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CERTIFICATE OF ANALYSIS FOR

LEAD-SILVER CONCENTRATE

(Cannington Mine, North West Queensland, Australia)

CERTIFIED REFERENCE MATERIAL

OREAS 353b

Table 1. Certified Value, Uncertainty & Tolerance Intervals for OREAS 353b.

Constituent	Certified Value†	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Umpire Labs (dry sample basis)					
Pb Fire Assay (Grav)					
Ag, Silver (ppm)	2184	2171	2197	2175	2193
Classical Wet Chemistry					
Pb, Lead (wt.%)	64.58	64.53	64.64	64.51	64.65

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

†This operationally defined measurand meets the requirements of ISO 17034 and all participating laboratories comply with the requirements of ISO 17025.

Note: intervals may appear asymmetric due to rounding.

Table 1 continued.

Constituent	Certified Value†	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Geoanalytical Labs ('as received' sample basis)					
4-Acid Digestion					
Ag, Silver (ppm)	2174	1988	2359	2119	2229
Al, Aluminium (wt.%)	0.211	0.201	0.221	0.204	0.217
As, Arsenic (ppm)	361	324	397	351	371
Ba, Barium (ppm)	12.7	10.6	14.8	IND	IND
Be, Beryllium (ppm)	0.22	0.18	0.25	0.20	0.23
Bi, Bismuth (ppm)	68	64	71	65	70
Ca, Calcium (wt.%)	0.210	0.201	0.219	0.202	0.218
Cd, Cadmium (ppm)	183	169	196	180	186
Ce, Cerium (ppm)	22.4	20.1	24.7	21.7	23.1
Co, Cobalt (ppm)	31.8	29.9	33.7	30.6	33.0
Cr, Chromium (ppm)	37.7	33.5	41.9	35.7	39.7
Cs, Caesium (ppm)	0.15	0.14	0.17	IND	IND
Cu, Copper (wt.%)	0.431	0.416	0.447	0.425	0.438
Fe, Iron (wt.%)	4.29	4.18	4.40	4.23	4.36
Ga, Gallium (ppm)	1.93	1.64	2.23	1.86	2.01
In, Indium (ppm)	1.26	1.14	1.39	1.21	1.31
K, Potassium (wt.%)	0.050	0.047	0.054	IND	IND
La, Lanthanum (ppm)	12.3	11.6	13.1	11.9	12.8
Li, Lithium (ppm)	6.33	5.29	7.37	6.08	6.58
Mg, Magnesium (wt.%)	0.875	0.845	0.906	0.857	0.894
Mn, Manganese (wt.%)	0.108	0.102	0.114	0.106	0.111
Mo, Molybdenum (ppm)	84	75	92	80	87
Na, Sodium (wt.%)	0.034	0.027	0.040	IND	IND
Nb, Niobium (ppm)	0.29	0.25	0.32	IND	IND
Ni, Nickel (ppm)	16.3	15.2	17.3	15.6	17.0
P, Phosphorus (wt.%)	0.027	0.025	0.029	0.026	0.028
Pb, Lead (wt.%)	59.18	45.95	72.41	57.65	60.71
Rb, Rubidium (ppm)	1.73	1.46	2.01	1.57	1.90
Re, Rhenium (ppm)	0.040	0.032	0.048	0.035	0.044
S, Sulphur (wt.%)	15.16	14.53	15.79	14.93	15.39
Sb, Antimony (ppm)	2342	2210	2475	2266	2419
Sn, Tin (ppm)	8.54	7.49	9.59	8.18	8.90
Sr, Strontium (ppm)	9.91	8.73	11.08	9.46	10.35
Ta, Tantalum (ppm)	< 0.05	IND	IND	IND	IND
Te, Tellurium (ppm)	0.50	0.38	0.62	0.43	0.57

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

†This operationally defined measurand meets the requirements of ISO 17034 and all participating laboratories comply with the requirements of ISO 17025.

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
4-Acid Digestion continued					
Th, Thorium (ppm)	0.50	0.45	0.56	0.47	0.54
Ti, Titanium (wt.%)	0.010	0.009	0.010	0.009	0.010
Tl, Thallium (ppm)	1.15	1.04	1.25	1.09	1.20
U, Uranium (ppm)	1.53	1.41	1.65	1.47	1.58
V, Vanadium (ppm)	5.73	4.86	6.61	5.22	6.24
Y, Yttrium (ppm)	7.63	6.34	8.92	7.31	7.94
Zn, Zinc (wt.%)	3.83	3.70	3.97	3.77	3.90
Zr, Zirconium (ppm)	2.82	2.61	3.04	2.61	3.03

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
†This operationally defined measurand meets the requirements of ISO 17034 and all participating laboratories comply with the requirements of ISO 17025.
Note: intervals may appear asymmetric due to rounding; IND = indeterminate (due to limited reading resolution of the methods employed).

