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CERTIFICATE OF ANALYSIS FOR

CERTIFIED REFERENCE MATERIAL

OREAS 683b

PGE Ore, Dishaba Mine (South Africa)

Table 1. Certified Values, Uncertainty & Tolerance Intervals in OREAS 683b.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Pb Fire Assay					
Au, Gold (ppb)	208	199	218	197*	219*
Pd, Palladium (ppb)	839	808	871	823	856
Pt, Platinum (ppb)	1766	1699	1833	1734	1798
NiS Fire Assay					
Au, Gold (ppb)	190	160	219	172*	207*
Ir, Iridium (ppb)	51.1	42.1	60.2	47.8	54.4
Pd, Palladium (ppb)	835	771	898	816	853
Pt, Platinum (ppb)	1659	1517	1801	1598	1720
Rh, Rhodium (ppb)	147	135	159	139	155
Ru, Ruthenium (ppb)	252	213	291	239	264
Infrared Combustion					
S, Sulphur (wt.%)	0.475	0.462	0.489	0.465	0.485
4-Acid Digestion					
Ag, Silver (ppm)	0.197	0.168	0.226	0.174	0.219
Al, Aluminium (wt.%)	6.95	6.76	7.14	6.86	7.04
As, Arsenic (ppm)	7.91	7.13	8.69	7.12	8.69
Ba, Barium (ppm)	139	134	144	136	141
Be, Beryllium (ppm)	0.49	0.44	0.53	0.47	0.51
Bi, Bismuth (ppm)	0.16	0.15	0.18	0.14	0.19
Ca, Calcium (wt.%)	5.06	4.93	5.19	4.99	5.13
Cd, Cadmium (ppm)	0.15	0.13	0.16	IND	IND
Ce, Cerium (ppm)	16.0	15.3	16.6	15.5	16.5
Co, Cobalt (ppm)	99	96	102	96	102
Cr, Chromium (wt.%)	1.03	0.92	1.14	0.99	1.08
Cs, Caesium (ppm)	1.67	1.58	1.76	1.60	1.73
Cu, Copper (ppm)	430	417	443	425	436
Dy, Dysprosium (ppm)	1.43	1.36	1.50	1.37	1.50
Er, Erbium (ppm)	0.87	0.79	0.95	0.83	0.90
Eu, Europium (ppm)	0.49	0.45	0.53	0.46	0.52
Fe, Iron (wt.%)	7.80	7.52	8.07	7.69	7.91
Ga, Gallium (ppm)	13.4	12.7	14.1	12.9	13.9
Gd, Gadolinium (ppm)	1.59	1.47	1.72	1.51	1.68
Hf, Hafnium (ppm)	0.81	0.73	0.89	0.77	0.86
Ho, Holmium (ppm)	0.30	0.27	0.32	0.28	0.31
In, Indium (ppm)	0.035	0.029	0.041	0.031	0.039
K, Potassium (wt.%)	0.483	0.467	0.498	0.474	0.492
La, Lanthanum (ppm)	7.33	6.91	7.74	7.19	7.46
Li, Lithium (ppm)	6.80	6.35	7.26	6.54	7.07

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).

*Gold Tolerance Limits for typical 30 g lead fire assay and 10 g nickel sulphide fire assay 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).

Table 1 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion continued					
Lu, Lutetium (ppm)	0.13	0.12	0.14	IND	IND
Mg, Magnesium (wt.%)	8.93	8.64	9.23	8.81	9.06
Mn, Manganese (wt.%)	0.121	0.117	0.126	0.119	0.123
Mo, Molybdenum (ppm)	2.70	2.55	2.85	2.58	2.82
Na, Sodium (wt.%)	0.936	0.910	0.963	0.921	0.952
Nb, Niobium (ppm)	2.60	2.45	2.74	2.46	2.73
Nd, Neodymium (ppm)	8.04	7.44	8.64	7.87	8.21
Ni, Nickel (wt.%)	0.167	0.161	0.173	0.164	0.170
P, Phosphorus (wt.%)	0.038	0.037	0.040	0.038	0.039
Pb, Lead (ppm)	10.9	10.2	11.7	10.4	11.4
Pr, Praseodymium (ppm)	1.98	1.82	2.13	1.89	2.07
Rb, Rubidium (ppm)	28.3	26.8	29.7	27.4	29.1
S, Sulphur (wt.%)	0.482	0.464	0.499	0.472	0.491
Sb, Antimony (ppm)	0.39	0.33	0.44	0.36	0.42
Sc, Scandium (ppm)	19.6	18.6	20.5	19.1	20.1
Sm, Samarium (ppm)	1.71	1.58	1.83	1.59	1.82
Sn, Tin (ppm)	0.93	0.82	1.04	IND	IND
Sr, Strontium (ppm)	238	229	248	234	243
Ta, Tantalum (ppm)	0.20	0.17	0.23	0.17	0.22
Tb, Terbium (ppm)	0.24	0.23	0.26	0.23	0.26
Te, Tellurium (ppm)	0.28	0.22	0.34	0.24	0.32
Th, Thorium (ppm)	2.97	2.63	3.32	2.82	3.13
Ti, Titanium (wt.%)	0.244	0.234	0.253	0.238	0.250
Tl, Thallium (ppm)	0.12	0.11	0.13	IND	IND
Tm, Thulium (ppm)	0.12	0.10	0.14	IND	IND
U, Uranium (ppm)	0.68	0.58	0.77	0.63	0.72
V, Vanadium (ppm)	202	194	209	197	206
W, Tungsten (ppm)	4.14	3.93	4.35	3.95	4.34
Y, Yttrium (ppm)	7.65	7.26	8.03	7.43	7.87
Yb, Ytterbium (ppm)	0.85	0.79	0.92	0.81	0.89
Zn, Zinc (ppm)	108	102	113	105	110
Zr, Zirconium (ppm)	27.9	25.2	30.6	26.7	29.1
Borate / Peroxide Fusion ICP					
Al_2O_3, Aluminium(III) oxide (wt.%)	12.97	12.66	13.28	12.80	13.14
Ba, Barium (ppm)	142	137	148	136	148
Bi, Bismuth (ppm)	0.17	0.15	0.20	IND	IND
CaO, Calcium oxide (wt.%)	7.04	6.88	7.21	6.92	7.17
Cd, Cadmium (ppm)	< 10	IND	IND	IND	IND
Ce, Cerium (ppm)	16.2	15.0	17.4	15.6	16.8
Co, Cobalt (ppm)	105	98	112	102	108

