

**CERTIFICATE OF ANALYSIS FOR**

**CERTIFIED REFERENCE MATERIAL**

**OREAS 471**

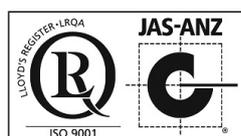
**Clay-Hosted Rare Earth Element (REE) Ore**

**TREO + Y<sub>2</sub>O<sub>3</sub> = 571 ppm**

*Jupiter REE Project, Laverton Region, Western Australia*



Accredited for compliance with ISO 17034



COA-1942-OREAS 471-R0  
BUP-70-10-04 Ver:1.0

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**Table 1. Certified Values, Uncertainty & Tolerance Intervals in OREAS 471.**

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
<b>Borate / Peroxide Fusion ICP</b>					
Al <sub>2</sub> O <sub>3</sub> , Aluminium(III) oxide (wt.%)	16.33	15.97	16.68	16.11	16.54
Ba, Barium (wt.%)	0.245	0.237	0.253	0.241	0.249
Be, Beryllium (ppm)	1.98	1.89	2.07	1.84	2.12
Bi, Bismuth (ppm)	0.30	0.23	0.38	IND	IND
CaO, Calcium oxide (wt.%)	1.23	1.19	1.27	1.21	1.25
CeO <sub>2</sub> , Cerium(IV) oxide (ppm)	251	242	260	247	256
Co, Cobalt (ppm)	15.4	14.4	16.3	14.6	16.2
Cr, Chromium (ppm)	62	56	68	59	65
Cs, Caesium (ppm)	6.97	6.57	7.37	6.68	7.26
Cu, Copper (ppm)	35.7	28.5	42.9	32.8	38.6
Dy <sub>2</sub> O <sub>3</sub> , Dysprosium(III) oxide (ppm)	5.81	5.44	6.18	5.57	6.05
Er <sub>2</sub> O <sub>3</sub> , Erbium(III) oxide (ppm)	2.78	2.59	2.97	2.65	2.90
Eu <sub>2</sub> O <sub>3</sub> , Europium(III) oxide (ppm)	3.11	2.89	3.33	2.98	3.24
Fe <sub>2</sub> O <sub>3</sub> , Iron(III) oxide (wt.%)	6.17	6.01	6.34	6.07	6.28
Ga, Gallium (ppm)	21.5	20.2	22.8	20.5	22.4
Gd <sub>2</sub> O <sub>3</sub> , Gadolinium(III) oxide (ppm)	9.48	9.03	9.94	9.14	9.82
Hf, Hafnium (ppm)	7.93	7.35	8.51	7.47	8.39
Ho <sub>2</sub> O <sub>3</sub> , Holmium(III) oxide (ppm)	1.03	0.97	1.09	0.99	1.07
In, Indium (ppm)	< 0.1	IND	IND	IND	IND
K <sub>2</sub> O, Potassium oxide (wt.%)	3.28	3.19	3.36	3.22	3.33
La <sub>2</sub> O <sub>3</sub> , Lanthanum(III) oxide (ppm)	124	119	128	121	126
Li, Lithium (ppm)	16.3	13.5	19.1	IND	IND
Lu <sub>2</sub> O <sub>3</sub> , Lutetium(III) oxide (ppm)	0.37	0.31	0.43	0.35	0.39
MgO, Magnesium oxide (wt.%)	1.30	1.27	1.33	1.28	1.32
MnO, Manganese oxide (wt.%)	0.050	0.049	0.052	0.049	0.052
Mo, Molybdenum (ppm)	2.33	1.92	2.73	2.22	2.44
Na <sub>2</sub> O, Sodium oxide (wt.%)	1.22	1.18	1.27	1.20	1.25
Nb, Niobium (ppm)	12.7	11.9	13.5	12.0	13.3
Nd <sub>2</sub> O <sub>3</sub> , Neodymium(III) oxide (ppm)	96	93	100	94	99
Ni, Nickel (ppm)	31.8	24.6	39.1	28.7	34.9
P <sub>2</sub> O <sub>5</sub> , Phosphorus(V) oxide (wt.%)	0.322	0.307	0.336	0.312	0.332
Pb, Lead (ppm)	33.0	30.5	35.5	31.3	34.8
Pr <sub>6</sub> O <sub>11</sub> , Praseodymium(III,IV) oxide (ppm)	27.7	26.6	28.7	27.0	28.4
Rb, Rubidium (ppm)	117	113	122	114	121
S, Sulphur (wt.%)	0.036	0.026	0.047	IND	IND
Sb, Antimony (ppm)	0.93	0.75	1.11	IND	IND
Sc, Scandium (ppm)	13.3	12.4	14.3	12.7	13.9

SI unit equivalents: ppm (parts per million;  $1 \times 10^{-6}$ )  $\equiv$  mg/kg; wt.% (weight per cent)  $\equiv$  % (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
<b>Borate / Peroxide Fusion ICP continued</b>					
SiO <sub>2</sub> , Silicon dioxide (wt.%)	63.34	62.22	64.47	62.72	63.97
Sm <sub>2</sub> O <sub>3</sub> , Samarium(III) oxide (ppm)	14.4	13.6	15.1	13.9	14.8
Sn, Tin (ppm)	3.17	2.45	3.89	2.83	3.50
Sr, Strontium (ppm)	445	431	459	435	455
Ta, Tantalum (ppm)	0.88	0.78	0.98	IND	IND
Tb <sub>4</sub> O <sub>7</sub> , Terbium(III,IV) oxide (ppm)	1.19	1.09	1.28	1.13	1.24
Th, Thorium (ppm)	22.3	21.5	23.1	21.8	22.8
Ti, Titanium (wt.%)	0.566	0.543	0.588	0.553	0.578
Tl, Thallium (ppm)	0.64	0.54	0.74	0.60	0.68
Tm <sub>2</sub> O <sub>3</sub> , Thulium(III) oxide (ppm)	0.39	0.36	0.42	0.37	0.41
TREO, Total Rare Earth Oxides (ppm)	537	521	553	528	547
TREO+Y <sub>2</sub> O <sub>3</sub> , Total Rare Earth Oxides + Yttrium oxide (ppm)	571	556	587	562	581
U, Uranium (ppm)	2.61	2.45	2.76	2.51	2.71
V, Vanadium (ppm)	104	99	109	100	107
W, Tungsten (ppm)	4.29	3.77	4.81	3.95	4.64
Y <sub>2</sub> O <sub>3</sub> , Yttrium(III) oxide (ppm)	31.7	30.5	33.0	30.6	32.9
Yb <sub>2</sub> O <sub>3</sub> , Ytterbium(III) oxide (ppm)	2.46	2.31	2.60	2.36	2.55
Zn, Zinc (ppm)	78	73	84	74	83
Zr, Zirconium (ppm)	316	298	333	304	327
<b>Borate Fusion XRF</b>					
Al <sub>2</sub> O <sub>3</sub> , Aluminium(III) oxide (wt.%)	16.41	16.21	16.61	16.35	16.47
BaO, Barium oxide (wt.%)	0.272	0.253	0.291	0.265	0.279
CaO, Calcium oxide (wt.%)	1.21	1.18	1.23	1.19	1.22
CeO <sub>2</sub> , Cerium(IV) oxide (ppm)	243	137	350	232	255
Dy <sub>2</sub> O <sub>3</sub> , Dysprosium(III) oxide (ppm)	< 100	IND	IND	IND	IND
Eu <sub>2</sub> O <sub>3</sub> , Europium(III) oxide (ppm)	< 100	IND	IND	IND	IND
Fe <sub>2</sub> O <sub>3</sub> , Iron(III) oxide (wt.%)	6.20	6.11	6.30	6.16	6.25
Gd <sub>2</sub> O <sub>3</sub> , Gadolinium(III) oxide (ppm)	< 100	IND	IND	IND	IND
Ho <sub>2</sub> O <sub>3</sub> , Holmium(III) oxide (ppm)	< 100	IND	IND	IND	IND
K <sub>2</sub> O, Potassium oxide (wt.%)	3.23	3.19	3.28	3.21	3.26
La <sub>2</sub> O <sub>3</sub> , Lanthanum(III) oxide (ppm)	145	113	178	139	152
Lu <sub>2</sub> O <sub>3</sub> , Lutetium(III) oxide (ppm)	< 100	IND	IND	IND	IND
MgO, Magnesium oxide (wt.%)	1.30	1.28	1.32	1.29	1.32
MnO, Manganese oxide (wt.%)	0.048	0.045	0.052	0.046	0.051
Na <sub>2</sub> O, Sodium oxide (wt.%)	1.22	1.18	1.27	1.21	1.24
P <sub>2</sub> O <sub>5</sub> , Phosphorus(V) oxide (wt.%)	0.324	0.313	0.335	0.318	0.331
Pr <sub>6</sub> O <sub>11</sub> , Praseodymium(III,IV) oxide (ppm)	< 100	IND	IND	IND	IND