Table 2. Certified Value, Uncertainty & Tolerance Intervals for other measurands in OREAS 353b

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Geoanalytical Labs ('as received' sample basis)					
Peroxide Fusion ICP					
Al, Aluminium (wt.%)	0.212	0.197	0.227	0.204	0.220
As, Arsenic (ppm)	392	368	415	381	403
Ba, Barium (ppm)	17.6	14.3	20.9	IND	IND
Be, Beryllium (ppm)	< 1	IND	IND	IND	IND
Bi, Bismuth (ppm)	67	63	71	66	68
Ca, Calcium (wt.%)	0.239	0.194	0.285	0.226	0.253
Cd, Cadmium (ppm)	179	161	197	173	185
Ce, Cerium (ppm)	21.4	18.9	23.8	20.5	22.3
Co, Cobalt (ppm)	29.7	28.7	30.7	28.5	30.8
Cu, Copper (wt.%)	0.430	0.410	0.451	0.423	0.437
Dy, Dysprosium (ppm)	1.31	1.07	1.54	1.23	1.38
Er, Erbium (ppm)	0.70	0.57	0.83	0.62	0.78
Fe, Iron (wt.%)	4.34	4.18	4.51	4.26	4.43
Ga, Gallium (ppm)	1.98	1.65	2.30	IND	IND
Gd, Gadolinium (ppm)	1.64	1.34	1.95	1.51	1.77
Ge, Germanium (ppm)	< 0.1	IND	IND	IND	IND
Ho, Holmium (ppm)	0.28	0.24	0.32	0.26	0.31
In, Indium (ppm)	1.39	1.18	1.59	IND	IND
La, Lanthanum (ppm)	12.1	10.7	13.5	11.5	12.6
Mg, Magnesium (wt.%)	0.905	0.871	0.939	0.886	0.924
Mn, Manganese (wt.%)	0.109	0.103	0.115	0.107	0.111
Mo, Molybdenum (ppm)	89	81	96	86	91
Nd, Neodymium (ppm)	8.64	7.35	9.94	8.45	8.84
Ni, Nickel (ppm)	< 10	IND	IND	IND	IND
P, Phosphorus (wt.%)	0.032	0.025	0.039	IND	IND
Pb, Lead (wt.%)	65.43	63.84	67.03	64.40	66.47
Pr, Praseodymium (ppm)	2.34	2.03	2.65	2.18	2.51
Rb, Rubidium (ppm)	1.98	1.47	2.49	1.82	2.15
S, Sulphur (wt.%)	15.46	15.00	15.92	15.15	15.77
Sb, Antimony (ppm)	2322	2141	2503	2210	2434
Sc, Scandium (ppm)	< 10	IND	IND	IND	IND
Si, Silicon (wt.%)	2.60	2.49	2.70	2.54	2.65
Sm, Samarium (ppm)	1.62	1.40	1.84	1.45	1.79
Sr, Strontium (ppm)	< 20	IND	IND	IND	IND
Tb, Terbium (ppm)	0.23	0.16	0.30	0.21	0.26
Th, Thorium (ppm)	0.47	0.41	0.54	IND	IND

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 2 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Peroxide Fusion ICP continued					
Ti, Titanium (wt.%)	0.010	0.008	0.012	IND	IND
Tl, Thallium (ppm)	1.21	1.04	1.39	IND	IND
U, Uranium (ppm)	1.71	1.45	1.96	IND	IND
Y, Yttrium (ppm)	9.06	8.55	9.57	8.78	9.34
Yb, Ytterbium (ppm)	0.47	0.41	0.53	IND	IND
Zn, Zinc (wt.%)	3.86	3.72	4.00	3.80	3.92
Infrared Combustion					
C, Carbon (wt.%)	1.09	1.07	1.11	1.07	1.11
S, Sulphur (wt.%)	15.10	14.71	15.49	14.88	15.32

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 3. Indicative Values for OREAS 353b.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Umpire Labs (dry sample basis)								
Thermogravimetry								
H_2O-	wt.%	*0.173*						
Geoanalytical Labs ('as received' sample basis)								
4-Acid Digestion								
Dy	ppm	*1.27*	Ho	ppm	*0.25*	Sm	ppm	*1.67*
Er	ppm	*0.63*	Lu	ppm	*< 0.1*	Tb	ppm	*0.22*
Eu	ppm	*1.63*	Nd	ppm	*9.14*	Tm	ppm	*< 0.1*
Gd	ppm	*1.97*	Pr	ppm	*2.61*	W	ppm	*0.67*
Ge	ppm	*0.30*	Sc	ppm	*0.42*	Yb	ppm	*0.45*
Hf	ppm	*0.10*	Se	ppm	*5.04*			
Peroxide Fusion ICP								
Ag	ppm	*1965*	K	wt.%	*0.083*	Sn	ppm	*12.9*
B	ppm	*< 50*	Li	ppm	*5.73*	Ta	ppm	*0.76*
Cr	ppm	*52*	Lu	ppm	*0.064*	Te	ppm	*< 5*
Cs	ppm	*0.23*	Nb	ppm	*3.48*	Tm	ppm	*0.090*
Eu	ppm	*1.66*	Re	ppm	*0.043*	V	ppm	*7.06*
Hf	ppm	*< 10*	Se	ppm	*12.5*	W	ppm	*0.94*

SI unit equivalents: 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 correct use' should be read carefully.