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
Borate / Peroxide Fusion ICP continued					
Cr, Chromium (wt.%)	1.35	1.29	1.41	1.32	1.38
Cs, Caesium (ppm)	1.67	1.46	1.88	1.56	1.78
Cu, Copper (ppm)	428	406	451	409	447
Dy, Dysprosium (ppm)	1.44	1.30	1.58	1.36	1.53
Er, Erbium (ppm)	0.85	0.77	0.92	0.80	0.90
Eu, Europium (ppm)	0.50	0.43	0.57	0.46	0.55
Fe_2O_3, Iron(III) oxide (wt.%)	11.30	10.98	11.63	11.10	11.51
Ga, Gallium (ppm)	14.0	12.8	15.1	13.2	14.7
Gd, Gadolinium (ppm)	1.63	1.45	1.81	1.49	1.77
Ho, Holmium (ppm)	0.29	0.26	0.32	0.27	0.32
In, Indium (ppm)	< 0.2	IND	IND	IND	IND
K_2O, Potassium oxide (wt.%)	0.581	0.547	0.614	0.555	0.607
La, Lanthanum (ppm)	7.71	7.19	8.22	7.48	7.93
Lu, Lutetium (ppm)	0.13	0.11	0.16	IND	IND
MgO, Magnesium oxide (wt.%)	14.75	14.35	15.15	14.44	15.06
MnO, Manganese oxide (wt.%)	0.159	0.152	0.166	0.155	0.162
Mo, Molybdenum (ppm)	2.93	1.82	4.03	IND	IND
Nd, Neodymium (ppm)	8.23	7.47	8.98	7.69	8.76
Ni, Nickel (wt.%)	0.175	0.168	0.183	0.172	0.179
P_2O_5, Phosphorus(V) oxide (wt.%)	0.094	0.083	0.105	0.091	0.097
Pr, Praseodymium (ppm)	2.04	1.87	2.20	1.97	2.11
Rb, Rubidium (ppm)	29.7	27.9	31.5	28.8	30.6
S, Sulphur (wt.%)	0.485	0.462	0.508	0.471	0.499
Sc, Scandium (ppm)	19.0	17.8	20.2	IND	IND
Se, Selenium (ppm)	< 20	IND	IND	IND	IND
SiO_2, Silicon dioxide (wt.%)	48.26	46.83	49.69	47.40	49.12
Sm, Samarium (ppm)	1.73	1.57	1.89	1.56	1.91
Sr, Strontium (ppm)	239	229	250	234	244
Tb, Terbium (ppm)	0.24	0.21	0.27	0.21	0.26
Th, Thorium (ppm)	2.97	2.53	3.42	2.75	3.19
TiO_2, Titanium dioxide (wt.%)	0.405	0.388	0.421	0.394	0.416
Tl, Thallium (ppm)	< 0.5	IND	IND	IND	IND
Tm, Thulium (ppm)	0.13	0.11	0.15	IND	IND
V, Vanadium (ppm)	204	191	217	199	209
W, Tungsten (ppm)	3.97	3.46	4.47	3.38	4.56
Y, Yttrium (ppm)	7.98	7.49	8.47	7.66	8.31
Yb, Ytterbium (ppm)	0.82	0.71	0.92	IND	IND
Zn, Zinc (ppm)	111	102	120	106	116
Zr, Zirconium (ppm)	36.5	32.1	40.9	31.7	41.2

SI unit equivalents: ppm (parts per million; 1×10^{-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. Indicative Values for OREAS 683b.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Pb Fire Assay								
Ir	ppb	*93.2*	Rh	ppb	*257*	Ru	ppb	*465*
NiS Fire Assay								
Os	ppb	*35.9*						
Infrared Combustion								
C	wt.%	*0.118*						
4-Acid Digestion								
B	ppm	*51*	Hg	ppm	*0.013*	Se	ppm	*1.00*
Ge	ppm	*0.092*	Re	ppm	*0.003*			
Borate / Peroxide Fusion ICP								
Ag	ppm	*< 1*	Hg	ppm	*0.35*	Sb	ppm	*0.45*
As	ppm	*10.4*	Li	ppm	*6.98*	Sn	ppm	*1.15*
B	ppm	*28.1*	Na_2O	wt.%	*1.48*	Ta	ppm	*0.18*
Be	ppm	*0.59*	Nb	ppm	*2.59*	Te	ppm	*< 1*
Ge	ppm	*1.15*	Pb	ppm	*13.9*	U	ppm	*0.71*
Hf	ppm	*1.01*	Re	ppm	*< 0.1*			
Borate Fusion XRF								
Al_2O_3	wt.%	*12.94*	Fe_2O_3	wt.%	*11.19*	S	wt.%	*0.425*
As	ppm	*< 10*	K_2O	wt.%	*0.567*	SiO_2	wt.%	*47.61*
BaO	ppm	*223*	MgO	wt.%	*14.61*	Sn	ppm	*9.17*
CaO	wt.%	*7.11*	MnO	wt.%	*0.162*	Sr	ppm	*250*
Cl	ppm	*497*	Na_2O	wt.%	*1.25*	TiO_2	wt.%	*0.411*
Co	ppm	*119*	Ni	wt.%	*0.182*	V_2O_5	ppm	*396*
Cr_2O_3	wt.%	*1.88*	P_2O_5	wt.%	*0.089*	Zn	ppm	*127*
Cu	ppm	*440*	Pb	ppm	*50*	Zr	ppm	*60*
Thermogravimetry								
LOI^{1000}	wt.%	*1.17*						

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 683b-DataPack.1.0.260730_141850.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 as scatter plots for Au, Pd and Pt by Pb fire assay in Figures 1–3, respectively. The plots include the certified value (green line), ±3 SD control limits (magenta), and ±5 % control limits (yellow). Accepted individual results are shown in blue, while individual outliers and dataset outliers are highlighted in red and violet, respectively.

INTENDED USE

OREAS 683b 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 683b may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 683b 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 683b was prepared from a blend of PGE ore and barren gabbronorite. The PGE ore was sourced from the Dishaba Mine within the Bushveld Complex, South Africa, while the barren gabbronorite was sourced from Black Hill Quarry, South Australia. Minor additions of UG2 Reef ore, gold ore and high-grade nickel sulphide ore were incorporated to achieve the targeted Cr–PGE, Au and Ni concentrations, respectively.

