.

Standard Deviation intervals (see Table 6, 'Performance Gates') 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.***

Homogeneity Evaluation

For analytes other than gold, 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 Cu 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 1.48 and 1.53 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. ***Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.***

The homogeneity of gold has been determined by INAA at ANSTO using the reduced analytical subsample method which utilises the known relationship between standard deviation and analytical subsample weight (Ingamells and Switzer, 1973 [2]). In this approach the sample aliquot is substantially reduced to a point where most of the variability in replicate assays should be due to inhomogeneity of the reference material and measurement error becomes negligible. Table 5 below shows the gold INAA data determined on 20 x 85 mg subsamples of OREAS 913. An equivalent scaled version of the results is also provided to demonstrate an appreciation of what this data means if 30 g fire assays were undertaken without the normal measurement error associated with this methodology. In this instance, the 1RSD of 0.21 % calculated for a 30 g fire assay sample (3.88 % at 85 mg weights) confirms the high level of gold homogeneity in OREAS 913.

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

Replicate No	Au 85 mg actual	Au 30 g equivalent*
1	2.141	2.171
2	2.167	2.173
3	2.219	2.175
4	2.481	2.189
5	2.195	2.174
6	2.184	2.173
7	2.196	2.174
8	2.096	2.169
9	2.142	2.171
10	2.158	2.172
11	2.182	2.173
12	2.145	2.171
13	2.188	2.174
14	2.128	2.171
15	2.183	2.173
16	2.131	2.171
17	2.235	2.176
18	2.125	2.170
19	2.096	2.169
20	2.066	2.167
Mean	2.173	2.173
Median	2.162	2.172
Std Dev.	0.084	0.004
Rel.Std.Dev.	**3.88%**	**0.21%**

*Results calculated for a 30 g 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 30 g sample mass
(x^{INAA}) = raw INAA result at 85 mg
$\bar{X}$ = mean of 85 mg INAA results

The homogeneity of OREAS 913 has also been evaluated in an Analysis of Variance (**ANOVA**) of the INAA data. The 20 samples were comprised of paired samples from each of 10 sampling lot intervals (representative of the prepared batch) and were randomised prior to assigning sample numbers. The duplicate samples enabled an ANOVA by comparison of within- and between-unit variances across the 10 pairs. The purpose of the ANOVA 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 913. The test was performed using the following parameters:

- Gold INAA – 20 results (1 laboratory providing duplicate analyses on 10 samples where each sample can be viewed as a ‘unit’);

- 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.

The data were not filtered for outliers before p-value calculation, which yielded 0.32—statistically insignificant, so the Null Hypothesis is accepted. ANOVA does not measure absolute homogeneity; it evaluates whether analytes are similarly distributed across the packaging run and whether variance between subsamples from the same unit differs from that between separate units. A reference material may show poor absolute homogeneity yet still meet a relative homogeneity (ANOVA) criterion if within-unit heterogeneity is substantial and consistent. Based on ANOVA and interlaboratory certification results, OREAS 913 is fit-for-purpose as a certified reference material (see 'Intended Use' above).

METROLOGICAL TRACEABILITY

The interlaboratory results that underpin the certified values are metrologically traceable to the international measurement scale (SI) of mass (either as a % mass fraction or as milligrams per kilogram (mg/kg)) [14]. In line with popular use, all data within tables in this certificate are expressed as the mass fraction in either weight percent (wt.%) or parts per million (ppm).

The analytical samples sent to participating laboratories were selected in a manner to be representative of the entire prepared batch of CRM. This representativeness 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. The systematic sampling method was chosen due to the low risk of overlooking repetitive effects or trends in the batch due to the way the CRM was processed. In line with ISO 17025 [8], each analytical data set received from the participating laboratories has been validated by its assayer through the inclusion of internal reference materials and QC checks during and post analysis.

Participating laboratories were selected based on demonstrated analytical competence, including prior performance in interlaboratory comparison programs conducted by ORE Pty Ltd, with consideration given to their expertise in relevant analytical methods, measurands, and sample matrices. For the measurands reported in this certificate (Table 1), data were sourced from laboratories accredited to ISO/IEC 17025. Where formal accreditation was not held for specific operationally defined measurands, metrological traceability was verified through the use of well-characterised, independently certified reference materials (CRMs) included as control samples in the round robin study.

In accordance with ISO 33405:2024-05 [5], clause 9.2.5, and ISO 17034:2016 [9], clause 7.12.4 b), the use of such control samples provides an acceptable means of demonstrating traceability in the absence of formal accreditation. In this certification program, traceability was further supported by the agreement of measured values for control samples with their known certified values, thereby offering additional confidence in the calibration and validity of measurement results across participating laboratories.

Operationally Defined Measurands

In accordance with ISO 33405:2024-05, Clause 9.2.4, measurands (analytes) may be certified as operationally defined. For these measurands, traceability to the SI may not be achievable because the analytical procedure involves sample transformations (e.g., leaching or extraction). While instrument calibration can be traceable to appropriate units, the transformation steps themselves are not directly traceable and can only be evaluated through reference comparisons or harmonized procedures.

Accordingly, characterisation of these measurands has been based on the concordance of results obtained from multiple laboratories using a common, well-defined procedure. This approach ensures fitness-for-purpose and fulfils the requirements for metrological traceability as specified in ISO 17034 and ISO 33405 for operationally defined measurands.