SI unit equivalents: ppm (parts per million;  $1 \times 10^{-6}$ )  $\equiv$  mg/kg; wt.% (weight per cent)  $\equiv$  % (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
<b>Borate Fusion XRF continued</b>					
SiO <sub>2</sub> , Silicon dioxide (wt.%)	63.35	62.64	64.06	63.11	63.59
Sm <sub>2</sub> O <sub>3</sub> , Samarium(III) oxide (ppm)	< 100	IND	IND	IND	IND
SO <sub>3</sub> , Sulphur trioxide (wt.%)	0.068	0.057	0.079	IND	IND
Tb <sub>4</sub> O <sub>7</sub> , Terbium(III,IV) oxide (ppm)	< 100	IND	IND	IND	IND
TiO <sub>2</sub> , Titanium dioxide (wt.%)	0.942	0.920	0.965	0.930	0.954
Tm <sub>2</sub> O <sub>3</sub> , Thulium(III) oxide (ppm)	< 100	IND	IND	IND	IND
V <sub>2</sub> O <sub>5</sub> , Vanadium(V) oxide (ppm)	175	134	215	IND	IND
Yb <sub>2</sub> O <sub>3</sub> , Ytterbium(III) oxide (ppm)	< 100	IND	IND	IND	IND
ZnO, Zinc oxide (ppm)	100	74	126	IND	IND
ZrO <sub>2</sub> , Zirconium dioxide (ppm)	403	305	500	386	419
<b>Thermogravimetry</b>					
LOI <sup>1000</sup> , Loss on ignition @1000 °C (wt.%)	4.73	4.44	5.01	4.66	4.79
<b>4-Acid Digestion</b>					
Al, Aluminium (wt.%)	8.46	8.14	8.78	8.27	8.65
As, Arsenic (ppm)	5.26	4.43	6.10	4.91	5.62
Ba, Barium (wt.%)	0.247	0.238	0.257	0.243	0.252
Be, Beryllium (ppm)	1.99	1.88	2.10	1.91	2.07
Bi, Bismuth (ppm)	0.30	0.28	0.32	0.28	0.32
Ca, Calcium (wt.%)	0.862	0.832	0.891	0.845	0.878
Ce, Cerium (ppm)	206	197	215	201	210
Co, Cobalt (ppm)	15.5	14.8	16.3	15.1	16.0
Cr, Chromium (ppm)	51	47	54	49	52
Cs, Caesium (ppm)	6.99	6.74	7.23	6.81	7.16
Cu, Copper (ppm)	32.7	31.5	33.9	31.8	33.7
Dy, Dysprosium (ppm)	4.85	4.60	5.11	4.69	5.02
Er, Erbium (ppm)	2.30	2.19	2.41	2.21	2.39
Eu, Europium (ppm)	2.63	2.50	2.76	2.54	2.72
Fe, Iron (wt.%)	4.23	4.08	4.39	4.16	4.31
Ga, Gallium (ppm)	21.3	20.4	22.2	20.8	21.8
Gd, Gadolinium (ppm)	8.20	7.75	8.66	7.94	8.47
Hf, Hafnium (ppm)	4.28	4.03	4.53	4.12	4.44
Ho, Holmium (ppm)	0.85	0.80	0.90	0.82	0.88
In, Indium (ppm)	0.059	0.051	0.067	0.055	0.063
K, Potassium (wt.%)	2.68	2.59	2.77	2.62	2.74
La, Lanthanum (ppm)	103	98	108	101	105
Li, Lithium (ppm)	16.4	15.6	17.1	15.9	16.8
Lu, Lutetium (ppm)	0.30	0.28	0.32	0.29	0.31

SI unit equivalents: ppm (parts per million;  $1 \times 10^{-6}$ )  $\equiv$  mg/kg; wt.% (weight per cent)  $\equiv$  % (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
<b>4-Acid Digestion continued</b>					
Mg, Magnesium (wt.%)	0.751	0.720	0.782	0.736	0.766
Mn, Manganese (wt.%)	0.038	0.037	0.039	0.038	0.039
Mo, Molybdenum (ppm)	2.07	1.96	2.18	1.99	2.15
Na, Sodium (wt.%)	0.903	0.869	0.936	0.885	0.920
Nb, Niobium (ppm)	12.1	11.5	12.7	11.7	12.5
Nd, Neodymium (ppm)	82	78	86	79	85
Ni, Nickel (ppm)	32.6	31.4	33.8	31.8	33.4
P, Phosphorus (wt.%)	0.143	0.139	0.148	0.140	0.146
Pb, Lead (ppm)	32.1	30.6	33.6	31.1	33.1
Pr, Praseodymium (ppm)	23.1	22.0	24.3	22.4	23.9
Rb, Rubidium (ppm)	119	114	125	116	123
Re, Rhenium (ppm)	< 0.002	IND	IND	IND	IND
S, Sulphur (wt.%)	0.030	0.029	0.031	0.029	0.031
Sb, Antimony (ppm)	0.96	0.90	1.01	0.92	0.99
Sc, Scandium (ppm)	12.7	12.1	13.3	12.4	13.0
Sm, Samarium (ppm)	12.3	11.7	12.8	11.8	12.7
Sn, Tin (ppm)	3.05	2.87	3.22	2.92	3.17
Sr, Strontium (ppm)	442	429	456	434	451
Ta, Tantalum (ppm)	0.79	0.73	0.85	0.75	0.83
Tb, Terbium (ppm)	0.95	0.89	1.00	0.91	0.99
Th, Thorium (ppm)	23.1	22.1	24.2	22.5	23.8
Ti, Titanium (wt.%)	0.531	0.512	0.549	0.517	0.545
Tl, Thallium (ppm)	0.68	0.64	0.72	0.66	0.70
Tm, Thulium (ppm)	0.30	0.28	0.33	0.29	0.32
U, Uranium (ppm)	2.44	2.31	2.57	2.34	2.55
V, Vanadium (ppm)	102	98	106	99	104
W, Tungsten (ppm)	3.99	3.80	4.18	3.85	4.14
Y, Yttrium (ppm)	22.6	21.5	23.6	21.9	23.2
Yb, Ytterbium (ppm)	1.96	1.83	2.09	1.87	2.05
Zn, Zinc (ppm)	77	73	80	75	78
Zr, Zirconium (ppm)	168	160	176	164	172

SI unit equivalents: ppm (parts per million;  $1 \times 10^{-6}$ )  $\equiv$  mg/kg; wt.% (weight per cent)  $\equiv$  % (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 471.**