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:

- Lead collection fire assay: ≥ 25 g
- Nickel sulphide collection fire assay: ≥ 10 g
- S by infrared combustion furnace / CS analyser: ≥ 0.1 g
- 4-acid digestion with ICP-OES and/or MS finish: ≥ 0.25 g
- Lithium borate / sodium peroxide fusion with ICP-OES and/or MS finish: ≥ 0.2 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 refer to the concentration levels in the packaged state. There is no need for drying prior to weighing and analysis.

Single-Use Sachets

OREAS 683b is available in single-use, 60 g laminated foil sachets sealed under an inert gas environment. Following analysis, it is the manufacturer's expectation that any remaining material is discarded. It is the user's responsibility to prevent contamination and avoid prolonged exposure of the sample to the atmosphere prior to analysis.

Repeat-Use Packaging (e.g., 500 g Plastic Jars)

After taking a subsample, users should replace the lid of the jar promptly and securely to prevent accidental spills and airborne contamination. OREAS 683b contains a non-hygroscopic* matrix with an indicative value for moisture provided to enable users to check for changes to stored material by determining moisture in the user's laboratory and comparing the result to the value in Table 3 in this certificate.

The risk to stability of the CRM in regard to oxidation from the breakdown of sulphide minerals to sulphates is minimal given its low sulphur concentration (0.48 wt.% S).

*A non-hygroscopic matrix means exposure to atmospheres significantly different, in terms of temperature and humidity, from the climate during manufacturing should have negligible impact on the precision of results. Hygroscopic moisture is the amount of adsorped moisture (weakly held H_2O- molecules on the surface of exposed material) following exposure to the local atmosphere. Usually, equilibration of material to the local atmosphere will only occur if the material is spread into a thin (~2mm thick) layer and left exposed for a period of 2 hours.

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)

When applying SDs to monitor performance, it is important to recognise that laboratories differ in proficiency, and that different methods have differing levels of precision. Each laboratory has its own inherent SD (specific to an analyte–method–concentration combination), which is not directly comparable to SDs derived from a round robin.

As most data in this round robin came from world-class laboratories, the interlaboratory SDs are narrower than would be expected across a broader mix. To provide more realistic benchmarks, this report presents pooled interlaboratory SDs, incorporating both within-lab variation and between-lab bias. These should be treated as a starting point only, with QC managers refining them against their own control charts.

The performance gates shown in Table 5 are intended only to be used as an initial guide as to what a laboratory may be able to achieve. Over a period of time monitoring your own laboratory's data for this CRM, SDs should be calculated directly from your own laboratory's process. This will enable you to establish more specific performance gates that are fit for purpose for your application as well as the ability to monitor bias. If your long-term trend analysis shows an average value that differs from the certified value, the significance of this bias should be assessed against the combined standard uncertainty of the certified value

and the laboratory's own measurement uncertainty. Where the observed difference lies within this combined uncertainty, the bias is generally not considered significant.

PERIOD OF VALIDITY

The certification of OREAS 683b remains valid, within the specified measurement uncertainties, until at least November 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 683b was prepared in the following manner:

- Drying of low-sulphide ores and barren material to constant mass at 105 °C
- Drying of sulphide-rich ore to constant mass at 85 °
- Crushing and multi-stage milling of the barren material to >98 % minus 75 microns
- Crushing and multi-stage milling of the ores to 100 % minus 30 microns
- Blending the ores and barren material in appropriate proportions to achieve desired grades
- Homogenisation using OREAS' novel processing technologies
- Packaging in 60 g units in laminated foil pouches

PHYSICAL PROPERTIES

OREAS 683b 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 683b.

Bulk Density (kg/m^3)	Moisture (wt.%)	Munsell Notation‡	Munsell Color‡
760	0.40	N7	Light Gray

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

MINERALOGY

Table 4. Indicative mineralogy of OREAS 683b by semi-quantitative XRD analysis.

Mineral / Mineral Group	% (mass ratio)
Pyrrhotite	1
Ilmenite	< 1
Spinel group	3
Serpentine	2
Chlorite	2
Annite - biotite - phlogopite	2
Ca amphibole	< 1
Clinopyroxene	6
Orthopyroxene	40
Talc	2
Olivine group	2
Plagioclase	35
K-feldspar	4
Quartz	2

The semi-quantitative XRD results shown in Table 4 above 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. 'Spinel group' appears to include mainly chromite and/or magnetite.

ANALYTICAL PROGRAM

Twenty-four 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)
- Au, Pd and Pt by Pb collection fire assay (25-50 g charge weight) with ICP-OES (12 laboratories), ICP-MS (5 laboratories) or AAS finish (2 laboratories)
- Au, Pt, Pd, Ir, Os, Rh and Ru by nickel sulphide (NiS) collection fire assay with ICP-OES, ICP-MS or INAA finish (up to 6 laboratories depending on the element)
- Total S by IR combustion furnace (21 laboratories)
- 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 sodium peroxide or lithium borate fusion (up to 21 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. Each participating laboratory received six test portions. The samples received by each laboratory were

obtained by taking samples 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 of the 12 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, Calgary, Alberta, Canada
3. AGAT Laboratories, Thunder Bay, Ontario, Canada
4. Alex Stewart International, Mendoza, Argentina
5. ALS, Johannesburg, South Africa
6. ALS, Lima, Peru
7. ALS, Loughrea, Galway, Ireland
8. ALS, Malaga, WA, Australia
9. ALS, Vancouver, BC, Canada
10. American Assay Laboratories, Sparks, Nevada, USA
11. ANSTO, Lucas Heights, NSW, Australia
12. Inspectorate (BV), Shanghai, Bao Shan District, China
13. Intertek, Cupang, Muntinlupa, Philippines
14. Intertek, Perth, WA, Australia
15. MINTEK Analytical Services, Randburg, South Africa
16. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
17. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
18. Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada
19. SGS, Ankara, Anatolia, Turkey
20. SGS Australia Mineral Services, Perth, WA, Australia
21. SGS Canada Inc., Vancouver, BC, Canada
22. SGS Geosol Laboratorios Ltda, Vespasiano, Minas Gerais, Brazil
23. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
24. 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 17034:2016 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 Ni by 4-acid digestion with ICP-OES/MS finish, where 99 % of the time ($1-\alpha=0.99$) at least 95 % of subsamples ($\rho=0.95$) will have concentrations lying between 0.164 and 0.170 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. Neutron Activation Analysis of Au (in ppb) on 20 x 85 mg subsamples 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	246	247
2	196	245
3	243	247
4	215	246
5	218	246
6	267	248
7	199	245
8	229	246
9	223	246
10	239	247
11	261	248
12	211	245
13	249	247
14	223	246
15	231	246
16	570	264
17	239	247
18	230	246
19	240	247
20	216	246
Mean	247	247
Median	230	246
Std Dev.	78.1	4.2
Rel.Std.Dev.	**31.60%**	**1.68%**

*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

Table 5 above shows the gold INAA data determined on 20 x 85 mg subsamples of OREAS 683b. 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 1.68 % calculated for a 30 g fire assay test portion, based on the measured value of 31.6 % at an 85 mg test portion, confirms the high degree of gold homogeneity achieved at the low Au concentration in OREAS 683b.