COMMUTABILITY

The certified values reported herein are derived from measurements performed using analytical methods involving sample pre-treatment steps, such as fusion or acid digestion. These processes convert the sample matrix into a chemically simplified and stable form, facilitating calibration traceable to primary standards via solution-based calibration protocols. Due to the established robustness and effectiveness of these pre-treatment methods, issues related to commutability are not expected to impact the suitability of this Certified Reference Material (CRM) for its intended use.

OREAS CRMs are prepared from natural ore materials, ensuring the presence of matrix and mineralogical characteristics representative of typical exploration, mine and process samples. Consistent with ISO 17034:2016 and ISO Guide 30, users are advised to select CRMs with matrix and mineralisation styles closely matching those of their routine samples to minimize matrix effects and enhance analytical comparability. Detailed descriptions of the CRM’s source material and mineralogical characteristics are provided in the ‘Source Material’ section to guide appropriate CRM selection.

PERFORMANCE GATES

Table 6 below 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 [1].

Table 6. Performance Gates for OREAS 913.

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	2.06	0.044	1.98	2.15	1.93	2.20	2.13%	4.27%	6.40%	1.96	2.17
Aqua Regia Digestion (sample weights 15-50g)											
Au, ppm	1.94	0.171	1.60	2.28	1.43	2.46	8.82%	17.64%	26.47%	1.84	2.04
Infrared Combustion											
S, wt.%	24.37	0.527	23.32	25.43	22.79	25.95	2.16%	4.33%	6.49%	23.15	25.59
Borate / Peroxide Fusion ICP											
Al, wt.%	4.01	0.093	3.82	4.20	3.73	4.29	2.33%	4.66%	6.99%	3.81	4.21
As, ppm	1014	44	926	1103	882	1147	4.35%	8.71%	13.06%	964	1065
Ba, ppm	125	5	114	135	109	140	4.18%	8.36%	12.54%	118	131
Be, ppm	< 1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Bi, ppm	6.16	0.171	5.82	6.50	5.65	6.68	2.78%	5.56%	8.34%	5.85	6.47
Ca, wt.%	1.14	0.046	1.04	1.23	1.00	1.28	4.08%	8.15%	12.23%	1.08	1.19
Cd, ppm	55	3.9	47	62	43	66	7.11%	14.21%	21.32%	52	57
Ce, ppm	8.99	0.487	8.02	9.96	7.53	10.45	5.41%	10.83%	16.24%	8.54	9.44
Co, ppm	85	4.8	76	95	71	99	5.59%	11.19%	16.78%	81	89
Cr, ppm	100	19	63	138	44	156	18.74%	37.47%	56.21%	95	105
Cs, ppm	0.58	0.11	0.36	0.80	0.25	0.92	19.16%	38.32%	57.48%	0.55	0.61
Cu, wt.%	1.49	0.022	1.45	1.54	1.43	1.56	1.48%	2.97%	4.45%	1.42	1.57
Dy, ppm	1.06	0.096	0.87	1.25	0.77	1.35	9.02%	18.04%	27.06%	1.01	1.11
Er, ppm	0.61	0.06	0.49	0.74	0.43	0.80	10.20%	20.41%	30.61%	0.58	0.65
Eu, ppm	0.32	0.032	0.26	0.39	0.23	0.42	9.80%	19.60%	29.39%	0.31	0.34
Fe, wt.%	23.07	0.440	22.19	23.95	21.75	24.39	1.91%	3.81%	5.72%	21.92	24.22
Ga, ppm	12.3	0.51	11.3	13.3	10.8	13.8	4.12%	8.25%	12.37%	11.7	12.9
Gd, ppm	1.06	0.096	0.87	1.26	0.78	1.35	9.02%	18.04%	27.06%	1.01	1.12
Ge, ppm	4.38	0.63	3.11	5.65	2.48	6.29	14.49%	28.97%	43.46%	4.16	4.60
Ho, ppm	0.21	0.014	0.18	0.24	0.17	0.25	6.78%	13.56%	20.34%	0.20	0.22
In, ppm	1.46	0.119	1.22	1.70	1.10	1.82	8.17%	16.34%	24.51%	1.39	1.53
K, wt.%	1.25	0.086	1.07	1.42	0.99	1.51	6.92%	13.84%	20.76%	1.18	1.31
La, ppm	4.05	0.280	3.48	4.61	3.20	4.89	6.92%	13.85%	20.77%	3.84	4.25
Lu, ppm	0.10	0.01	0.08	0.12	0.07	0.13	10.87%	21.75%	32.62%	0.10	0.11
Mg, wt.%	0.800	0.032	0.737	0.863	0.705	0.894	3.95%	7.90%	11.84%	0.760	0.840
Mn, wt.%	0.026	0.002	0.022	0.029	0.021	0.031	6.61%	13.21%	19.82%	0.024	0.027
Mo, ppm	62	7	48	76	42	82	10.90%	21.80%	32.70%	59	65
Nb, ppm	2.10	0.42	1.26	2.93	0.84	3.35	19.94%	39.87%	59.81%	1.99	2.20
Nd, ppm	4.59	0.309	3.97	5.21	3.66	5.52	6.73%	13.47%	20.20%	4.36	4.82
Ni, ppm	54	11	33	75	22	86	19.64%	39.28%	58.92%	51	57
Pb, ppm	1401	53	1295	1508	1241	1562	3.81%	7.61%	11.42%	1331	1472
Pr, ppm	1.07	0.048	0.98	1.17	0.93	1.22	4.50%	8.99%	13.49%	1.02	1.13
Rb, ppm	24.7	1.47	21.8	27.6	20.3	29.1	5.94%	11.88%	17.82%	23.4	25.9
S, wt.%	24.30	0.495	23.31	25.29	22.81	25.78	2.04%	4.08%	6.12%	23.08	25.51
Sb, ppm	107	3	102	112	99	115	2.44%	4.89%	7.33%	102	112
Sc, ppm	12.0	0.80	10.4	13.6	9.6	14.4	6.70%	13.39%	20.09%	11.4	12.6
Se, ppm	58	10	38	77	29	86	16.69%	33.38%	50.07%	55	60