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
<b>Borate / Peroxide Fusion ICP</b>								
Ag	ppm	0.195	Cd	ppm	< 10	Se	ppm	< 20
As	ppm	5.07	Ge	ppm	1.05	Te	ppm	< 1
B	ppm	87	Re	ppm	< 0.1			
<b>Borate Fusion XRF</b>								
As <sub>2</sub> O <sub>3</sub>	ppm	18.5	Hg	ppm	< 20	Rh	ppm	< 1
Au	ppm	< 20	I	ppm	< 10	Ru	ppm	< 1
Bi <sub>2</sub> O <sub>3</sub>	ppm	< 11	In	ppm	< 10	Sb <sub>2</sub> O <sub>3</sub>	ppm	< 36
Cd	ppm	< 10	Ir	ppm	< 10	Sc <sub>2</sub> O <sub>3</sub>	ppm	16.5
Cl	wt.%	0.238	MoO <sub>3</sub>	ppm	< 1.5	Se	ppm	< 1
Co <sub>3</sub> O <sub>4</sub>	ppm	< 50	Nb <sub>2</sub> O <sub>5</sub>	ppm	79	SnO <sub>2</sub>	ppm	< 100
Cr <sub>2</sub> O <sub>3</sub>	ppm	78	Nd <sub>2</sub> O <sub>3</sub>	ppm	84	SrO	ppm	541
Cs <sub>2</sub> O	ppm	< 11	NiO	ppm	95	Ta <sub>2</sub> O <sub>5</sub>	ppm	< 100
CuO	ppm	52	Os	ppm	< 10	Tc	ppm	< 1
Er <sub>2</sub> O <sub>3</sub>	ppm	105	PbO	ppm	56	Te	ppm	40.7
F	ppm	< 5000	Pd	ppb	< 1000	Th	ppm	< 50
Fr	ppm	< 30	Pm	ppm	118	Tl	ppm	< 50
Ga <sub>2</sub> O <sub>3</sub>	ppm	117	Pt	ppb	< 1000	U <sub>3</sub> O <sub>8</sub>	ppm	< 100
Ge	ppm	< 30	Ra	ppm	< 20	WO <sub>3</sub>	ppm	< 100
H <sub>2</sub> O-	wt.%	1.10	Rb <sub>2</sub> O	ppm	119	Y	ppm	62
HfO <sub>2</sub>	ppm	< 100	Re	ppm	< 10			
<b>Infrared Combustion</b>								
C	wt.%	0.042	S	wt.%	0.030			
<b>4-Acid Digestion</b>								
Ag	ppm	0.049	Ge	ppm	0.27	Se	ppm	1.69
Cd	ppm	0.028	Hg	ppm	0.013	Te	ppm	0.085

SI unit equivalents: ppb (parts per billion;  $1 \times 10^{-9}$ )  $\equiv$   $\mu\text{g}/\text{kg}$ ; ppm (parts per million;  $1 \times 10^{-6}$ )  $\equiv$   $\text{mg}/\text{kg}$ ; wt.% (weight per cent)  $\equiv$  % (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 provides the certified values and their associated 95 % expanded uncertainty and tolerance intervals, Table 2 shows indicative values including major and trace element characterisation, Table 3 provides some indicative physical properties, Table 4 shows indicative mineralogy by semi-quantitative XRD analysis 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<sup>3</sup>) are presented in the detailed certification data for this CRM (**OREAS 471-DataPack.1.0.260218\_090706.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 Dy<sub>2</sub>O<sub>3</sub>, Nd<sub>2</sub>O<sub>3</sub>, Pr<sub>6</sub>O<sub>11</sub> and Tb<sub>4</sub>O<sub>7</sub> by borate/peroxide fusion ICP in Figures 1 to 4 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 471 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 471 may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 471 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 471 is a certified reference material (CRM) produced from a blend of clay-hosted rare earth element (REE) ores, mudstone, silica and kaolin. The REE-bearing ores were sourced from the Jupiter deposit in the Laverton region of Western Australia.

Mineralisation occurs within a deeply weathered regolith developed over an underlying carbonatite–alkaline volcanic sequence. Supergene processes have resulted in enrichment of total rare earth oxides (TREO), including a significant proportion of magnet rare earth oxides (MREO), notably neodymium and praseodymium, with subordinate dysprosium and terbium. The CRM matrix is quartz-rich and comprises abundant mica–illite and kaolinite-group clays, with additional smectite/vermiculite-type clay minerals. Minor iron oxides (goethite and magnetite), traces of hematite and anatase are present as accessory phases. Rare earth elements are interpreted to occur predominantly within fine-grained secondary phases associated with the clay fraction.

## 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:

- Borate fusion /Sodium peroxide with ICP-OES and/or MS finish:  $\geq 0.2$  g;
- Borate fusion with X-ray fluorescence finish:  $\geq 0.2$  g;
- Loss on Ignition (LOI) at 1000 °C:  $\geq 1$  g;
- 4-acid digestion with ICP-OES and/or MS finish:  $\geq 0.25$  g.

## INSTRUCTIONS FOR HANDLING & 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 [11].

As per routine analysis at commercial laboratories, the certified values derived by borate fusion with XRF finish are on a dry sample basis.

Analytes by all other methods refer to the concentration levels in the packaged state. There is no need for drying prior to weighing and analysis for these methods.

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

## **PERIOD OF VALIDITY & STORAGE INSTRUCTIONS**

The certification of OREAS 471 remains valid, within the specified measurement uncertainties, until at least May 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.

### Single-use sachets

OREAS 471 is packaged in single-use, 10 g laminated foil sachets. 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 471 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 stability of the CRM in regard to oxidation from the breakdown of sulphide minerals to sulphates is minimal given its low sulphur concentration (~ 0.03 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 adsorbed moisture (weakly held H<sub>2</sub>O- 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.

## COMMINUTION AND HOMOGENISATION PROCEDURES

The materials constituting OREAS 471 was prepared in the following manner:

- Crushing and multi-stage milling of the barren materials to >95% minus 75 microns;
- Crushing and multi-stage milling of the ores to 100% minus 30 microns;
- Blending the ores and barren materials in appropriate proportions to achieve desired grades;
- Homogenisation using OREAS' novel processing technologies;
- Packaging in 10 g units in laminated foil pouches and 500 g units in plastic wide-mouth jars.

## PHYSICAL PROPERTIES

OREAS 471 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 471.**

Bulk Density (kg/m <sup>3</sup> )	Moisture (wt.%)	Munsell Notation <sup>‡</sup>	Munsell Color <sup>‡</sup>
529	1.02	10YR 8/2	Very Pale Orange

<sup>‡</sup>The Munsell Rock Color Chart helps geologists and archaeologists 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, vermiculite and/or illite. A trace of anatase may be present in the samples. A trace of chlorite may be present.

**Table 4. Indicative mineralogy of OREAS 471 by semi-quantitative XRD analysis.**

Mineral / Mineral Group	% (mass ratio)
Hematite	2
Goethite	2
Clay minerals	5
Serpentine	1
Kandite group	13
Annite - biotite - phlogopite	1
Muscovite - illite	11
Ca amphibole	4
Plagioclase	12
K-feldspar and/or rutile	14
Quartz	35
Dolomite - ankerite	< 1
Apatite group	< 1
Crandallite group	1

## ANALYTICAL PROGRAM

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

- Lithium borate or sodium peroxide fusion with full suite ICP-OES and ICP-MS elemental packages (up to 27 laboratories depending on the element);
- Lithium borate fusion whole rock analysis package by X-ray fluorescence (up to 13 laboratories depending on the element);
- Thermogravimetry: Loss on Ignition (LOI) at 1000 °C (8 laboratories used a thermogravimetric analyser, 6 laboratories included LOI with their fusion package and 3 laboratories used a conventional muffle furnace);
- 4-acid (HNO<sub>3</sub>-HF-HClO<sub>4</sub>-HCl) digestion with full suite ICP-OES and ICP-MS elemental packages (up to 26 laboratories depending on the element).

Samples of this CRM were analysed by Intertek Genalysis Laboratory (Perth, Australia) using ammonium sulphate ionic leaching followed by ICP-MS (method ICL/MS16). A range of ammonium sulphate concentrations and leach pH conditions were tested to assess the method's effectiveness. Despite these variations, recoveries of rare earth elements remained consistently low, indicating that ammonium sulphate leaching is ineffective for extracting REEs from this material. Therefore, this CRM represents a clay-hosted REE

deposit without significant ion-exchangeable rare earth element content typical of ion-adsorbed clays.