The homogeneity of OREAS 683b 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 683b. 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 0.39 — 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 683b is fit-for-purpose as a certified reference material (see ‘Intended Use’ below).

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) or parts per billion (ppb).

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 [5], clause 9.2.5, and ISO 17034:2016 [9], clause 7.12.4b), 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, 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, fulfilling the requirements for metrological traceability as specified in ISO 17034:2016 and ISO 33405:2024 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 683b.

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, ppb	208	9.3	190	227	180	236	4.45%	8.89%	13.34%	198	219
Pd, ppb	839	39	762	917	723	955	4.61%	9.22%	13.83%	797	881
Pt, ppb	1766	75	1617	1916	1542	1991	4.24%	8.47%	12.71%	1678	1854
NiS Fire Assay											
Au, ppb	190	16.8	156	224	139	240	8.86%	17.73%	26.59%	180	199
Ir, ppb	51.1	6.3	38.6	63.7	32.3	70.0	12.27%	24.55%	36.82%	48.6	53.7
Pd, ppb	835	29	776	894	746	923	3.53%	7.06%	10.59%	793	876
Pt, ppb	1659	82	1496	1823	1414	1904	4.92%	9.85%	14.77%	1576	1742
Rh, ppb	147	6	135	159	129	165	4.06%	8.12%	12.17%	139	154
Ru, ppb	252	25	202	301	178	326	9.83%	19.67%	29.50%	239	264
Infrared Combustion											
S, wt.%	0.475	0.019	0.438	0.512	0.420	0.531	3.89%	7.79%	11.68%	0.452	0.499
4-Acid Digestion											
Ag, ppm	0.197	0.020	0.156	0.238	0.136	0.258	10.38%	20.76%	31.14%	0.187	0.207
Al, wt.%	6.95	0.222	6.51	7.40	6.29	7.62	3.20%	6.40%	9.60%	6.61	7.30
As, ppm	7.91	0.540	6.83	8.99	6.29	9.53	6.83%	13.65%	20.48%	7.51	8.30
Ba, ppm	139	6	127	151	121	157	4.31%	8.63%	12.94%	132	146
Be, ppm	0.49	0.06	0.37	0.60	0.31	0.66	11.92%	23.84%	35.76%	0.46	0.51
Bi, ppm	0.16	0.02	0.13	0.20	0.11	0.21	10.10%	20.20%	30.30%	0.16	0.17
Ca, wt.%	5.06	0.103	4.85	5.26	4.75	5.37	2.03%	4.06%	6.09%	4.80	5.31
Cd, ppm	0.15	0.014	0.12	0.18	0.10	0.19	9.71%	19.42%	29.13%	0.14	0.15
Ce, ppm	16.0	0.60	14.8	17.2	14.2	17.8	3.75%	7.49%	11.24%	15.2	16.8
Co, ppm	99	4.2	91	107	86	112	4.23%	8.46%	12.69%	94	104
Cr, wt.%	1.03	0.17	0.69	1.38	0.51	1.55	16.72%	33.43%	50.15%	0.98	1.08
Cs, ppm	1.67	0.087	1.49	1.84	1.40	1.93	5.24%	10.49%	15.73%	1.58	1.75
Cu, ppm	430	11	408	452	397	463	2.57%	5.15%	7.72%	409	452
Dy, ppm	1.43	0.052	1.33	1.54	1.27	1.59	3.65%	7.30%	10.95%	1.36	1.50
Er, ppm	0.87	0.046	0.78	0.96	0.73	1.00	5.25%	10.50%	15.75%	0.82	0.91
Eu, ppm	0.49	0.034	0.42	0.56	0.39	0.59	6.91%	13.82%	20.72%	0.47	0.51
Fe, wt.%	7.80	0.324	7.15	8.45	6.83	8.77	4.16%	8.32%	12.47%	7.41	8.19
Ga, ppm	13.4	0.97	11.5	15.3	10.5	16.3	7.22%	14.44%	21.65%	12.7	14.1
Gd, ppm	1.59	0.075	1.44	1.74	1.37	1.82	4.74%	9.47%	14.21%	1.51	1.67
Hf, ppm	0.81	0.067	0.68	0.94	0.61	1.01	8.22%	16.44%	24.65%	0.77	0.85
Ho, ppm	0.30	0.019	0.26	0.33	0.24	0.35	6.29%	12.58%	18.86%	0.28	0.31
In, ppm	0.035	0.005	0.024	0.045	0.019	0.051	15.29%	30.58%	45.86%	0.033	0.036
K, wt.%	0.483	0.016	0.452	0.514	0.436	0.530	3.24%	6.47%	9.71%	0.459	0.507
La, ppm	7.33	0.561	6.20	8.45	5.64	9.01	7.66%	15.33%	22.99%	6.96	7.69
Li, ppm	6.80	0.666	5.47	8.14	4.81	8.80	9.78%	19.56%	29.34%	6.46	7.15
Lu, ppm	0.13	0.011	0.11	0.15	0.10	0.16	8.35%	16.70%	25.05%	0.12	0.14
Mg, wt.%	8.93	0.239	8.46	9.41	8.22	9.65	2.67%	5.35%	8.02%	8.49	9.38
Mn, wt.%	0.121	0.004	0.113	0.129	0.109	0.133	3.25%	6.50%	9.75%	0.115	0.127
Mo, ppm	2.70	0.156	2.39	3.01	2.23	3.17	5.77%	11.53%	17.30%	2.56	2.83