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

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

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

Table 6 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
Borate / Peroxide Fusion ICP continued											
SiO_2, wt.%	34.48	0.933	32.61	36.35	31.68	37.28	2.71%	5.41%	8.12%	32.76	36.20
Sm, ppm	1.04	0.11	0.83	1.25	0.72	1.36	10.27%	20.54%	30.81%	0.99	1.09
Sn, ppm	13.0	1.07	10.8	15.1	9.8	16.2	8.22%	16.44%	24.66%	12.3	13.6
Sr, ppm	51	3.1	45	57	41	60	6.10%	12.21%	18.31%	48	53
Tb, ppm	0.17	0.015	0.14	0.20	0.13	0.21	8.63%	17.26%	25.89%	0.16	0.18
Te, ppm	4.94	0.373	4.20	5.69	3.82	6.06	7.55%	15.10%	22.65%	4.69	5.19
Th, ppm	1.10	0.068	0.97	1.24	0.90	1.30	6.15%	12.31%	18.46%	1.05	1.16
Ti, wt.%	0.178	0.008	0.162	0.194	0.153	0.203	4.63%	9.26%	13.89%	0.169	0.187
Tl, ppm	9.16	0.736	7.69	10.63	6.95	11.37	8.04%	16.08%	24.12%	8.70	9.62
Tm, ppm	0.093	0.009	0.075	0.111	0.065	0.121	9.90%	19.79%	29.69%	0.088	0.098
U, ppm	4.59	0.284	4.03	5.16	3.74	5.45	6.19%	12.37%	18.56%	4.36	4.82
V, ppm	96	6.1	83	108	77	114	6.42%	12.84%	19.25%	91	100
W, ppm	5.32	0.65	4.03	6.62	3.38	7.27	12.20%	24.39%	36.59%	5.06	5.59
Y, ppm	5.72	0.393	4.93	6.50	4.54	6.89	6.88%	13.75%	20.63%	5.43	6.00
Yb, ppm	0.64	0.08	0.48	0.81	0.39	0.89	12.85%	25.70%	38.55%	0.61	0.67
Zn, wt.%	1.22	0.058	1.11	1.34	1.05	1.40	4.71%	9.42%	14.13%	1.16	1.28
Zr, ppm	44.8	3.57	37.7	51.9	34.1	55.5	7.96%	15.93%	23.89%	42.5	47.0
4-Acid Digestion											
Ag, ppm	13.1	0.67	11.8	14.5	11.1	15.1	5.10%	10.21%	15.31%	12.5	13.8
Al, wt.%	3.89	0.186	3.52	4.26	3.33	4.44	4.78%	9.55%	14.33%	3.69	4.08
As, ppm	968	48	871	1065	823	1114	5.01%	10.01%	15.02%	920	1017
Ba, ppm	115	15	85	145	70	160	13.02%	26.05%	39.07%	109	121
Be, ppm	0.21	0.03	0.14	0.28	0.11	0.31	15.87%	31.75%	47.62%	0.20	0.22
Bi, ppm	6.12	0.431	5.25	6.98	4.82	7.41	7.05%	14.10%	21.14%	5.81	6.42
Ca, wt.%	1.11	0.049	1.01	1.21	0.96	1.26	4.39%	8.78%	13.17%	1.05	1.17
Cd, ppm	57	1.8	53	60	51	62	3.14%	6.28%	9.43%	54	59
Ce, ppm	9.13	0.530	8.07	10.19	7.54	10.72	5.80%	11.60%	17.41%	8.67	9.59
Co, ppm	87	3.4	80	94	76	97	3.97%	7.94%	11.91%	82	91
Cr, ppm	99	6.5	86	111	79	118	6.55%	13.10%	19.65%	94	103
Cs, ppm	0.51	0.040	0.43	0.59	0.39	0.63	7.82%	15.64%	23.46%	0.49	0.54
Cu, wt.%	1.51	0.030	1.45	1.57	1.42	1.60	1.97%	3.94%	5.90%	1.43	1.58
Dy, ppm	1.03	0.073	0.89	1.18	0.81	1.25	7.09%	14.19%	21.28%	0.98	1.09
Er, ppm	0.61	0.042	0.52	0.69	0.48	0.73	7.00%	13.99%	20.99%	0.58	0.64
Eu, ppm	0.32	0.024	0.27	0.37	0.25	0.39	7.43%	14.85%	22.28%	0.30	0.34
Fe, wt.%	22.36	0.558	21.25	23.48	20.69	24.03	2.49%	4.99%	7.48%	21.24	23.48
Ga, ppm	12.5	0.76	11.0	14.0	10.2	14.8	6.09%	12.18%	18.26%	11.9	13.1
Gd, ppm	1.07	0.089	0.89	1.25	0.80	1.34	8.28%	16.56%	24.84%	1.02	1.12
Ge, ppm	0.34	0.09	0.17	0.51	0.09	0.60	24.99%	49.97%	74.96%	0.33	0.36
Hf, ppm	0.77	0.058	0.65	0.89	0.60	0.95	7.56%	15.11%	22.67%	0.73	0.81
Ho, ppm	0.20	0.02	0.15	0.25	0.13	0.27	12.13%	24.26%	36.39%	0.19	0.21
In, ppm	1.48	0.078	1.32	1.63	1.24	1.71	5.27%	10.54%	15.81%	1.40	1.55
K, wt.%	1.19	0.055	1.08	1.30	1.03	1.36	4.59%	9.18%	13.76%	1.13	1.25
La, ppm	4.01	0.294	3.42	4.60	3.13	4.89	7.34%	14.69%	22.03%	3.81	4.21

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

Note 1: intervals may appear asymmetric due to rounding.