Tables 1 and 2 provide the certified values and their associated 95% expanded uncertainty and tolerance intervals, Table 3 shows indicative (non-certified) values, Table 4 provides some indicative physical properties and Table 5 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 lab means from the corrected mean of means (PDM^3) are presented in the detailed certification data for this CRM (**OREAS 353b-DataPack.1.0.231003_224957.xlsx**).

Results are also presented in scatter plots for Pb by classical titration and Ag by fire assay with gravimetric finish in Figures 1 and 2 respectively, together with ±3SD (magenta) and ±5% (yellow) control lines and certified value (green line). Accepted individual results are coloured blue and individual and dataset outliers are identified in red and violet, respectively.

SOURCE MATERIAL

OREAS 353b is a certified reference material (CRM) prepared from a Pb-Ag concentrate sample sourced from South32 Ltd's Cannington mine plant. The stratabound, metasediment hosted (Broken Hill Type) deposit is located ~200 kms south-east of Mount Isa in north-west Queensland, Australia. The major sulphides occur as argentiferous galena and sphalerite with subordinate magnetite-pyrrhotite and minor marcasite and arsenopyrite-lollingite-chalcopyrite.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 353b was prepared in the following manner:

- Drying to constant mass at 85°C;
- Multi-stage milling to 100% minus 30 microns;
- Homogenisation using OREAS' novel processing technologies;
- Packaging into 10g and 50g units sealed under nitrogen in laminated foil pouches.

PHYSICAL PROPERTIES

OREAS 353b was tested at ORE Research & Exploration Pty Ltd's onsite facility for various physical properties. Table 4 presents these findings that should be used for informational purposes only.

Table 4. Physical properties of OREAS 231b.

Bulk Density (kg/m^3)	Moisture (wt.%)	Munsell Notation‡	Munsell Color‡
986	0.36	N3	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.

ANALYTICAL PROGRAM

For the interlaboratory 'round robin' certification program, samples were taken at 10 predetermined sampling intervals immediately following homogenisation and are considered representative of the entire prepared batch of OREAS 353b.

Umpire Laboratories

Fourteen 'umpire' laboratories each received a single 110g sample and undertook silver, lead and moisture analysis on the sample as received. The term 'umpire' here refers to the routine analysis by these laboratories using classical methodologies for precious and base metals.

Strict, pre-assay instructions were provided to ensure proper handling of moisture including:

- Equilibration of sample material to laboratory atmosphere for a minimum of 2 hours;
- Hygroscopic moisture analysis at 105°C determined on a separate subsample and weighed for analysis at the same time as the sample aliquots for Ag and Pb as per ISO 9599.

The laboratories were requested to report analyte concentrations on both a dry (using the moisture value to correct the sample to dry basis) and moisture-bearing basis and include all results for moisture determinations. **The 'Umpire Lab' certified values shown in Table 1 are on a dry sample basis (see 'Instructions for correct use' section).**

The following analytical methods were undertaken:

- Silver by reduced charge (mostly 10-15g) fire assay with gravimetric finish (14 laboratories);
- Lead was determined in 3 trials by classical wet chemistry (EDTA titration) finish (14 laboratories, except 1 lab who performed borate fusion XRF finish).

Geoanalytical Laboratories

Thirteen geoanalytical laboratories also participated in the analytical program for OREAS 353b. Each laboratory was sent 6 x 30g samples to undertake the following:

- 4-acid digestion (HF-HNO_3-$HClO_4$-HCl) with ICP-OES and/or ICP-MS finish (up to 13 laboratories depending on the element);
- Peroxide fusion with ICP-OES and/or ICP-MS finish (up to 11 laboratories depending on the element);
- Infrared combustion furnace for C (12 laboratories) and S (11 laboratories).

STATISTICAL ANALYSIS

Certified Values and their uncertainty intervals (Tables 1 and 2) 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. 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. However, while statistics are taken into account, the exercise of a statistician's prerogative plays a significant role in identifying outliers.

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 ISO 98-3 [5]. All known or suspected sources of bias have been investigated or taken into account.

Indicative (uncertified) values (Table 3) are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where interlaboratory consensus is poor.

Standard Deviation intervals (see Table 5) provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this CRM in a QA/QC program. They take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability.

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

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

The standard deviation is then calculated for each analyte from the pooled accepted analyses generated from the certification program.

Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) shown in Tables 1 and 2 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 lead by classical wet chemistry, where 99% of the time (1-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 64.51 and 64.65 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.***

The homogeneity of OREAS 353b has also been evaluated using a nested ANOVA within the data provided by the geoanalytical laboratories for elements present in concentrations that are at least 20 times the lower limit of detection. No significant *p*-values were found indicating that no evidence exists that between-unit variance is greater than within-unit variance.

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 entire prepared batch of OREAS 353b 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 353b is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PERFORMANCE GATES

Table 5 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 5. Performance Gates for OREAS 353b.

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
Umpire Labs (dry sample basis)											
Pb Fire Assay (Grav)											
Ag, ppm	2184	23	2137	2231	2114	2254	1.07%	2.14%	3.21%	2075	2293
Classical Wet Chemistry											
Pb, wt.%	64.58	0.113	64.36	64.81	64.24	64.92	0.17%	0.35%	0.52%	61.35	67.81
Geoanalytical Labs ('as received' sample basis)											
4-Acid Digestion											
Ag, ppm	2174	168	1838	2510	1669	2678	7.73%	15.47%	23.20%	2065	2282
Al, wt.%	0.211	0.007	0.197	0.225	0.190	0.232	3.27%	6.53%	9.80%	0.200	0.222
As, ppm	361	52	256	465	204	518	14.51%	29.02%	43.53%	343	379
Ba, ppm	12.7	2.0	8.7	16.7	6.7	18.7	15.69%	31.39%	47.08%	12.1	13.3
Be, ppm	0.22	0.03	0.16	0.27	0.13	0.30	12.68%	25.36%	38.04%	0.20	0.23
Bi, ppm	68	3.9	60	75	56	79	5.73%	11.46%	17.19%	64	71
Ca, wt.%	0.210	0.009	0.193	0.228	0.184	0.236	4.16%	8.32%	12.48%	0.200	0.221
Cd, ppm	183	19	144	222	125	241	10.59%	21.19%	31.78%	174	192
Ce, ppm	22.4	2.22	18.0	26.8	15.8	29.1	9.90%	19.80%	29.70%	21.3	23.5
Co, ppm	31.8	2.24	27.3	36.3	25.1	38.5	7.03%	14.07%	21.10%	30.2	33.4
Cr, ppm	37.7	5.1	27.4	48.0	22.3	53.1	13.62%	27.24%	40.86%	35.8	39.6
Cs, ppm	0.15	0.013	0.13	0.18	0.12	0.19	8.26%	16.51%	24.77%	0.15	0.16
Cu, wt.%	0.431	0.017	0.398	0.464	0.382	0.481	3.84%	7.67%	11.51%	0.410	0.453
Fe, wt.%	4.29	0.089	4.11	4.47	4.02	4.56	2.08%	4.16%	6.25%	4.08	4.51
Ga, ppm	1.93	0.35	1.24	2.62	0.90	2.97	17.88%	35.76%	53.64%	1.84	2.03
In, ppm	1.26	0.13	1.00	1.53	0.87	1.66	10.37%	20.74%	31.12%	1.20	1.33
K, wt.%	0.050	0.004	0.043	0.058	0.039	0.062	7.48%	14.96%	22.44%	0.048	0.053
La, ppm	12.3	0.48	11.4	13.3	10.9	13.8	3.91%	7.81%	11.72%	11.7	12.9
Li, ppm	6.33	1.23	3.86	8.80	2.63	10.03	19.49%	38.99%	58.48%	6.01	6.65
Mg, wt.%	0.875	0.033	0.809	0.942	0.776	0.975	3.80%	7.61%	11.41%	0.832	0.919
Mn, wt.%	0.108	0.007	0.095	0.122	0.088	0.129	6.25%	12.50%	18.75%	0.103	0.114
Mo, ppm	84	12	60	108	48	120	14.35%	28.70%	43.05%	80	88
Na, wt.%	0.034	0.006	0.021	0.046	0.015	0.052	18.20%	36.40%	54.60%	0.032	0.035
Nb, ppm	0.29	0.028	0.23	0.34	0.20	0.37	9.72%	19.44%	29.16%	0.27	0.30
Ni, ppm	16.3	1.05	14.2	18.4	13.1	19.4	6.43%	12.87%	19.30%	15.5	17.1
P, wt.%	0.027	0.003	0.021	0.033	0.018	0.036	11.03%	22.06%	33.09%	0.026	0.028
Pb, wt.%	59.18	9.69	39.81	78.55	30.12	88.24	16.37%	32.73%	49.10%	56.22	62.14
Rb, ppm	1.73	0.31	1.11	2.36	0.79	2.68	18.12%	36.25%	54.37%	1.65	1.82
Re, ppm	0.040	0.003	0.034	0.046	0.031	0.049	7.62%	15.24%	22.86%	0.038	0.042
S, wt.%	15.16	0.612	13.93	16.38	13.32	16.99	4.04%	8.07%	12.11%	14.40	15.92
Sb, ppm	2342	145	2052	2633	1907	2778	6.20%	12.39%	18.59%	2225	2460
Sn, ppm	8.54	1.09	6.37	10.71	5.28	11.80	12.72%	25.44%	38.17%	8.11	8.97
Sr, ppm	9.91	1.51	6.88	12.93	5.37	14.45	15.28%	30.55%	45.83%	9.41	10.40
Ta, ppm	< 0.05	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Te, ppm	0.50	0.08	0.34	0.65	0.27	0.73	15.62%	31.23%	46.85%	0.47	0.52
Th, ppm	0.50	0.044	0.42	0.59	0.37	0.64	8.81%	17.62%	26.44%	0.48	0.53
Ti, wt.%	0.010	0.001	0.008	0.011	0.007	0.012	8.60%	17.20%	25.80%	0.009	0.010