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 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											
Na, wt.%	0.936	0.028	0.880	0.993	0.852	1.021	3.02%	6.04%	9.07%	0.890	0.983
Nb, ppm	2.60	0.160	2.28	2.92	2.12	3.08	6.16%	12.33%	18.49%	2.47	2.73
Nd, ppm	8.04	0.520	7.00	9.08	6.48	9.60	6.46%	12.93%	19.39%	7.64	8.44
Ni, wt.%	0.167	0.007	0.153	0.181	0.146	0.188	4.17%	8.34%	12.51%	0.159	0.175
P, wt.%	0.038	0.002	0.035	0.042	0.033	0.044	4.51%	9.03%	13.54%	0.036	0.040
Pb, ppm	10.9	0.94	9.1	12.8	8.1	13.8	8.57%	17.14%	25.71%	10.4	11.5
Pr, ppm	1.98	0.126	1.72	2.23	1.60	2.35	6.37%	12.74%	19.11%	1.88	2.07
Rb, ppm	28.3	1.82	24.6	31.9	22.8	33.7	6.43%	12.86%	19.28%	26.8	29.7
S, wt.%	0.482	0.021	0.440	0.523	0.420	0.543	4.26%	8.53%	12.79%	0.457	0.506
Sb, ppm	0.39	0.06	0.27	0.50	0.21	0.56	15.22%	30.45%	45.67%	0.37	0.41
Sc, ppm	19.6	1.27	17.1	22.1	15.8	23.4	6.47%	12.94%	19.41%	18.6	20.6
Sm, ppm	1.71	0.058	1.59	1.82	1.53	1.88	3.41%	6.81%	10.22%	1.62	1.79
Sn, ppm	0.93	0.10	0.73	1.12	0.63	1.22	10.64%	21.27%	31.91%	0.88	0.97
Sr, ppm	238	11	216	260	205	271	4.64%	9.27%	13.91%	226	250
Ta, ppm	0.20	0.04	0.12	0.27	0.08	0.31	19.06%	38.12%	57.18%	0.19	0.21
Tb, ppm	0.24	0.019	0.20	0.28	0.19	0.30	7.81%	15.61%	23.42%	0.23	0.25
Te, ppm	0.28	0.04	0.20	0.36	0.17	0.39	13.63%	27.27%	40.90%	0.27	0.29
Th, ppm	2.97	0.267	2.44	3.51	2.17	3.78	8.99%	17.98%	26.97%	2.83	3.12
Ti, wt.%	0.244	0.011	0.221	0.266	0.210	0.278	4.64%	9.29%	13.93%	0.232	0.256
Tl, ppm	0.12	0.007	0.10	0.13	0.10	0.14	6.29%	12.58%	18.87%	0.11	0.12
Tm, ppm	0.12	0.02	0.09	0.16	0.07	0.18	15.10%	30.21%	45.31%	0.12	0.13
U, ppm	0.68	0.058	0.56	0.79	0.50	0.85	8.58%	17.17%	25.75%	0.64	0.71
V, ppm	202	5	191	212	185	218	2.69%	5.38%	8.07%	191	212
W, ppm	4.14	0.155	3.83	4.45	3.68	4.61	3.75%	7.49%	11.24%	3.94	4.35
Y, ppm	7.65	0.641	6.37	8.93	5.73	9.57	8.38%	16.76%	25.14%	7.27	8.03
Yb, ppm	0.85	0.043	0.77	0.94	0.72	0.98	5.00%	10.00%	15.00%	0.81	0.90
Zn, ppm	108	7	95	121	88	127	6.08%	12.17%	18.25%	102	113
Zr, ppm	27.9	2.9	22.2	33.6	19.3	36.5	10.25%	20.51%	30.76%	26.5	29.3
Borate / Peroxide Fusion ICP											
Al_2O_3, wt.%	12.97	0.417	12.14	13.80	11.72	14.22	3.21%	6.43%	9.64%	12.32	13.62
Ba, ppm	142	4	135	150	131	153	2.61%	5.21%	7.82%	135	149
Bi, ppm	0.17	0.04	0.10	0.25	0.07	0.28	20.86%	41.71%	62.57%	0.17	0.18
CaO, wt.%	7.04	0.146	6.75	7.34	6.61	7.48	2.07%	4.14%	6.21%	6.69	7.40
Cd, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Ce, ppm	16.2	1.44	13.3	19.1	11.8	20.5	8.92%	17.83%	26.75%	15.4	17.0
Co, ppm	105	5	95	115	90	120	4.83%	9.66%	14.49%	100	110
Cr, wt.%	1.35	0.102	1.15	1.55	1.04	1.66	7.55%	15.10%	22.65%	1.28	1.42
Cs, ppm	1.67	0.115	1.44	1.90	1.32	2.02	6.91%	13.82%	20.73%	1.59	1.75
Cu, ppm	428	25	378	478	353	503	5.87%	11.73%	17.60%	407	450
Dy, ppm	1.44	0.122	1.20	1.69	1.08	1.81	8.47%	16.93%	25.40%	1.37	1.51
Er, ppm	0.85	0.061	0.72	0.97	0.66	1.03	7.20%	14.40%	21.60%	0.80	0.89
Eu, ppm	0.50	0.06	0.38	0.63	0.32	0.69	12.32%	24.65%	36.97%	0.48	0.53
Fe_2O_3, wt.%	11.30	0.324	10.66	11.95	10.33	12.28	2.87%	5.74%	8.61%	10.74	11.87