For the round robin program, six 2 kg test units were collected at predetermined intervals during the bagging stage, immediately after homogenisation. These units are considered representative of the entire prepared batch. Each participating laboratory received six test portions, obtained by subsampling 15 g from each of the six distinct 2 kg units.

Homogeneity was assessed by submitting 12 pulp samples to a single laboratory for analysis. Paired 15 g samples were drawn from each of the six test units, enabling an Analysis of Variance (ANOVA) to compare within-unit and between-unit variances. This statistical method provides a relative measure of homogeneity and tests the null hypothesis that all units derive from the same population distribution (refer to the 'Homogeneity Evaluation' section below).

## PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. African Natural Resources & Mines Ltd, Suleja, Niger State, Nigeria
3. AGAT Laboratories, Calgary, Alberta, Canada
4. Alex Stewart International, Mendoza, Argentina
5. ALS, Brisbane, QLD, Australia
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. ARGETEST Mineral Processing, Ankara, Central Anatolia, Turkey
12. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
13. CERTIMIN, Lima, Peru
14. Inspectorate (BV), Lima, Peru
15. Intertek, Perth, WA, Australia
16. Intertek, Townsville, QLD, Australia
17. Intertek Genalysis, Adelaide, SA, Australia
18. Lucid Laboratories Private Limited, Hyderabad, Telangana, India
19. Ontario Geological Survey, Sudbury, Ontario, Canada
20. Performance Laboratories, Ruwa, Harare, Zimbabwe
21. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
22. PT Indo Mineral Research, Bungursari, West Java, Indonesia
23. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
24. SGS, Randfontein, Gauteng, South Africa
25. SGS Australia Mineral Services, Perth, WA, Australia
26. SGS Geosol Laboratorios Ltda, Vespasiano, Minas Gerais, Brazil
27. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
28. Stewart Assay & Environmental Laboratories LLC, Kara-Balta, Chüy, Kyrgyzstan
29. UIS Analytical Services, Centurion, South Africa

***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 [5] and [14]. 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 5, '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 individuals, 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 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 Nd<sub>2</sub>O<sub>3</sub> by fusion ICP where 99 % of the time (1- $\alpha$ =0.99) at least 95 % of subsamples ( $p=0.95$ ) will have concentrations lying between 94 and 99 ppm. 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.***

### Analysis of Variance (ANOVA) Study

In addition to the precision error method outlined above, homogeneity was also evaluated using an ANOVA study. This involved sending 12 x 20 g pulp samples to the ALS Brisbane, laboratory for analysis by lithium borate fusion with ICP-MS finish (code ME- MS81). The 12 samples consisted of paired samples from each of the six sampling units to enable an

Analysis of Variance (ANOVA) by comparison of within- and between-unit variances across the six pairs. The ANOVA enables a relative measure of homogeneity and permits a test of the null hypothesis that all 'units' are drawn from the same population distribution. An ANOVA constructed in this way tests that no statistically significant difference exists in the variance between-units to that of the variance within-units. A  $p$ -value  $< 0.05$  would indicate rejection of the null hypothesis at the 95 % confidence level (i.e., a significant difference likely does exist; meaning there is evidence of heterogeneity between the sample intervals).

Of the fifteen analytes evaluated by ANOVA, only Ti showed a statistically significant  $p$ -value (0.025). Statistically significant results should be assessed for technical significance as well. The RSD for Ti across the 12 samples is 1.71 %, which indicates that the variation is tightly constrained. The magnitude of any between-unit variation is therefore minor relative to typical measurement uncertainty. Furthermore, round-robin data for Ti determined by fusion with ICP and four-acid digestion with ICP show no evidence of systematic grouping when plotted by sampling interval. All other  $p$ -values were not significant, and the null hypothesis is retained. The apparent significance for Ti is considered a statistical anomaly rather than evidence of CRM heterogeneity.

It is important to note that ANOVA provides a relative measure of homogeneity and that a CRM having poor absolute homogeneity can still pass these tests if the within-unit heterogeneity is large and similar across all units. Based on the statistical analysis of the results of the interlaboratory certification program, it can be concluded that OREAS 471 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).

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 [7], 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 [4], clause 9.2.5, and ISO 17034:2016 [8], 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 and mining 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 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](http://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)  $\pm$  10 %.

*i.e., Certified Value  $\pm$ 10 %  $\pm$ 2DL [1].*

**Table 5. Performance Gates for OREAS 471.**

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
<b>Borate / Peroxide Fusion ICP</b>											
Al <sub>2</sub> O <sub>3</sub> , wt. %	16.33	0.402	15.52	17.13	15.12	17.53	2.46%	4.93%	7.39%	15.51	17.14
Ba, wt. %	0.245	0.008	0.230	0.260	0.222	0.268	3.09%	6.17%	9.26%	0.233	0.257
Be, ppm	1.98	0.045	1.89	2.07	1.85	2.12	2.26%	4.51%	6.77%	1.88	2.08
Bi, ppm	0.30	0.04	0.23	0.38	0.19	0.42	12.30%	24.60%	36.90%	0.29	0.32
CaO, wt. %	1.23	0.048	1.13	1.33	1.09	1.38	3.91%	7.83%	11.74%	1.17	1.29
CeO <sub>2</sub> , ppm	251	6	238	264	232	271	2.56%	5.13%	7.69%	239	264
Co, ppm	15.4	0.70	14.0	16.8	13.3	17.5	4.53%	9.06%	13.59%	14.6	16.1
Cr, ppm	62	3.7	55	69	51	73	5.89%	11.78%	17.66%	59	65
Cs, ppm	6.97	0.374	6.22	7.72	5.85	8.09	5.37%	10.73%	16.10%	6.62	7.32
Cu, ppm	35.7	8.3	19.0	52.4	10.7	60.7	23.37%	46.73%	70.10%	33.9	37.5
Dy <sub>2</sub> O <sub>3</sub> , ppm	5.81	0.254	5.30	6.32	5.05	6.57	4.37%	8.74%	13.11%	5.52	6.10
Er <sub>2</sub> O <sub>3</sub> , ppm	2.78	0.144	2.49	3.07	2.34	3.21	5.20%	10.40%	15.60%	2.64	2.92
Eu <sub>2</sub> O <sub>3</sub> , ppm	3.11	0.202	2.71	3.51	2.50	3.72	6.49%	12.98%	19.47%	2.95	3.27
Fe <sub>2</sub> O <sub>3</sub> , wt. %	6.17	0.137	5.90	6.45	5.76	6.58	2.21%	4.43%	6.64%	5.86	6.48
Ga, ppm	21.5	1.28	18.9	24.0	17.6	25.3	5.96%	11.93%	17.89%	20.4	22.5
Gd <sub>2</sub> O <sub>3</sub> , ppm	9.48	0.562	8.36	10.61	7.80	11.17	5.93%	11.85%	17.78%	9.01	9.96
Hf, ppm	7.93	0.523	6.88	8.97	6.36	9.50	6.60%	13.19%	19.79%	7.53	8.32
Ho <sub>2</sub> O <sub>3</sub> , ppm	1.03	0.041	0.95	1.11	0.91	1.15	3.97%	7.94%	11.91%	0.98	1.08
In, ppm	< 0.1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
K <sub>2</sub> O, wt. %	3.28	0.084	3.11	3.44	3.02	3.53	2.57%	5.14%	7.71%	3.11	3.44
La <sub>2</sub> O <sub>3</sub> , ppm	124	4	116	132	112	136	3.25%	6.49%	9.74%	117	130
Li, ppm	16.3	1.47	13.3	19.2	11.9	20.7	9.04%	18.08%	27.12%	15.5	17.1
Lu <sub>2</sub> O <sub>3</sub> , ppm	0.37	0.032	0.30	0.43	0.27	0.46	8.71%	17.43%	26.14%	0.35	0.39
MgO, wt. %	1.30	0.028	1.24	1.36	1.22	1.38	2.17%	4.33%	6.50%	1.23	1.36
MnO, wt. %	0.050	0.001	0.048	0.053	0.046	0.055	2.89%	5.78%	8.67%	0.048	0.053
Mo, ppm	2.33	0.62	1.08	3.58	0.46	4.20	26.78%	53.56%	80.34%	2.21	2.45
Na <sub>2</sub> O, wt. %	1.22	0.040	1.14	1.30	1.10	1.35	3.27%	6.55%	9.82%	1.16	1.29
Nb, ppm	12.7	0.95	10.8	14.6	9.8	15.5	7.51%	15.02%	22.53%	12.1	13.3
Nd <sub>2</sub> O <sub>3</sub> , ppm	96	3.2	90	103	87	106	3.29%	6.58%	9.87%	92	101
Ni, ppm	31.8	3.7	24.4	39.2	20.7	42.9	11.62%	23.25%	34.87%	30.2	33.4
P <sub>2</sub> O <sub>5</sub> , wt. %	0.322	0.011	0.301	0.343	0.290	0.354	3.29%	6.59%	9.88%	0.306	0.338
Pb, ppm	33.0	2.15	28.7	37.3	26.6	39.5	6.51%	13.01%	19.52%	31.4	34.7
Pr <sub>6</sub> O <sub>11</sub> , ppm	27.7	0.74	26.2	29.1	25.4	29.9	2.66%	5.32%	7.97%	26.3	29.0
Rb, ppm	117	4	109	126	104	131	3.74%	7.49%	11.23%	112	123
S, wt. %	0.036	0.010	0.017	0.055	0.007	0.065	26.84%	53.69%	80.53%	0.034	0.038