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

Table 6 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											
Li, ppm	5.57	0.442	4.69	6.45	4.25	6.90	7.93%	15.85%	23.78%	5.29	5.85
Lu, ppm	0.094	0.013	0.067	0.121	0.054	0.134	14.11%	28.22%	42.33%	0.089	0.099
Mg, wt.%	0.737	0.035	0.666	0.807	0.631	0.843	4.80%	9.60%	14.40%	0.700	0.773
Mn, wt.%	0.025	0.001	0.023	0.028	0.022	0.029	4.59%	9.18%	13.78%	0.024	0.027
Mo, ppm	59	2.4	54	64	51	66	4.14%	8.29%	12.43%	56	62
Na, wt.%	0.394	0.014	0.365	0.423	0.351	0.438	3.68%	7.35%	11.03%	0.375	0.414
Nb, ppm	1.53	0.106	1.32	1.74	1.21	1.85	6.96%	13.92%	20.88%	1.45	1.61
Nd, ppm	4.56	0.277	4.00	5.11	3.73	5.39	6.07%	12.15%	18.22%	4.33	4.79
Ni, ppm	49.3	2.88	43.5	55.0	40.7	57.9	5.84%	11.67%	17.51%	46.8	51.7
P, wt.%	0.013	0.001	0.012	0.014	0.011	0.015	4.93%	9.87%	14.80%	0.012	0.014
Pb, ppm	1365	56	1254	1476	1198	1532	4.08%	8.16%	12.24%	1297	1433
Pr, ppm	1.09	0.081	0.93	1.25	0.85	1.34	7.42%	14.84%	22.26%	1.04	1.15
Rb, ppm	24.3	1.43	21.4	27.2	20.0	28.6	5.90%	11.80%	17.70%	23.1	25.5
Re, ppm	0.017	0.003	0.012	0.023	0.009	0.026	16.30%	32.59%	48.89%	0.016	0.018
S, wt.%	23.55	0.759	22.03	25.07	21.27	25.83	3.22%	6.45%	9.67%	22.37	24.73
Sb, ppm	102	5	92	112	87	117	4.95%	9.91%	14.86%	97	107
Sc, ppm	12.5	0.69	11.1	13.9	10.4	14.6	5.54%	11.08%	16.62%	11.9	13.1
Se, ppm	59	6	47	72	41	78	10.42%	20.84%	31.26%	56	62
Sm, ppm	1.05	0.086	0.88	1.23	0.80	1.31	8.14%	16.28%	24.41%	1.00	1.11
Sn, ppm	12.0	0.88	10.2	13.7	9.3	14.6	7.34%	14.69%	22.03%	11.4	12.6
Sr, ppm	48.6	2.23	44.2	53.1	41.9	55.3	4.59%	9.17%	13.76%	46.2	51.1
Ta, ppm	0.11	0.01	0.08	0.13	0.07	0.14	10.50%	21.00%	31.51%	0.10	0.11
Tb, ppm	0.16	0.02	0.12	0.20	0.10	0.22	12.50%	24.99%	37.49%	0.15	0.17
Te, ppm	4.98	0.400	4.18	5.78	3.78	6.18	8.04%	16.08%	24.12%	4.73	5.23
Th, ppm	1.09	0.088	0.92	1.27	0.83	1.35	8.05%	16.11%	24.16%	1.04	1.15
Ti, wt.%	0.135	0.007	0.121	0.149	0.114	0.156	5.16%	10.31%	15.47%	0.128	0.142
Tl, ppm	9.29	0.605	8.08	10.50	7.47	11.10	6.51%	13.03%	19.54%	8.82	9.75
Tm, ppm	0.080	0.016	0.047	0.112	0.031	0.129	20.55%	41.10%	61.66%	0.076	0.084
U, ppm	4.64	0.243	4.15	5.13	3.91	5.37	5.23%	10.47%	15.70%	4.41	4.87
V, ppm	92	5.2	82	103	77	108	5.62%	11.24%	16.86%	88	97
W, ppm	4.99	0.374	4.24	5.74	3.87	6.11	7.49%	14.98%	22.47%	4.74	5.24
Y, ppm	5.55	0.265	5.01	6.08	4.75	6.34	4.78%	9.57%	14.35%	5.27	5.82
Yb, ppm	0.59	0.07	0.45	0.73	0.38	0.80	11.72%	23.44%	35.16%	0.56	0.62
Zn, wt.%	1.23	0.034	1.16	1.30	1.13	1.33	2.76%	5.53%	8.29%	1.17	1.29
Zr, ppm	28.8	1.58	25.6	31.9	24.0	33.5	5.51%	11.02%	16.53%	27.3	30.2
Aqua Regia Digestion											
Ag, ppm	13.1	0.71	11.6	14.5	10.9	15.2	5.45%	10.91%	16.36%	12.4	13.7
Al, wt.%	1.02	0.066	0.89	1.15	0.82	1.21	6.44%	12.89%	19.33%	0.97	1.07
As, ppm	984	45	895	1074	850	1119	4.55%	9.10%	13.66%	935	1034
B, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Be, ppm	< 0.05	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Bi, ppm	5.99	0.331	5.33	6.65	5.00	6.98	5.53%	11.05%	16.58%	5.69	6.29
Ca, wt.%	0.624	0.047	0.530	0.717	0.483	0.764	7.50%	15.01%	22.51%	0.592	0.655

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

Note 1: intervals may appear asymmetric due to rounding.