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; 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											
Ga, ppm	14.0	0.95	12.1	15.9	11.1	16.8	6.81%	13.63%	20.44%	13.3	14.7
Gd, ppm	1.63	0.133	1.36	1.90	1.23	2.03	8.16%	16.33%	24.49%	1.55	1.71
Ho, ppm	0.29	0.027	0.24	0.35	0.21	0.37	9.09%	18.18%	27.27%	0.28	0.31
In, ppm	< 0.2	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
K_2O, wt.%	0.581	0.028	0.525	0.636	0.498	0.663	4.76%	9.51%	14.27%	0.552	0.610
La, ppm	7.71	0.447	6.81	8.60	6.36	9.05	5.80%	11.61%	17.41%	7.32	8.09
Lu, ppm	0.13	0.02	0.10	0.17	0.08	0.18	12.50%	25.00%	37.50%	0.13	0.14
MgO, wt.%	14.75	0.539	13.67	15.83	13.13	16.37	3.65%	7.30%	10.96%	14.01	15.49
MnO, wt.%	0.159	0.007	0.146	0.172	0.139	0.179	4.12%	8.24%	12.36%	0.151	0.167
Mo, ppm	2.93	0.77	1.39	4.46	0.63	5.23	26.20%	52.40%	78.60%	2.78	3.07
Nd, ppm	8.23	0.600	7.03	9.43	6.43	10.03	7.29%	14.58%	21.87%	7.82	8.64
Ni, wt.%	0.175	0.009	0.158	0.193	0.149	0.202	5.01%	10.02%	15.03%	0.167	0.184
P_2O_5, wt.%	0.094	0.011	0.072	0.116	0.061	0.127	11.56%	23.11%	34.67%	0.089	0.099
Pr, ppm	2.04	0.147	1.74	2.33	1.59	2.48	7.22%	14.44%	21.66%	1.93	2.14
Rb, ppm	29.7	1.13	27.5	32.0	26.3	33.1	3.79%	7.59%	11.38%	28.2	31.2
S, wt.%	0.485	0.025	0.434	0.536	0.409	0.561	5.23%	10.46%	15.68%	0.461	0.509
Sc, ppm	19.0	1.12	16.8	21.2	15.6	22.3	5.88%	11.76%	17.64%	18.0	19.9
Se, ppm	< 20	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
SiO_2, wt.%	48.26	1.300	45.66	50.86	44.36	52.16	2.69%	5.39%	8.08%	45.85	50.67
Sm, ppm	1.73	0.18	1.38	2.08	1.20	2.26	10.20%	20.39%	30.59%	1.64	1.82
Sr, ppm	239	6	226	252	220	258	2.64%	5.29%	7.93%	227	251
Tb, ppm	0.24	0.02	0.19	0.29	0.17	0.31	10.13%	20.26%	30.40%	0.23	0.25
Th, ppm	2.97	0.31	2.35	3.60	2.04	3.91	10.49%	20.99%	31.48%	2.82	3.12
TiO_2, wt.%	0.405	0.019	0.366	0.443	0.347	0.463	4.75%	9.50%	14.26%	0.385	0.425
Tl, ppm	< 0.5	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Tm, ppm	0.13	0.01	0.10	0.16	0.09	0.17	10.60%	21.21%	31.81%	0.12	0.14
V, ppm	204	15	175	233	160	248	7.15%	14.29%	21.44%	194	214
W, ppm	3.97	0.43	3.11	4.82	2.68	5.25	10.78%	21.55%	32.33%	3.77	4.17
Y, ppm	7.98	0.361	7.26	8.70	6.90	9.06	4.52%	9.04%	13.56%	7.58	8.38
Yb, ppm	0.82	0.060	0.69	0.94	0.63	1.00	7.41%	14.81%	22.22%	0.77	0.86
Zn, ppm	111	10	90	131	80	141	9.22%	18.45%	27.67%	105	116
Zr, ppm	36.5	2.70	31.1	41.9	28.4	44.6	7.41%	14.82%	22.22%	34.7	38.3

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; 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.

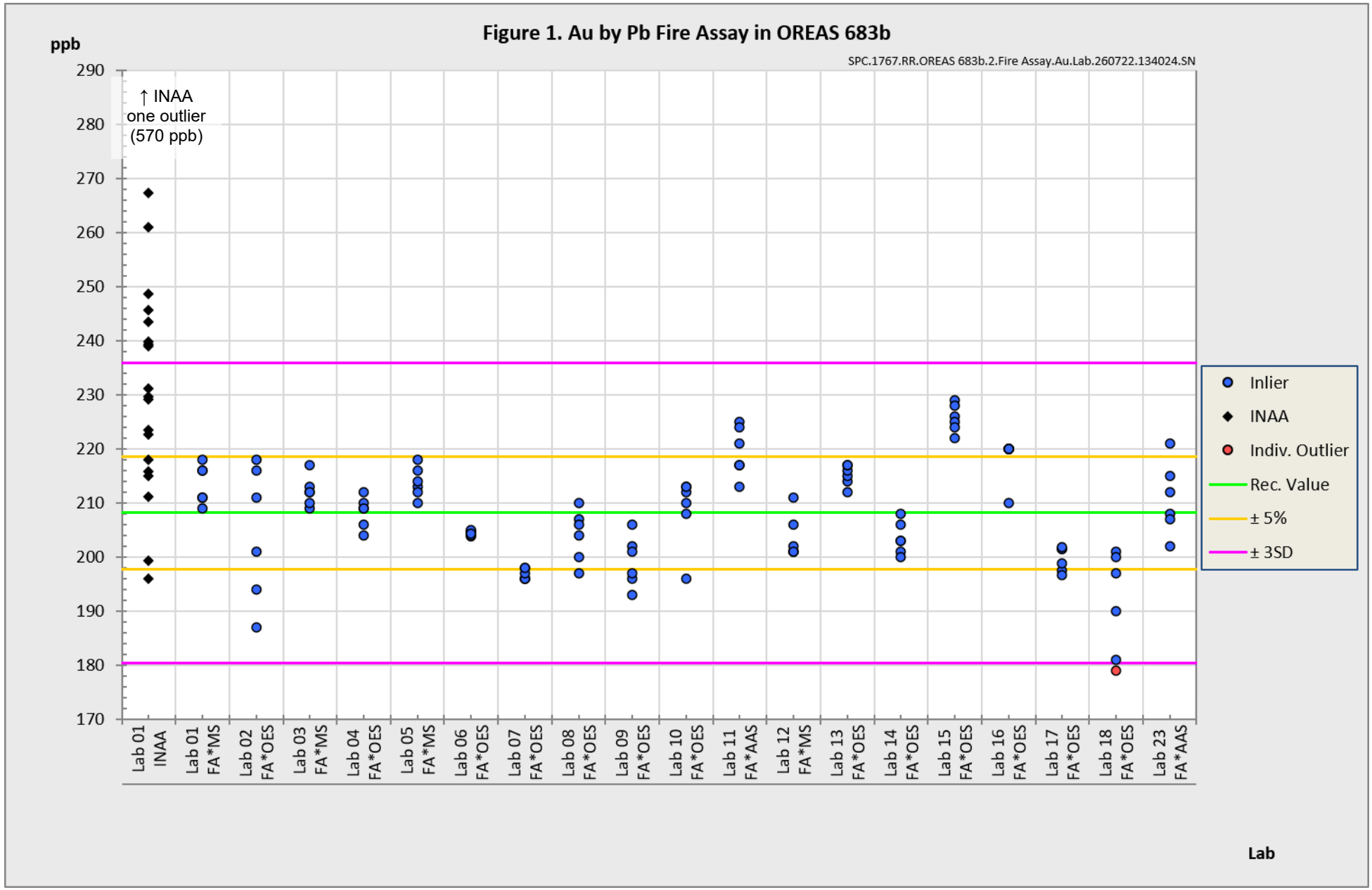
Figure 1. Au by Pb Fire Assay in OREAS 683b
ppb
SPC.1767.RR.OREAS 683b.2.Fire Assay.Au.Lab.260722.134024.SN
↑ INAA
one outlier
(570 ppb)
290
280
270
260
250
240
230
220
210
200
190
180
170
Lab 01 INAA
Lab 01 FA*MS
Lab 02 FA*OES
Lab 03 FA*MS
Lab 04 FA*OES
Lab 05 FA*MS
Lab 06 FA*OES
Lab 07 FA*OES
Lab 08 FA*OES
Lab 09 FA*OES
Lab 10 FA*OES
Lab 11 FA*AAS
Lab 12 FA*MS
Lab 13 FA*OES
Lab 14 FA*OES
Lab 15 FA*OES
Lab 16 FA*OES
Lab 17 FA*OES
Lab 18 FA*OES
Lab 23 FA*AAS
Inlier
INAA
Indiv. Outlier
Rec. Value
± 5%
± 3SD
Lab