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

Notes: intervals may appear asymmetric due to rounding; 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.

IND = indeterminate.

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
<b>Borate / Peroxide Fusion ICP continued</b>											
Sb, ppm	0.93	0.14	0.65	1.21	0.51	1.35	15.05%	30.09%	45.14%	0.89	0.98
Sc, ppm	13.3	1.02	11.3	15.4	10.3	16.4	7.67%	15.34%	23.00%	12.7	14.0
SiO <sub>2</sub> , wt. %	63.34	0.726	61.89	64.80	61.16	65.52	1.15%	2.29%	3.44%	60.18	66.51
Sm <sub>2</sub> O <sub>3</sub> , ppm	14.4	0.77	12.8	15.9	12.0	16.7	5.36%	10.73%	16.09%	13.6	15.1
Sn, ppm	3.17	0.48	2.21	4.12	1.73	4.60	15.11%	30.22%	45.34%	3.01	3.33
Sr, ppm	445	13	420	470	407	483	2.82%	5.64%	8.46%	423	467
Ta, ppm	0.88	0.10	0.69	1.07	0.59	1.17	10.90%	21.79%	32.69%	0.84	0.93
Tb <sub>4</sub> O <sub>7</sub> , ppm	1.19	0.087	1.01	1.36	0.92	1.45	7.38%	14.76%	22.14%	1.13	1.24
Th, ppm	22.3	0.74	20.8	23.8	20.0	24.5	3.34%	6.68%	10.01%	21.2	23.4
Ti, wt. %	0.566	0.026	0.513	0.619	0.486	0.645	4.68%	9.36%	14.04%	0.538	0.594
Tl, ppm	0.64	0.10	0.45	0.84	0.35	0.93	15.18%	30.36%	45.53%	0.61	0.67
Tm <sub>2</sub> O <sub>3</sub> , ppm	0.39	0.032	0.33	0.45	0.29	0.49	8.30%	16.60%	24.91%	0.37	0.41
TREO, ppm	537	11	515	559	504	570	2.03%	4.07%	6.10%	510	564
TREO+Y <sub>2</sub> O <sub>3</sub> , ppm	571	15	542	601	527	615	2.57%	5.14%	7.71%	543	600
U, ppm	2.61	0.103	2.40	2.82	2.30	2.92	3.96%	7.92%	11.88%	2.48	2.74
V, ppm	104	6	93	115	87	120	5.30%	10.60%	15.89%	99	109
W, ppm	4.29	0.324	3.64	4.94	3.32	5.26	7.56%	15.11%	22.67%	4.08	4.51
Y <sub>2</sub> O <sub>3</sub> , ppm	31.7	1.17	29.4	34.1	28.2	35.2	3.67%	7.35%	11.02%	30.2	33.3
Yb <sub>2</sub> O <sub>3</sub> , ppm	2.46	0.158	2.14	2.77	1.98	2.93	6.45%	12.91%	19.36%	2.33	2.58
Zn, ppm	78	5.0	68	88	63	93	6.34%	12.69%	19.03%	74	82
Zr, ppm	316	20	275	356	255	376	6.39%	12.78%	19.18%	300	331
<b>Borate Fusion XRF</b>											
Al <sub>2</sub> O <sub>3</sub> , wt. %	16.41	0.246	15.92	16.90	15.67	17.15	1.50%	2.99%	4.49%	15.59	17.23
BaO, wt. %	0.272	0.017	0.238	0.307	0.221	0.324	6.32%	12.65%	18.97%	0.259	0.286
CaO, wt. %	1.21	0.019	1.17	1.24	1.15	1.26	1.55%	3.10%	4.66%	1.15	1.27
CeO <sub>2</sub> , ppm	243	63	117	370	53	434	26.05%	52.10%	78.14%	231	256
Dy <sub>2</sub> O <sub>3</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Eu <sub>2</sub> O <sub>3</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Fe <sub>2</sub> O <sub>3</sub> , wt. %	6.20	0.107	5.99	6.42	5.88	6.52	1.72%	3.44%	5.16%	5.89	6.51
Gd <sub>2</sub> O <sub>3</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Ho <sub>2</sub> O <sub>3</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
K <sub>2</sub> O, wt. %	3.23	0.051	3.13	3.33	3.08	3.39	1.57%	3.14%	4.70%	3.07	3.39
La <sub>2</sub> O <sub>3</sub> , ppm	145	44	57	234	12	279	30.55%	61.09%	91.64%	138	153
Lu <sub>2</sub> O <sub>3</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
MgO, wt. %	1.30	0.021	1.26	1.34	1.24	1.36	1.58%	3.17%	4.75%	1.24	1.37
MnO, wt. %	0.048	0.003	0.042	0.055	0.038	0.059	7.08%	14.16%	21.23%	0.046	0.051
Na <sub>2</sub> O, wt. %	1.22	0.044	1.14	1.31	1.09	1.36	3.59%	7.18%	10.77%	1.16	1.28
P <sub>2</sub> O <sub>5</sub> , wt. %	0.324	0.011	0.302	0.347	0.291	0.358	3.48%	6.95%	10.43%	0.308	0.341
Pr <sub>6</sub> O <sub>11</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
SiO <sub>2</sub> , wt. %	63.35	0.889	61.57	65.13	60.68	66.02	1.40%	2.81%	4.21%	60.18	66.52
Sm <sub>2</sub> O <sub>3</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
SO <sub>3</sub> , wt. %	0.068	0.006	0.056	0.080	0.050	0.086	8.90%	17.79%	26.69%	0.065	0.071
Tb <sub>4</sub> O <sub>7</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND

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

Notes: intervals may appear asymmetric due to rounding; 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.

IND = indeterminate.