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

Table 6 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											
Cd, ppm	55	3.8	47	62	43	66	7.04%	14.07%	21.11%	52	57
Ce, ppm	6.47	0.456	5.56	7.39	5.10	7.84	7.05%	14.10%	21.15%	6.15	6.80
Co, ppm	84	4.4	75	92	71	97	5.22%	10.44%	15.66%	80	88
Cr, ppm	51	4.1	42	59	38	63	8.05%	16.11%	24.16%	48	53
Cs, ppm	0.20	0.02	0.15	0.24	0.13	0.26	11.26%	22.51%	33.77%	0.19	0.21
Cu, wt.%	1.48	0.038	1.41	1.56	1.37	1.60	2.58%	5.16%	7.74%	1.41	1.56
Dy, ppm	0.71	0.09	0.53	0.88	0.44	0.97	12.50%	25.00%	37.51%	0.67	0.74
Er, ppm	0.41	0.05	0.31	0.51	0.26	0.55	11.83%	23.66%	35.49%	0.39	0.43
Eu, ppm	0.20	0.03	0.15	0.26	0.13	0.28	12.34%	24.69%	37.03%	0.19	0.21
Fe, wt.%	21.64	0.825	19.99	23.29	19.16	24.11	3.81%	7.62%	11.43%	20.56	22.72
Ga, ppm	4.66	0.389	3.88	5.43	3.49	5.82	8.35%	16.70%	25.04%	4.42	4.89
Gd, ppm	0.73	0.13	0.47	1.00	0.34	1.13	17.78%	35.56%	53.34%	0.70	0.77
Ge, ppm	0.34	0.05	0.24	0.44	0.19	0.49	14.74%	29.49%	44.23%	0.32	0.36
Hf, ppm	0.31	0.05	0.21	0.41	0.17	0.46	15.76%	31.52%	47.28%	0.30	0.33
Hg, ppm	3.43	0.283	2.86	4.00	2.58	4.28	8.24%	16.48%	24.71%	3.26	3.60
Ho, ppm	0.12	0.03	0.07	0.18	0.05	0.20	21.04%	42.09%	63.13%	0.12	0.13
In, ppm	1.48	0.101	1.28	1.68	1.17	1.78	6.86%	13.72%	20.58%	1.40	1.55
K, wt.%	0.241	0.022	0.198	0.284	0.176	0.305	8.95%	17.90%	26.84%	0.229	0.253
La, ppm	3.09	0.193	2.70	3.47	2.51	3.67	6.24%	12.47%	18.71%	2.93	3.24
Li, ppm	3.52	0.195	3.13	3.91	2.93	4.10	5.55%	11.11%	16.66%	3.34	3.69
Lu, ppm	0.054	0.015	0.025	0.083	0.010	0.098	27.20%	54.41%	81.61%	0.051	0.056
Mg, wt.%	0.567	0.034	0.499	0.635	0.465	0.669	6.01%	12.02%	18.03%	0.539	0.595
Mn, wt.%	0.020	0.001	0.017	0.023	0.015	0.024	7.50%	15.00%	22.50%	0.019	0.021
Mo, ppm	44.2	11.3	21.6	66.9	10.3	78.2	25.58%	51.16%	76.74%	42.0	46.5
Na, wt.%	0.052	0.006	0.041	0.064	0.035	0.070	11.14%	22.29%	33.43%	0.050	0.055
Nb, ppm	0.18	0.05	0.07	0.28	0.02	0.33	30.07%	60.13%	90.20%	0.17	0.18
Nd, ppm	3.13	0.38	2.37	3.90	1.98	4.29	12.26%	24.53%	36.79%	2.98	3.29
Ni, ppm	47.5	2.50	42.5	52.5	40.0	55.0	5.27%	10.55%	15.82%	45.1	49.9
P, wt.%	0.013	0.001	0.012	0.015	0.011	0.015	5.23%	10.45%	15.68%	0.013	0.014
Pb, ppm	1332	73	1186	1478	1113	1551	5.47%	10.95%	16.42%	1265	1398
Pr, ppm	0.80	0.10	0.60	1.00	0.50	1.09	12.28%	24.57%	36.85%	0.76	0.84
Rb, ppm	5.17	0.383	4.40	5.93	4.02	6.31	7.41%	14.82%	22.23%	4.91	5.42
S, wt.%	23.08	0.918	21.25	24.92	20.33	25.84	3.98%	7.95%	11.93%	21.93	24.24
Sb, ppm	75	12	51	98	40	110	15.71%	31.43%	47.14%	71	79
Sc, ppm	3.76	0.221	3.31	4.20	3.09	4.42	5.89%	11.78%	17.67%	3.57	3.95
Se, ppm	62	9	43	81	34	91	15.23%	30.45%	45.68%	59	65
Sm, ppm	0.70	0.09	0.51	0.88	0.42	0.97	13.15%	26.30%	39.45%	0.66	0.73
Sn, ppm	8.51	0.319	7.87	9.15	7.56	9.47	3.75%	7.50%	11.24%	8.09	8.94
Sr, ppm	11.7	1.6	8.4	14.9	6.8	16.6	14.00%	28.00%	42.00%	11.1	12.2
Ta, ppm	< 0.01	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Tb, ppm	0.10	0.008	0.09	0.12	0.08	0.13	7.93%	15.87%	23.80%	0.10	0.11
Te, ppm	5.17	0.66	3.85	6.50	3.18	7.17	12.83%	25.66%	38.50%	4.91	5.43
Th, ppm	0.99	0.093	0.81	1.18	0.71	1.27	9.36%	18.72%	28.08%	0.94	1.04

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

Note 1: intervals may appear asymmetric due to rounding.