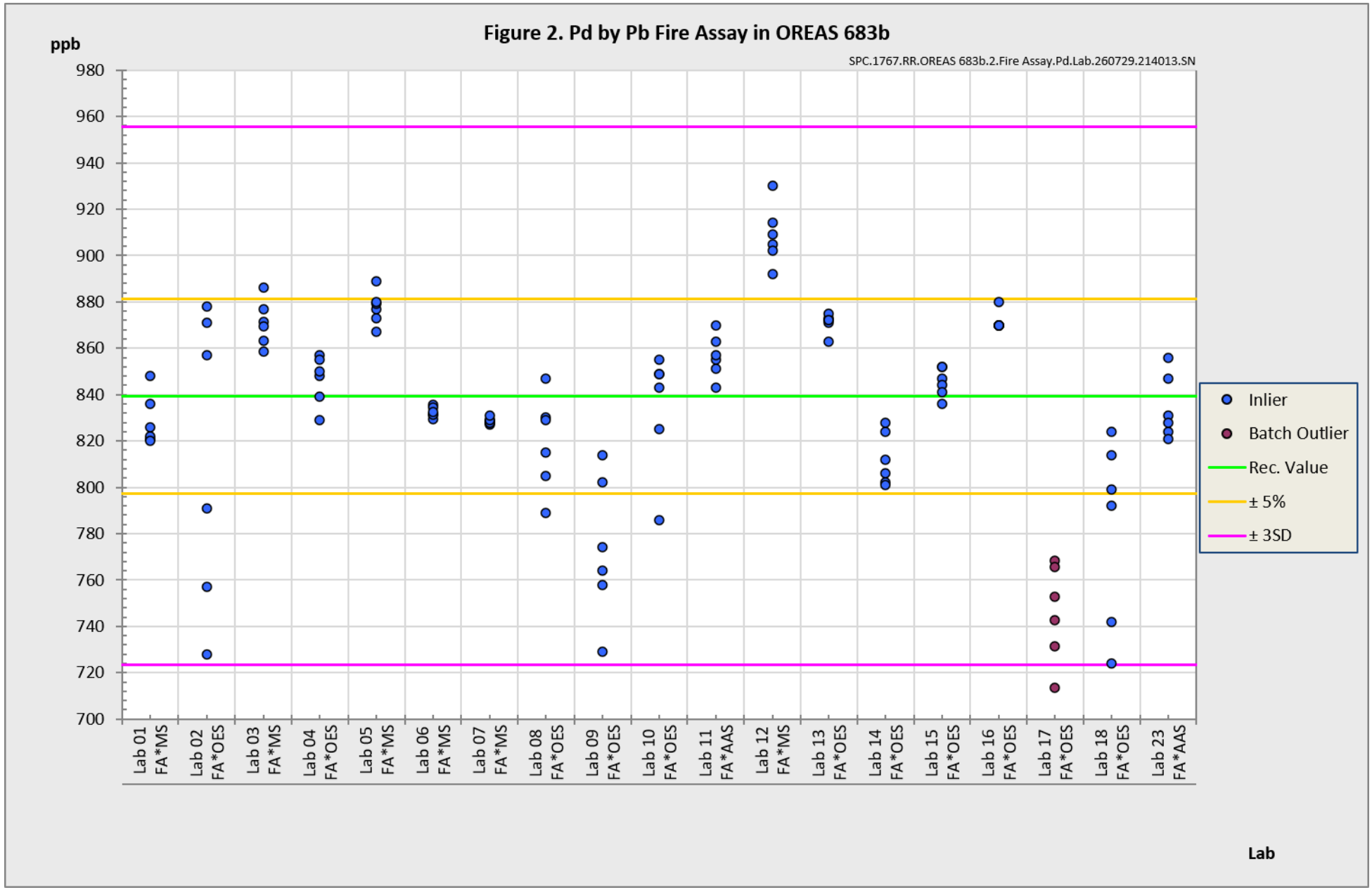
Figure 2. Pd by Pb Fire Assay in OREAS 683b
ppb
SPC.1767.RR.OREAS 683b.2.Fire Assay.Pd.Lab.260729.214013.SN
980
960
940
920
900
880
860
840
820
800
780
760
740
720
700
Lab 01 FA*MS
Lab 02 FA*OES
Lab 03 FA*MS
Lab 04 FA*OES
Lab 05 FA*MS
Lab 06 FA*MS
Lab 07 FA*MS
Lab 08 FA*OES
Lab 09 FA*OES
Lab 10 FA*OES
Lab 11 FA*AAS
Lab 12 FA*MS
Lab 13 FA*OES
Lab 14 FA*OES
Lab 15 FA*OES
Lab 16 FA*OES
Lab 17 FA*OES
Lab 18 FA*OES
Lab 23 FA*AAS
Lab
Inlier
Batch Outlier
Rec. Value
± 5%
± 3SD