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
<b>Borate Fusion XRF continued</b>											
TiO <sub>2</sub> , wt. %	0.942	0.026	0.891	0.994	0.865	1.020	2.74%	5.47%	8.21%	0.895	0.990
Tm <sub>2</sub> O <sub>3</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
V <sub>2</sub> O <sub>5</sub> , ppm	175	33	108	241	75	275	19.10%	38.20%	57.30%	166	183
Yb <sub>2</sub> O <sub>3</sub> , ppm	< 100	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
ZnO, ppm	100	23	54	145	32	168	22.72%	45.43%	68.15%	95	105
ZrO <sub>2</sub> , ppm	403	43	317	488	274	531	10.62%	21.23%	31.85%	383	423
<b>Thermogravimetry</b>											
LOI <sup>1000</sup> , wt. %	4.73	0.53	3.66	5.80	3.12	6.33	11.32%	22.64%	33.96%	4.49	4.96
<b>4-Acid Digestion</b>											
Al, wt. %	8.46	0.241	7.98	8.94	7.74	9.18	2.84%	5.69%	8.53%	8.04	8.88
As, ppm	5.26	1.15	2.96	7.57	1.81	8.72	21.89%	43.78%	65.67%	5.00	5.53
Ba, wt. %	0.247	0.011	0.226	0.269	0.215	0.280	4.44%	8.87%	13.31%	0.235	0.260
Be, ppm	1.99	0.107	1.78	2.20	1.67	2.31	5.35%	10.70%	16.06%	1.89	2.09
Bi, ppm	0.30	0.019	0.26	0.34	0.24	0.36	6.18%	12.35%	18.53%	0.29	0.32
Ca, wt. %	0.862	0.025	0.811	0.912	0.786	0.937	2.92%	5.84%	8.77%	0.819	0.905
Ce, ppm	206	13	181	231	168	244	6.09%	12.17%	18.26%	196	216
Co, ppm	15.5	0.72	14.1	17.0	13.4	17.7	4.64%	9.29%	13.93%	14.8	16.3
Cr, ppm	51	4.3	42	59	38	63	8.42%	16.84%	25.26%	48	53
Cs, ppm	6.99	0.323	6.34	7.63	6.02	7.96	4.63%	9.25%	13.88%	6.64	7.34
Cu, ppm	32.7	1.21	30.3	35.1	29.1	36.3	3.70%	7.39%	11.09%	31.1	34.4
Dy, ppm	4.85	0.313	4.23	5.48	3.91	5.79	6.45%	12.90%	19.35%	4.61	5.10
Er, ppm	2.30	0.153	1.99	2.61	1.84	2.76	6.65%	13.30%	19.95%	2.18	2.41
Eu, ppm	2.63	0.170	2.29	2.97	2.12	3.14	6.47%	12.95%	19.42%	2.50	2.76
Fe, wt. %	4.23	0.111	4.01	4.45	3.90	4.57	2.61%	5.23%	7.84%	4.02	4.45
Ga, ppm	21.3	0.82	19.7	23.0	18.9	23.8	3.86%	7.73%	11.59%	20.3	22.4
Gd, ppm	8.20	0.696	6.81	9.60	6.11	10.29	8.49%	16.97%	25.46%	7.79	8.61
Hf, ppm	4.28	0.290	3.70	4.86	3.41	5.15	6.77%	13.53%	20.30%	4.07	4.49
Ho, ppm	0.85	0.054	0.74	0.96	0.69	1.01	6.32%	12.63%	18.95%	0.81	0.89
In, ppm	0.059	0.005	0.050	0.068	0.045	0.072	7.76%	15.52%	23.28%	0.056	0.062
K, wt. %	2.68	0.074	2.53	2.83	2.46	2.90	2.77%	5.53%	8.30%	2.55	2.81
La, ppm	103	7	89	117	82	124	6.92%	13.84%	20.76%	98	108
Li, ppm	16.4	0.62	15.1	17.6	14.5	18.2	3.80%	7.60%	11.41%	15.6	17.2
Lu, ppm	0.30	0.014	0.27	0.33	0.26	0.34	4.80%	9.61%	14.41%	0.29	0.32
Mg, wt. %	0.751	0.032	0.688	0.815	0.656	0.847	4.24%	8.47%	12.71%	0.714	0.789
Mn, wt. %	0.038	0.001	0.037	0.040	0.036	0.040	1.97%	3.94%	5.90%	0.036	0.040
Mo, ppm	2.07	0.079	1.91	2.23	1.83	2.31	3.83%	7.66%	11.50%	1.97	2.17
Na, wt. %	0.903	0.025	0.852	0.953	0.826	0.979	2.82%	5.64%	8.45%	0.857	0.948
Nb, ppm	12.1	0.70	10.7	13.5	10.0	14.2	5.80%	11.61%	17.41%	11.5	12.7
Nd, ppm	82	4.5	73	91	68	95	5.50%	10.99%	16.49%	78	86
Ni, ppm	32.6	1.02	30.6	34.7	29.5	35.7	3.14%	6.28%	9.41%	31.0	34.2
P, wt. %	0.143	0.004	0.135	0.151	0.132	0.154	2.65%	5.29%	7.94%	0.136	0.150
Pb, ppm	32.1	1.65	28.8	35.4	27.2	37.1	5.15%	10.30%	15.45%	30.5	33.7
Pr, ppm	23.1	1.59	20.0	26.3	18.4	27.9	6.89%	13.77%	20.66%	22.0	24.3

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

Notes: intervals may appear asymmetric due to rounding; 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.

IND = indeterminate.

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
<b>4-Acid Digestion continued</b>											
Rb, ppm	119	7	106	133	99	140	5.76%	11.52%	17.28%	113	125
Re, ppm	< 0.002	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
S, wt. %	0.030	0.001	0.028	0.032	0.027	0.033	2.83%	5.66%	8.49%	0.028	0.031
Sb, ppm	0.96	0.041	0.88	1.04	0.84	1.08	4.24%	8.47%	12.71%	0.91	1.00
Sc, ppm	12.7	0.74	11.2	14.2	10.5	14.9	5.86%	11.72%	17.58%	12.1	13.3
Sm, ppm	12.3	0.82	10.6	13.9	9.8	14.7	6.70%	13.41%	20.11%	11.6	12.9
Sn, ppm	3.05	0.160	2.73	3.37	2.57	3.53	5.26%	10.51%	15.77%	2.89	3.20
Sr, ppm	442	11	420	465	408	477	2.59%	5.18%	7.77%	420	465
Ta, ppm	0.79	0.09	0.62	0.96	0.53	1.05	10.95%	21.90%	32.86%	0.75	0.83
Tb, ppm	0.95	0.078	0.79	1.10	0.71	1.18	8.28%	16.57%	24.85%	0.90	0.99
Th, ppm	23.1	1.27	20.6	25.7	19.3	27.0	5.51%	11.02%	16.53%	22.0	24.3
Ti, wt. %	0.531	0.020	0.491	0.570	0.471	0.590	3.73%	7.47%	11.20%	0.504	0.557
Tl, ppm	0.68	0.052	0.58	0.78	0.52	0.83	7.62%	15.24%	22.86%	0.64	0.71
Tm, ppm	0.30	0.029	0.25	0.36	0.22	0.39	9.45%	18.90%	28.35%	0.29	0.32
U, ppm	2.44	0.158	2.13	2.76	1.97	2.92	6.46%	12.92%	19.37%	2.32	2.56
V, ppm	102	3	95	109	92	112	3.26%	6.52%	9.79%	97	107
W, ppm	3.99	0.220	3.55	4.43	3.33	4.65	5.51%	11.02%	16.53%	3.79	4.19
Y, ppm	22.6	2.04	18.5	26.7	16.4	28.7	9.04%	18.08%	27.12%	21.4	23.7
Yb, ppm	1.96	0.132	1.70	2.23	1.56	2.36	6.75%	13.51%	20.26%	1.86	2.06
Zn, ppm	77	2.5	72	81	69	84	3.21%	6.43%	9.64%	73	80
Zr, ppm	168	9	149	187	140	196	5.62%	11.23%	16.85%	160	176

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

Notes: intervals may appear asymmetric due to rounding; 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.

IND = indeterminate.