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

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											
Tl, ppm	1.15	0.089	0.97	1.33	0.88	1.41	7.74%	15.49%	23.23%	1.09	1.21
U, ppm	1.53	0.137	1.25	1.80	1.11	1.94	9.00%	18.01%	27.01%	1.45	1.60
V, ppm	5.73	0.78	4.17	7.29	3.39	8.08	13.62%	27.24%	40.87%	5.45	6.02
Y, ppm	7.63	1.74	4.14	11.12	2.39	12.86	22.87%	45.75%	68.62%	7.25	8.01
Zn, wt.%	3.83	0.175	3.48	4.18	3.31	4.36	4.58%	9.16%	13.73%	3.64	4.03
Zr, ppm	2.82	0.163	2.50	3.15	2.33	3.31	5.77%	11.54%	17.31%	2.68	2.96
Peroxide Fusion ICP											
Al, wt.%	0.212	0.016	0.180	0.244	0.163	0.260	7.60%	15.20%	22.81%	0.201	0.222
As, ppm	392	22	347	437	324	459	5.74%	11.48%	17.22%	372	411
Ba, ppm	17.6	2.4	12.8	22.3	10.4	24.7	13.59%	27.19%	40.78%	16.7	18.4
Be, ppm	< 1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Bi, ppm	67	4.0	59	75	55	79	5.97%	11.93%	17.90%	64	70
Ca, wt.%	0.239	0.032	0.175	0.304	0.142	0.336	13.50%	27.00%	40.50%	0.227	0.251
Cd, ppm	179	14	152	206	138	220	7.58%	15.16%	22.74%	170	188
Ce, ppm	21.4	1.58	18.2	24.5	16.6	26.1	7.38%	14.76%	22.13%	20.3	22.4
Co, ppm	29.7	0.78	28.1	31.2	27.3	32.0	2.63%	5.27%	7.90%	28.2	31.1
Cu, wt.%	0.430	0.015	0.401	0.460	0.387	0.474	3.38%	6.77%	10.15%	0.409	0.452
Dy, ppm	1.31	0.126	1.05	1.56	0.93	1.68	9.68%	19.36%	29.04%	1.24	1.37
Er, ppm	0.70	0.08	0.54	0.86	0.47	0.93	11.11%	22.23%	33.34%	0.66	0.73
Fe, wt.%	4.34	0.085	4.17	4.51	4.09	4.60	1.97%	3.93%	5.90%	4.13	4.56
Ga, ppm	1.98	0.23	1.52	2.44	1.29	2.67	11.64%	23.28%	34.92%	1.88	2.08
Gd, ppm	1.64	0.18	1.28	2.01	1.10	2.19	11.03%	22.06%	33.09%	1.56	1.73
Ge, ppm	< 0.1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Ho, ppm	0.28	0.04	0.21	0.35	0.17	0.39	12.70%	25.39%	38.09%	0.27	0.30
In, ppm	1.39	0.137	1.11	1.66	0.98	1.80	9.86%	19.72%	29.58%	1.32	1.45
La, ppm	12.1	0.92	10.3	13.9	9.3	14.8	7.58%	15.16%	22.74%	11.5	12.7
Mg, wt.%	0.905	0.027	0.851	0.959	0.823	0.986	3.00%	6.00%	9.00%	0.860	0.950
Mn, wt.%	0.109	0.005	0.099	0.119	0.094	0.124	4.55%	9.10%	13.65%	0.104	0.114
Mo, ppm	89	5.1	79	99	73	104	5.73%	11.47%	17.20%	84	93
Nd, ppm	8.64	0.92	6.81	10.48	5.90	11.39	10.59%	21.18%	31.77%	8.21	9.08
Ni, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
P, wt.%	0.032	0.004	0.023	0.041	0.019	0.045	13.62%	27.25%	40.87%	0.030	0.034
Pb, wt.%	65.43	1.600	62.23	68.63	60.63	70.24	2.45%	4.89%	7.34%	62.16	68.71
Pr, ppm	2.34	0.24	1.86	2.82	1.62	3.06	10.25%	20.50%	30.76%	2.23	2.46
Rb, ppm	1.98	0.40	1.19	2.78	0.80	3.17	19.96%	39.92%	59.88%	1.88	2.08
S, wt.%	15.46	0.411	14.64	16.28	14.23	16.69	2.66%	5.32%	7.98%	14.69	16.23
Sb, ppm	2322	176	1970	2674	1794	2850	7.58%	15.16%	22.73%	2206	2438
Sc, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Si, wt.%	2.60	0.090	2.42	2.78	2.33	2.87	3.48%	6.96%	10.44%	2.47	2.73
Sm, ppm	1.62	0.18	1.25	1.98	1.07	2.17	11.30%	22.60%	33.89%	1.54	1.70
Sr, ppm	< 20	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Tb, ppm	0.23	0.03	0.17	0.29	0.14	0.32	13.15%	26.30%	39.45%	0.22	0.24
Th, ppm	0.47	0.042	0.39	0.55	0.35	0.60	8.84%	17.67%	26.51%	0.45	0.49