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

Table 6 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											
Ti, wt.%	0.032	0.010	0.012	0.051	0.003	0.060	30.31%	60.63%	90.94%	0.030	0.033
Tl, ppm	2.77	0.189	2.39	3.15	2.20	3.34	6.81%	13.62%	20.43%	2.63	2.91
U, ppm	4.29	0.173	3.95	4.64	3.78	4.81	4.03%	8.05%	12.08%	4.08	4.51
V, ppm	34.9	4.7	25.5	44.3	20.8	49.0	13.47%	26.93%	40.40%	33.2	36.6
W, ppm	2.85	0.105	2.64	3.06	2.53	3.16	3.69%	7.37%	11.06%	2.71	2.99
Y, ppm	3.28	0.258	2.76	3.79	2.50	4.05	7.87%	15.74%	23.61%	3.11	3.44
Yb, ppm	0.38	0.05	0.28	0.48	0.24	0.53	12.79%	25.57%	38.36%	0.36	0.40
Zn, wt.%	1.19	0.051	1.09	1.30	1.04	1.35	4.30%	8.59%	12.89%	1.13	1.25
Zr, ppm	12.4	1.9	8.6	16.1	6.7	18.0	15.18%	30.37%	45.55%	11.8	13.0

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

Note 1: intervals may appear asymmetric due to rounding.

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

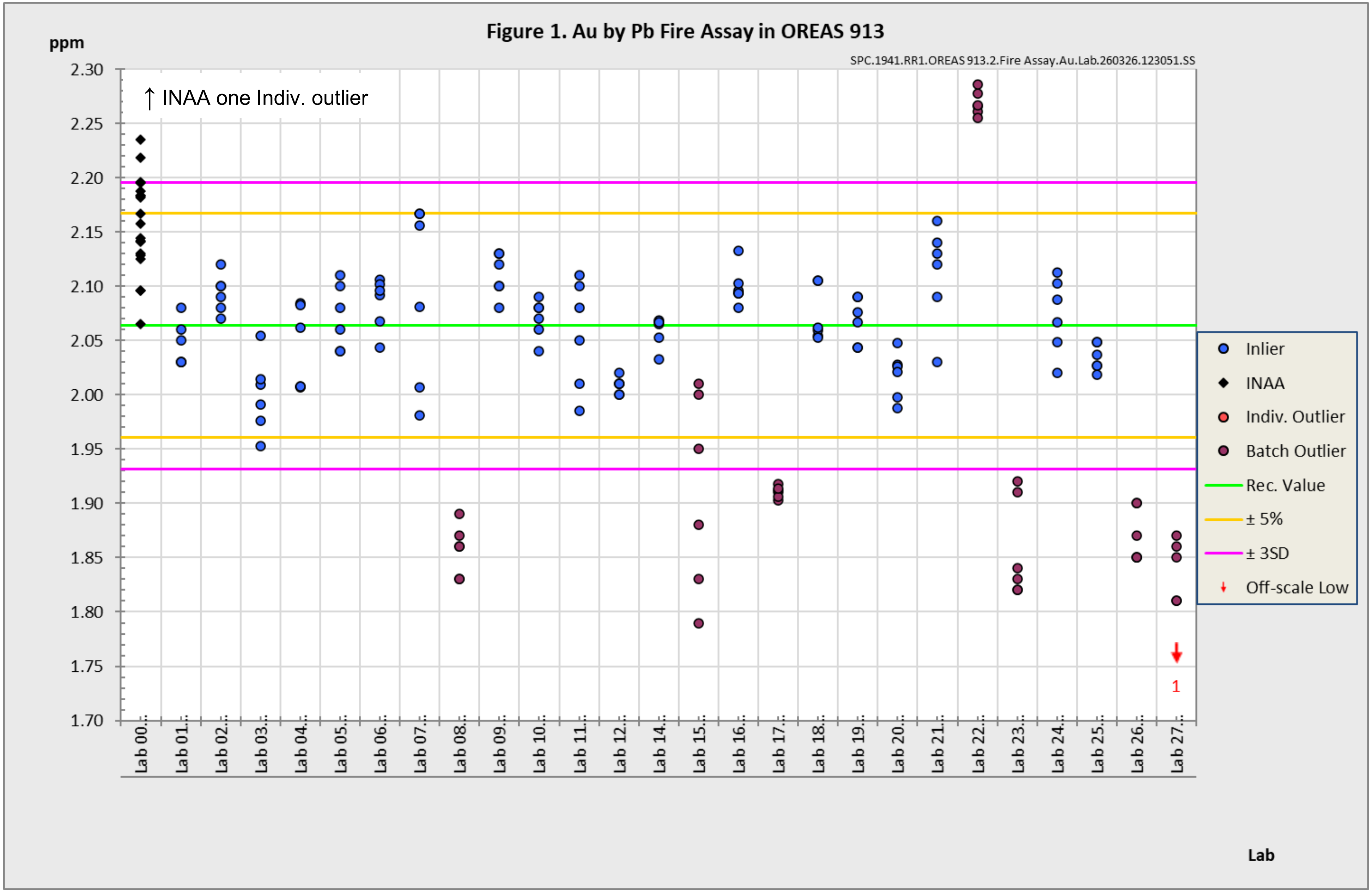
Figure 1. Au by Pb Fire Assay in OREAS 913
ppm
SPC.1941.RR1.OREAS 913.2.Fire Assay.Au.Lab.260326.123051.SS
↑ INAA one Indiv. outlier
2.30
2.25
2.20
2.15
2.10
2.05
2.00
1.95
1.90
1.85
1.80
1.75
1.70
Lab 00...
Lab 01...
Lab 02...
Lab 03...
Lab 04...
Lab 05...
Lab 06...
Lab 07...
Lab 08...
Lab 09...
Lab 10...
Lab 11...
Lab 12...
Lab 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 27...
1
Inlier
INAA
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD
Off-scale Low
Lab