Figure 1. Dy<sub>2</sub>O<sub>3</sub> by Borate / Peroxide Fusion ICP in OREAS 471

SPC.1942.RR1.OREAS471.2.Fusion ICP.Dy2O3.Lab.260130.082802.SS

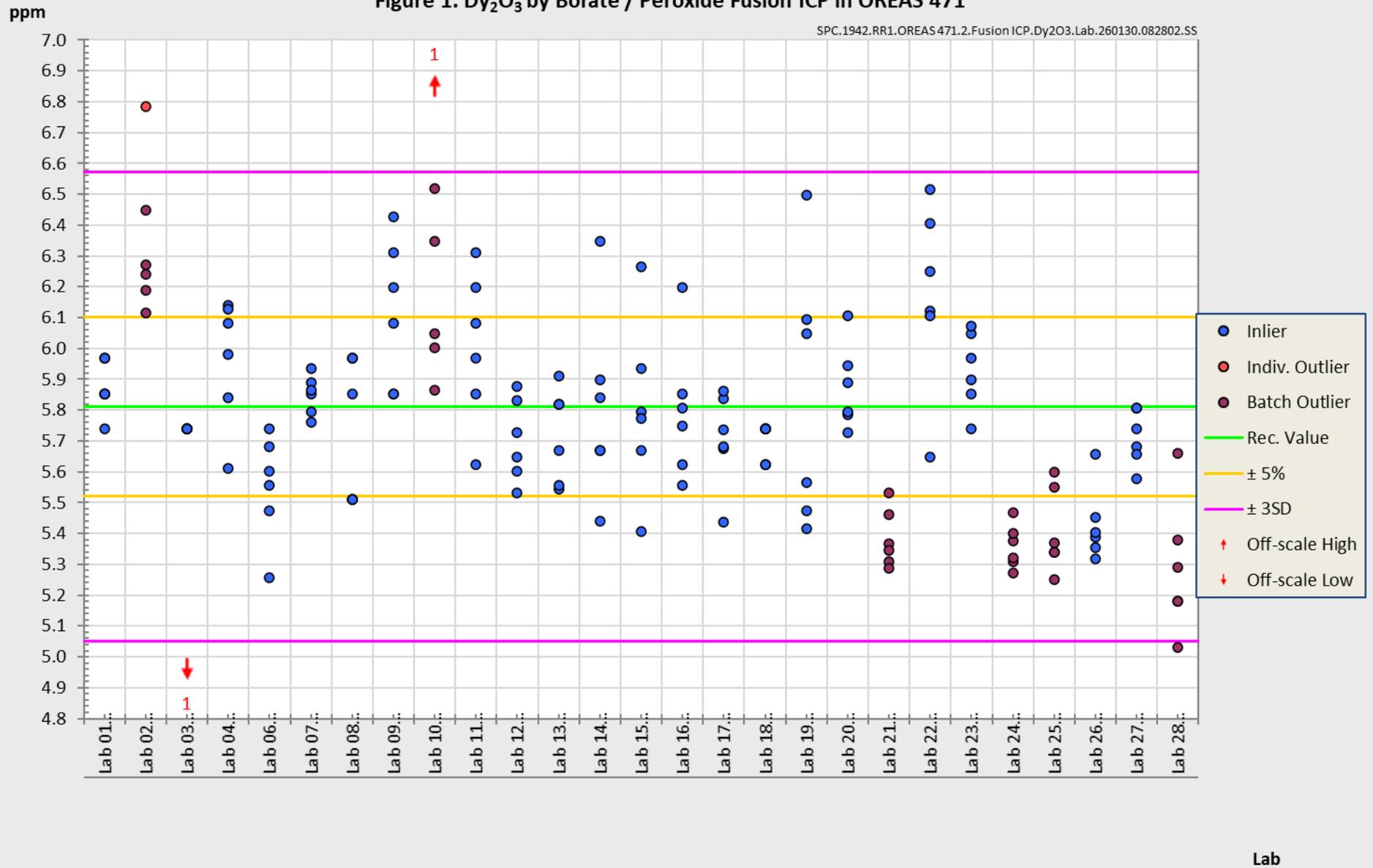


Figure 2. Nd<sub>2</sub>O<sub>3</sub> by Borate / Peroxide Fusion ICP in OREAS 471

SPC.1942.RR1.OREAS 471.2.Fusion ICP.Nd2O3.Lab.260130.074127.SS

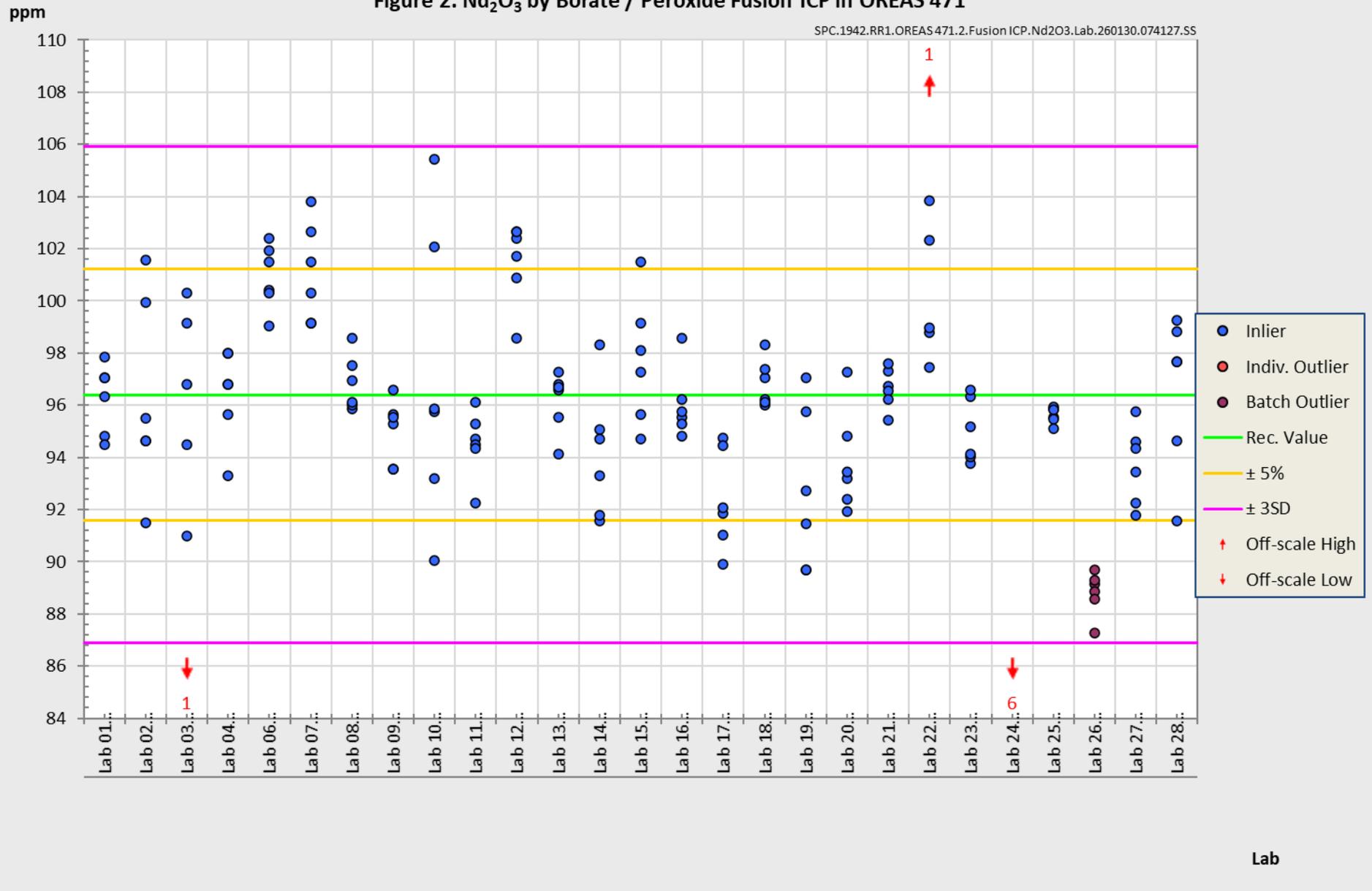


Figure 3. Pr<sub>6</sub>O<sub>11</sub> by Borate / Peroxide Fusion ICP in OREAS 471