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

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
Peroxide Fusion ICP continued											
Ti, wt.%	0.010	0.002	0.006	0.014	0.004	0.016	19.62%	39.25%	58.87%	0.009	0.010
Tl, ppm	1.21	0.088	1.04	1.39	0.95	1.48	7.28%	14.56%	21.83%	1.15	1.27
U, ppm	1.71	0.24	1.23	2.19	0.99	2.43	14.02%	28.03%	42.05%	1.62	1.79
Y, ppm	9.06	0.361	8.34	9.78	7.98	10.14	3.99%	7.98%	11.96%	8.61	9.51
Yb, ppm	0.47	0.06	0.35	0.58	0.29	0.64	12.34%	24.68%	37.02%	0.44	0.49
Zn, wt.%	3.86	0.126	3.61	4.11	3.48	4.24	3.26%	6.52%	9.79%	3.67	4.05
Infrared Combustion											
C, wt.%	1.09	0.029	1.03	1.15	1.00	1.18	2.63%	5.26%	7.89%	1.03	1.14
S, wt.%	15.10	0.485	14.13	16.07	13.65	16.55	3.21%	6.42%	9.63%	14.34	15.85

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.

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*♦= Umpire laboratory (classical methods); * = Geoanalytical laboratory (instrumental methods).*

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

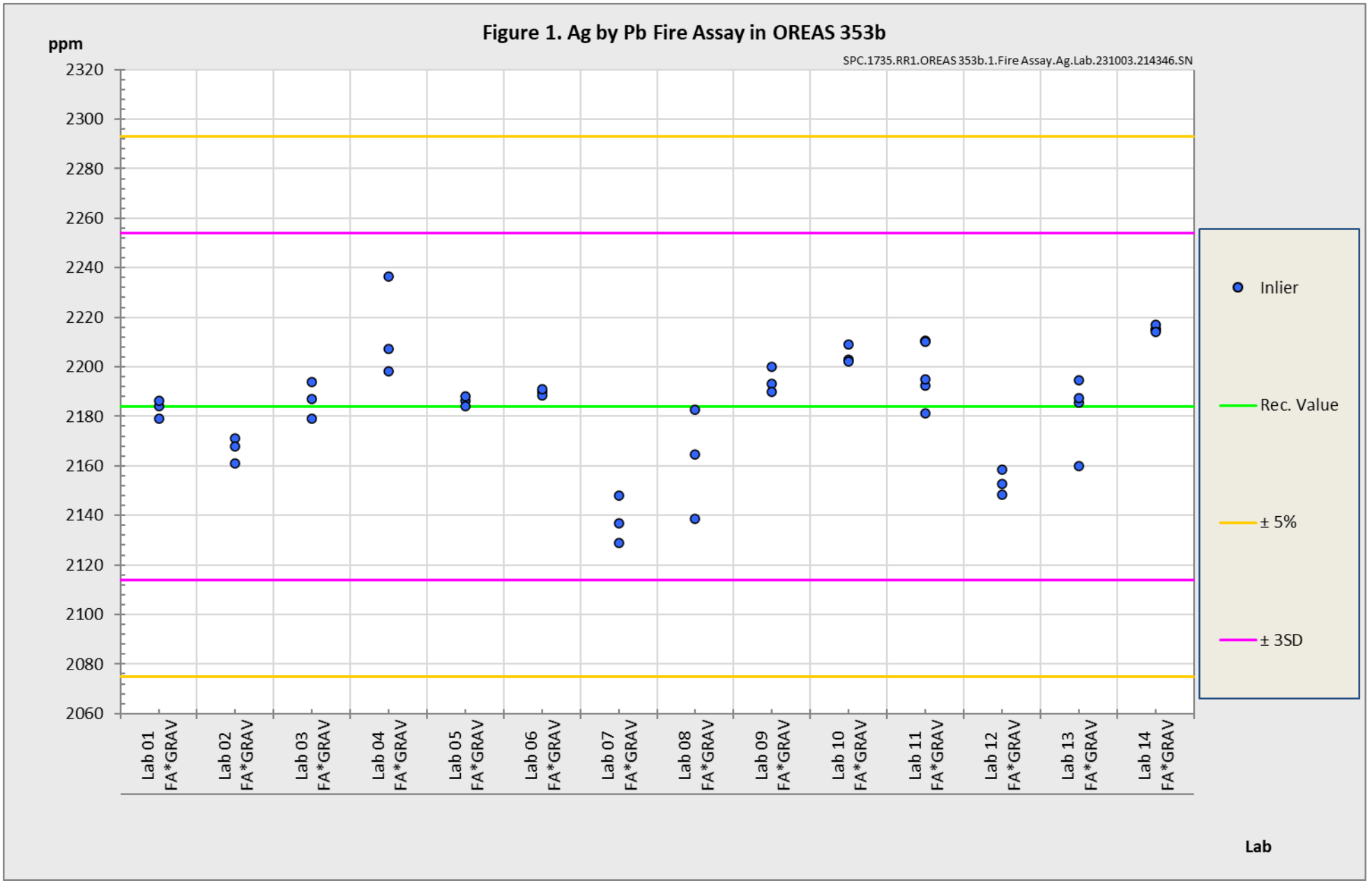
Figure 1. Ag by Pb Fire Assay in OREAS 353b
ppm
SPC.1735.RR1.OREAS 353b.1.Fire Assay.Ag.Lab.231003.214346.SN
2320
2300
2280
2260
2240
2220
2200
2180
2160
2140
2120
2100
2080
2060
Lab 01 FA*GRAV
Lab 02 FA*GRAV
Lab 03 FA*GRAV
Lab 04 FA*GRAV
Lab 05 FA*GRAV
Lab 06 FA*GRAV
Lab 07 FA*GRAV
Lab 08 FA*GRAV
Lab 09 FA*GRAV
Lab 10 FA*GRAV
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Lab 12 FA*GRAV
Lab 13 FA*GRAV
Lab 14 FA*GRAV
Lab
Inlier
Rec. Value
± 5%
± 3SD