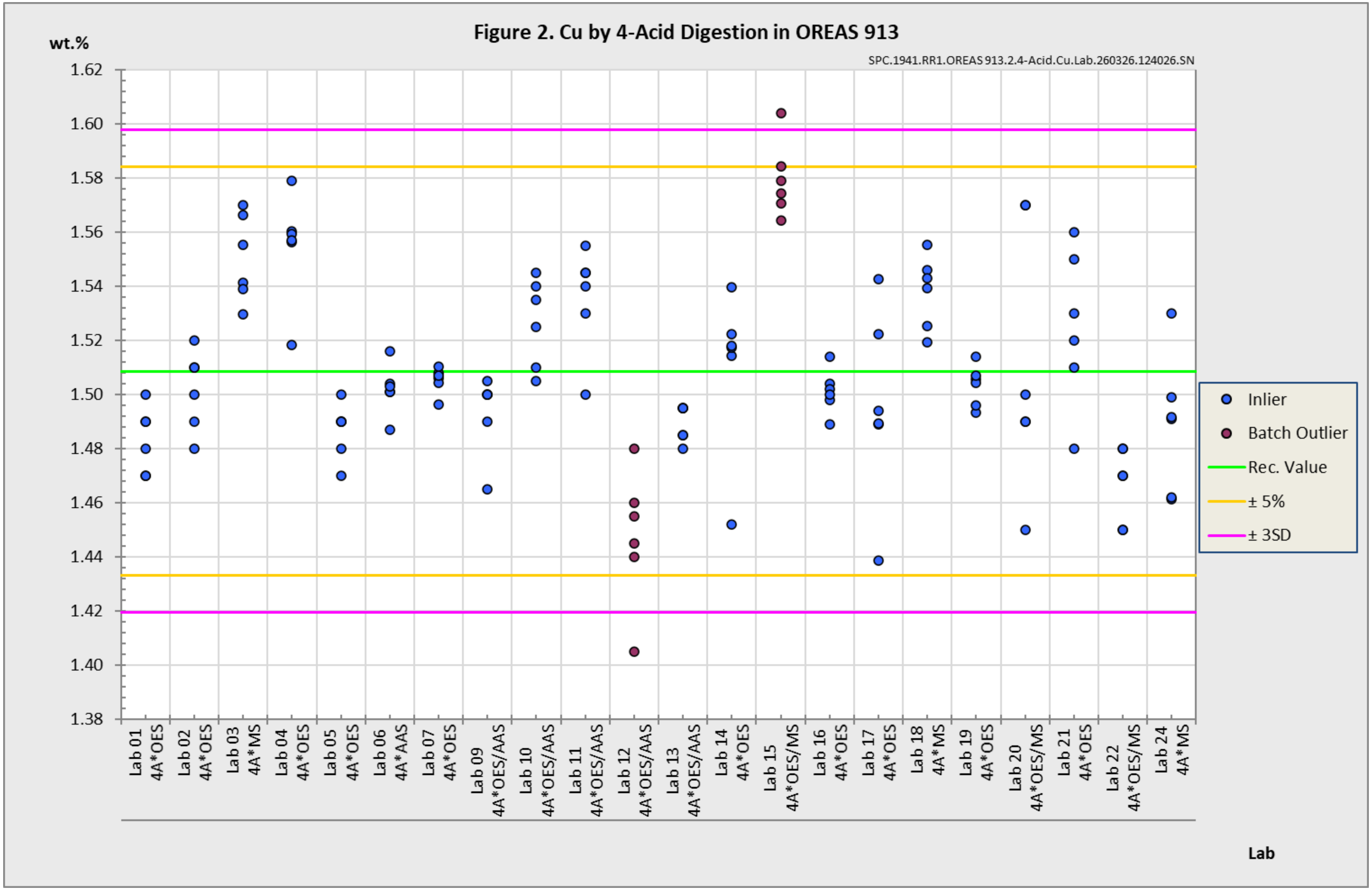
Figure 2. Cu by 4-Acid Digestion in OREAS 913
SPC.1941.RR1.OREAS 913.2.4-Acid.Cu.Lab.260326.124026.SN
wt.%
1.62
1.60
1.58
1.56
1.54
1.52
1.50
1.48
1.46
1.44
1.42
1.40
1.38
Lab 01 4A*OES
Lab 02 4A*OES
Lab 03 4A*MS
Lab 04 4A*OES
Lab 05 4A*OES
Lab 06 4A*AAS
Lab 07 4A*OES
Lab 09 4A*OES/AAS
Lab 10 4A*OES/AAS
Lab 11 4A*OES/AAS
Lab 12 4A*OES/AAS
Lab 13 4A*OES/AAS
Lab 14 4A*OES
Lab 15 4A*OES/MS
Lab 16 4A*OES
Lab 17 4A*OES
Lab 18 4A*MS
Lab 19 4A*OES
Lab 20 4A*OES/MS
Lab 21 4A*OES
Lab 22 4A*OES/MS
Lab 24 4A*MS
Lab
Inlier
Batch Outlier
Rec. Value
± 5%
± 3SD