SPC.1942.RR1.OREAS471.2.Fusion ICP.Pr6O11.Lab.260130.074312.SS

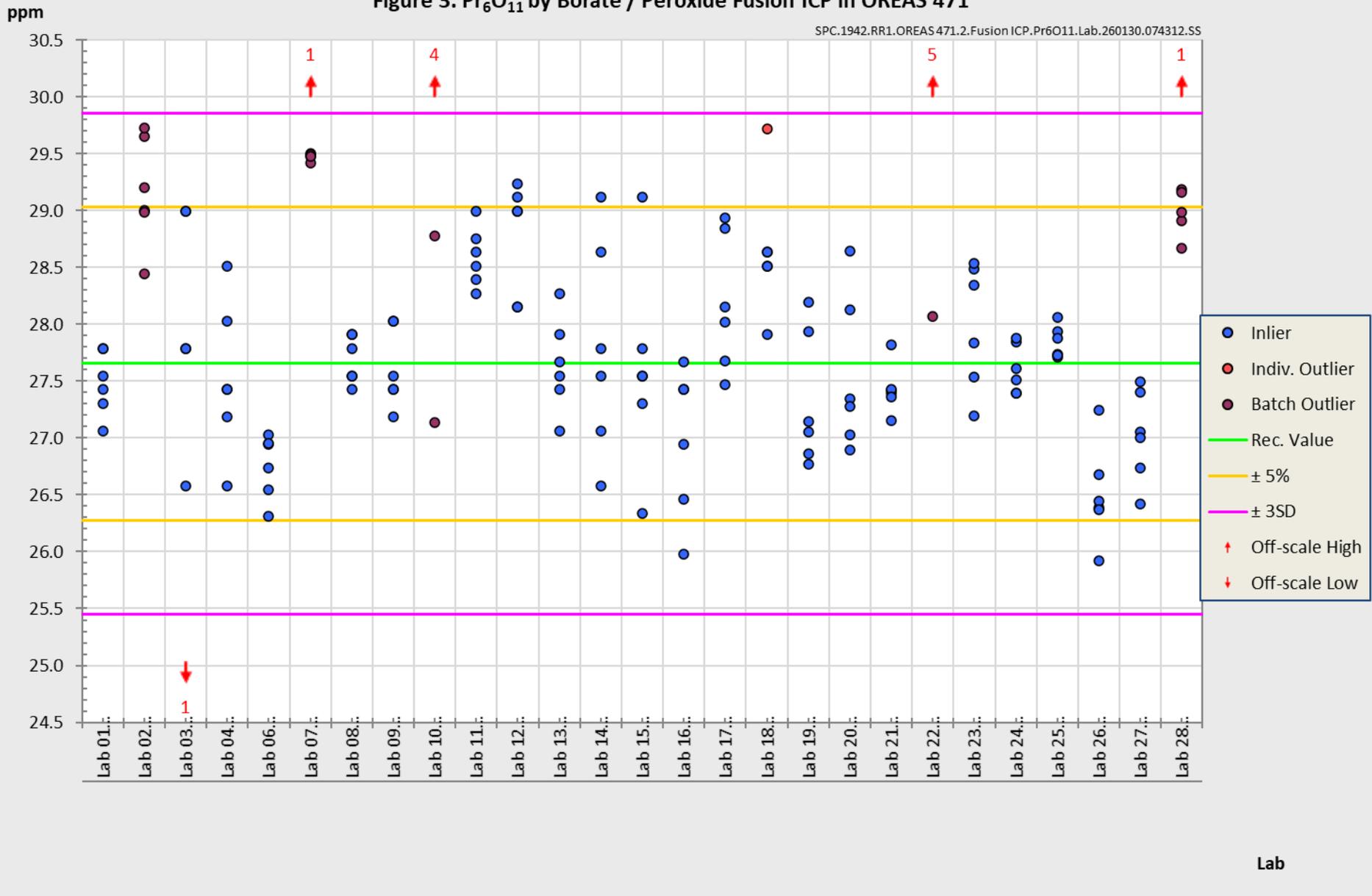
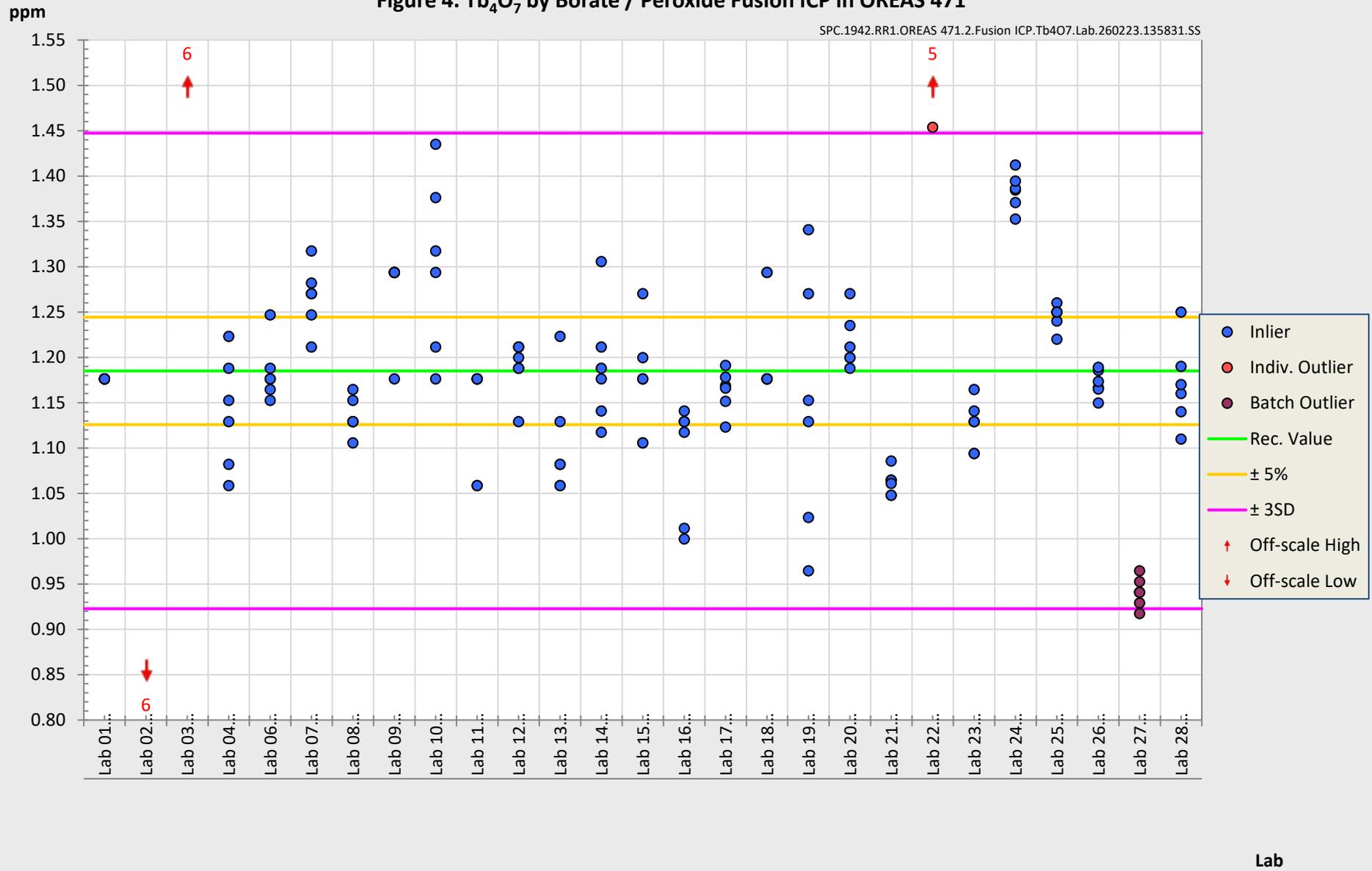


Figure 4. Tb<sub>4</sub>O<sub>7</sub> by Borate / Peroxide Fusion ICP in OREAS 471

SPC.1942.RR1.OREAS 471.2.Fusion ICP.Tb4O7.Lab.260223.135831.SS



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## DOCUMENT HISTORY

Revision No.	Date	Changes applied
0	18 <sup>th</sup> February 2026	First publication.

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