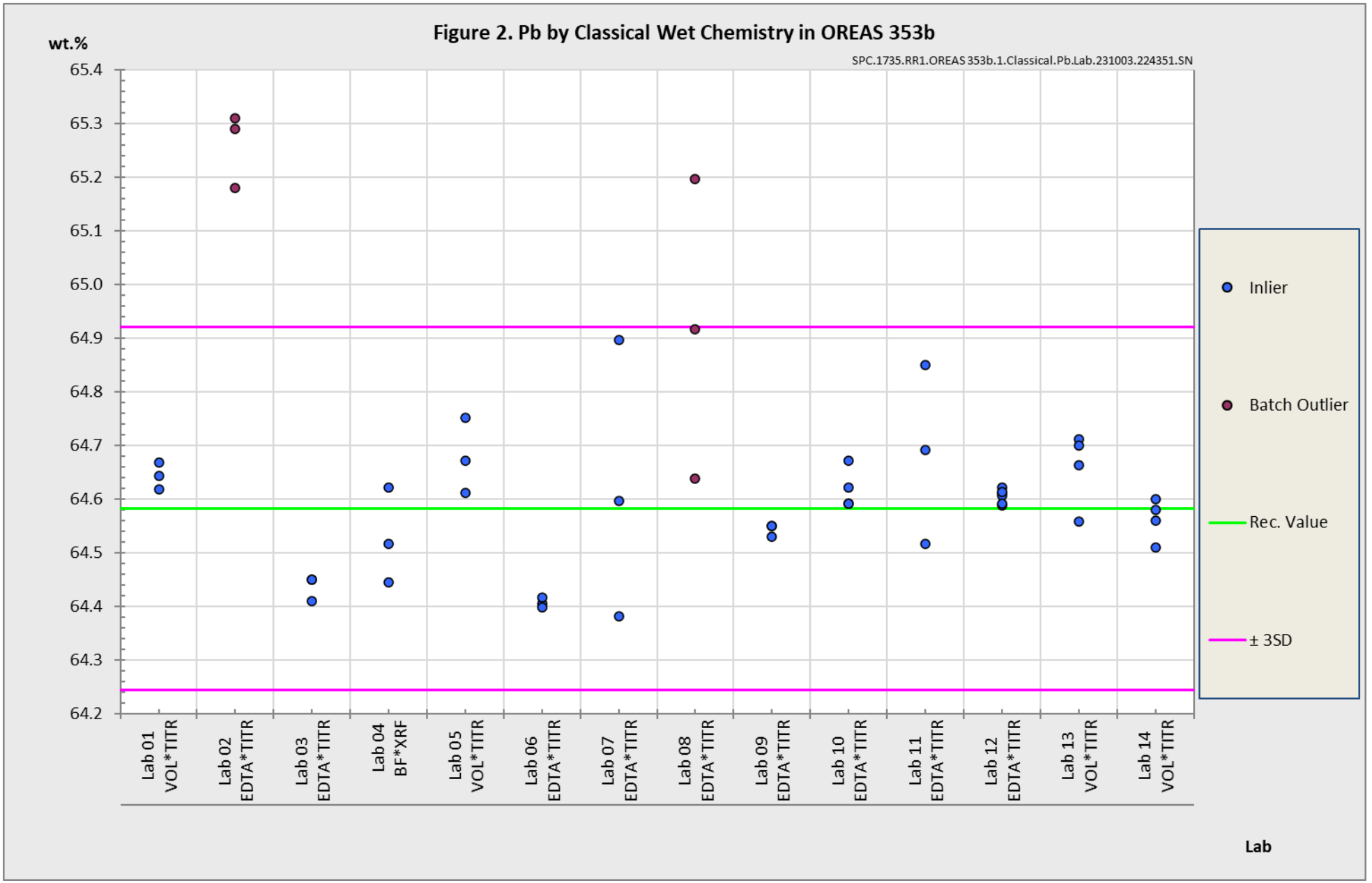
Figure 2. Pb by Classical Wet Chemistry in OREAS 353b
wt.%
SPC.1735.RR1.OREAS 353b.1.Classical.Pb.Lab.231003.224351.SN
65.4
65.3
65.2
65.1
65.0
64.9
64.8
64.7
64.6
64.5
64.4
64.3
64.2
Lab 01 VOL*TITR
Lab 02 EDTA*TITR
Lab 03 EDTA*TITR
Lab 04 BF*XRF
Lab 05 VOL*TITR
Lab 06 EDTA*TITR
Lab 07 EDTA*TITR
Lab 08 EDTA*TITR
Lab 09 EDTA*TITR
Lab 10 EDTA*TITR
Lab 11 EDTA*TITR
Lab 12 EDTA*TITR
Lab 13 VOL*TITR
Lab 14 VOL*TITR
Lab
Inlier
Batch Outlier
Rec. Value
± 3SD