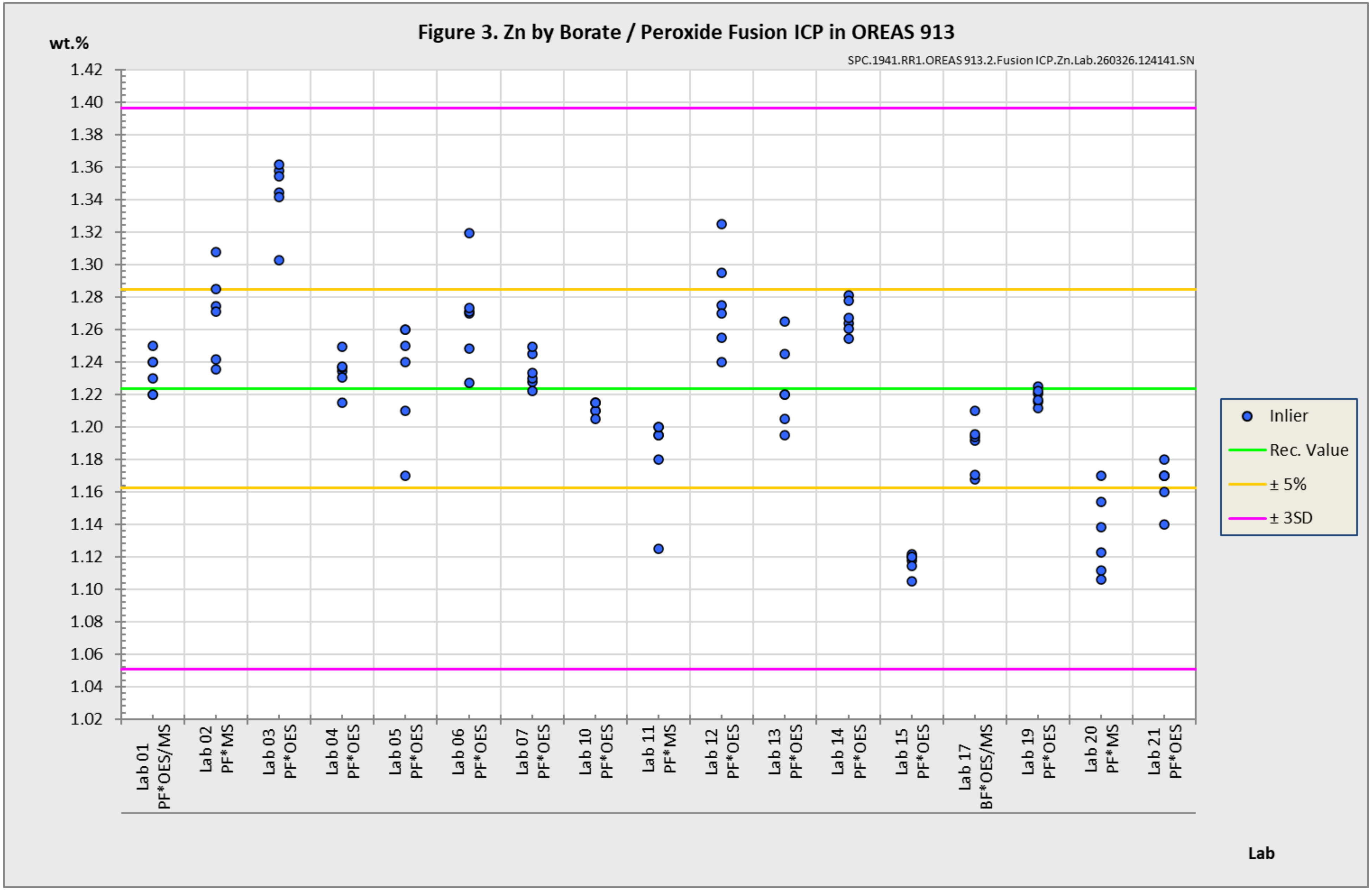
Figure 3. Zn by Borate / Peroxide Fusion ICP in OREAS 913
wt.%
SPC.1941.RR1.OREAS 913.2.Fusion ICP.Zn.Lab.260326.124141.SN
1.42
1.40
1.38
1.36
1.34
1.32
1.30
1.28
1.26
1.24
1.22
1.20
1.18
1.16
1.14
1.12
1.10
1.08
1.06
1.04
1.02
Lab 01 PF*OES/MS
Lab 02 PF*MS
Lab 03 PF*OES
Lab 04 PF*OES
Lab 05 PF*OES
Lab 06 PF*OES
Lab 07 PF*OES
Lab 10 PF*OES
Lab 11 PF*MS
Lab 12 PF*OES
Lab 13 PF*OES
Lab 14 PF*OES
Lab 15 PF*OES
Lab 17 BF*OES/MS
Lab 19 PF*OES
Lab 20 PF*MS
Lab 21 PF*OES
Inlier
Rec. Value
± 5%
± 3SD
Lab

PREPARER AND SUPPLIER

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ACCREDITATION

ORE Pty Ltd is accredited for compliance with ISO 17034:2016 (Accreditation number 20483).

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

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DOCUMENT HISTORY

Revision No.	Date	Changes applied
1	26th May 2026	Revised 'Instructions for handling, storage & correct use'.
0	1st April 2026	First publication.

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