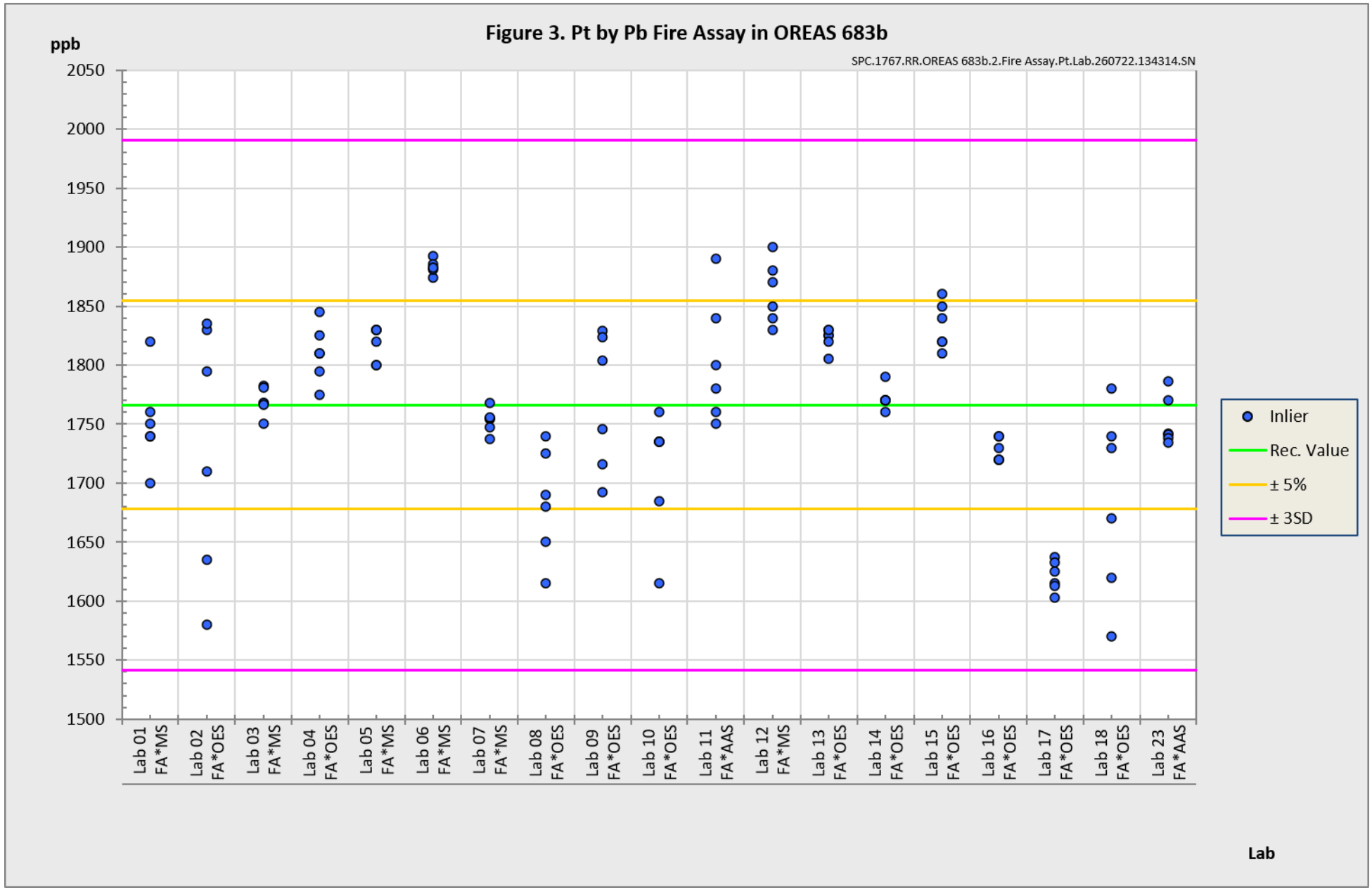
Figure 3. Pt by Pb Fire Assay in OREAS 683b
ppb
SPC.1767.RR.OREAS 683b.2.Fire Assay.Pt.Lab.260722.134314.SN
2050
2000
1950
1900
1850
1800
1750
1700
1650
1600
1550
1500
Lab 01 FA*MS
Lab 02 FA*OES
Lab 03 FA*MS
Lab 04 FA*OES
Lab 05 FA*MS
Lab 06 FA*MS
Lab 07 FA*MS
Lab 08 FA*OES
Lab 09 FA*OES
Lab 10 FA*OES
Lab 11 FA*AAS
Lab 12 FA*MS
Lab 13 FA*OES
Lab 14 FA*OES
Lab 15 FA*OES
Lab 16 FA*OES
Lab 17 FA*OES
Lab 18 FA*OES
Lab 23 FA*AAS
Inlier
Rec. Value
± 5%
± 3SD
Lab

PREPARER AND SUPPLIER

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ACCREDITATION

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

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DOCUMENT HISTORY

Revision No.	Date	Changes applied
0	3rd August 2026	First publication.

REFERENCES

[1] Govett, G.J.S. (1983). Handbook of Exploration Geochemistry, Volume 2: Statistics and Data Analysis in Geochemical Prospecting (Variations of accuracy and precision).

[2] Ingamells, C. O. and Switzer, P. (1973). A Proposed Sampling Constant for Use in Geochemical Analysis, Talanta 20, 547-568.

[3] ISO Guide 30:2015. Terms and definitions used in connection with reference materials.

[4] ISO 33401:2024-01. Reference materials – Contents of certificates, labels and accompanying documentation.

[5] ISO 33405:2024-05. Reference materials – Approaches for characterization and assessment of homogeneity and stability.

[6] ISO Guide 98-3:2008. Guide to the expression of uncertainty in measurement (GUM:1995).

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

[8] ISO 17025:2017, General requirements for the competence of testing and calibration laboratories.

[9] ISO 17034:2016. General requirements for the competence of reference material producers.

[10] Munsell Rock Color Book (2014). Rock-Color Chart Committee, Geological Society of America (GSA), Minnesota (USA).

[11] OREAS-BUP-70-09-11: Statistical Analysis - OREAS Evaluation Method.

[12] OREAS-TN-04-1498: Stability under transport; an experimental study of OREAS CRMs.

[13] OREAS-TN-05-1674: Long-term storage stability; an experimental study of OREAS CRMs.

[14] Thompson, A.; Taylor, B.N. (2008); Guide for the Use of the International System of Units (SI); NIST Special Publication 811; U.S. Government Printing Office: Washington, DC; available at: https://physics.nist.gov/cuu/pdf/sp811.pdf (accessed Nov 2021).

[15] Van der Veen A.M.H. et al. (2001). Uncertainty calculations in the certification of reference materials, Accred Qual Assur 6: 290-294.