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)). 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 '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. 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.

The participating laboratories were chosen on the basis of their competence (from past performance in interlaboratory programs undertaken by ORE Pty Ltd) for a particular analytical method, analyte or analyte suite and sample matrix. These laboratories are accredited to ISO 17025 for Ag and Pb determined by classical methodologies and elements by 4-acid digestion. The other operationally defined measurands characterised in this certificate are derived from data procured mostly from ISO 17025 accredited laboratories. The certified values presented in this report are calculated from the means of accepted data following robust technical and statistical analysis as detailed in this report.

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

COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving pre-treatment (fusion/digestion) 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 ''metallurgical concentrate' 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 the field samples being analysed.

INTENDED USE

OREAS 353b 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 353b may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 353b is intended for the following uses:

- For the monitoring of laboratory performance in the analysis of analytes reported in Tables 1 and 2 in geological samples;
- For the verification of analytical methods for analytes reported in Tables 1 and 2;
- For the calibration of instruments used in the determination of the concentration of analytes reported in Tables 1 and 2. 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 Tables 1 and 2).

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:

- Ag by fire assay: ≥10g;
- Pb by classical wet chemistry: ≥0.5g;
- 4-acid digestion with ICP-OES and/or MS finish: ≥0.25g;
- Peroxide fusion with ICP-OES and/or MS finish: ≥0.1g;
- Total S and C by Infrared combustion furnace/CS analyser: ≥0.1g.

PERIOD OF VALIDITY & STORAGE INSTRUCTIONS

OREAS 353b is high in reactive sulphide content and has been packaged under a nitrogen environment in robust laminated foil pouches in single-use 10g and 50g units. In its unopened state in the sachets (sealed under nitrogen), OREAS 353b has a shelf life of at least ten years (until September 2033).

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

INSTRUCTIONS FOR HANDLING & CORRECT USE

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

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

Umpire laboratories using classical methods:

The umpire laboratory certified values for Ag and Pb refer to the concentration levels on a dry sample basis. At each laboratory analyses were performed on the sample as received (without drying) with the subsample for moisture analysis weighed simultaneously with the subsamples for Au and Cu assay. The Au and Cu data was then corrected to dry basis using the moisture value obtained at each laboratory.

With the exception of one laboratory, moisture content varied amongst the laboratories from 0.05-0.45% with an average of 0.20%. The indicative value provided for moisture (H_2O-) should be viewed as informational only. Hygroscopic moisture is a dynamic property of pulp materials and will vary in response to the local laboratory atmosphere following equilibration.

Geoanalytical laboratories using instrumental methods:

All analyses were performed on the samples as received and reported as such in line with conventional instrumental method procedures.

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 5 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 interval then generally there is no cause for concern in regard to bias.

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	4th October, 2023	First publication.

QMS CERTIFICATION

ORE Pty Ltd is accredited for compliance with ISO 17034.

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

CERTIFYING OFFICER

4th October, 2023

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

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