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CERTIFICATE OF ANALYSIS FOR

Uranium Ore

(Mantra Resources Nyota Prospect, Tanzania)

CERTIFIED REFERENCE MATERIAL

OREAS 123

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Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fusion XRF						
Al_2O_3, Aluminium(III) oxide (wt.%)	9.07	0.140	8.96	9.17	9.01	9.13
BaO, Barium oxide (ppm)	1114	41	1081	1146	1088	1140
CaO, Calcium oxide (wt.%)	0.140	0.007	0.136	0.144	0.139	0.141
Fe_2O_3, Iron(III) oxide (wt.%)	2.32	0.030	2.30	2.34	2.29	2.35
K_2O, Potassium oxide (wt.%)	3.27	0.039	3.24	3.30	3.25	3.30
MgO, Magnesium oxide (wt.%)	0.427	0.021	0.411	0.443	0.419	0.434
MnO, Manganese oxide (wt.%)	0.100	0.004	0.098	0.102	0.099	0.101
P_2O_5, Phosphorus(V) oxide (wt.%)	0.052	0.004	0.049	0.055	0.051	0.053
SiO_2, Silicon dioxide (wt.%)	81.79	0.343	81.58	82.00	81.40	82.18
TiO_2, Titanium dioxide (wt.%)	0.442	0.016	0.430	0.454	0.432	0.453
U, Uranium (ppm)	858	30	839	877	844	872
Borate / Peroxide Fusion ICP						
Al, Aluminium (wt.%)	4.60	0.191	4.45	4.75	4.52	4.68
Ba, Barium (ppm)	1001	49	957	1045	980	1022
Ca, Calcium (wt.%)	0.099	0.003	0.096	0.102	IND	IND
Ce, Cerium (ppm)	46.7	2.50	44.9	48.5	44.9	48.5
Cr, Chromium (ppm)	54	8	46	61	48	60
Cs, Cesium (ppm)	0.75	0.071	0.68	0.82	IND	IND
Dy, Dysprosium (ppm)	2.57	0.157	2.46	2.68	2.37	2.77
Er, Erbium (ppm)	1.45	0.097	1.38	1.51	IND	IND
Eu, Europium (ppm)	1.09	0.100	1.01	1.17	1.02	1.16
Fe, Iron (wt.%)	1.61	0.033	1.59	1.63	1.58	1.64
Ga, Gallium (ppm)	10.6	0.55	10.2	11.1	IND	IND
Gd, Gadolinium (ppm)	3.13	0.44	2.94	3.32	2.84	3.42
Hf, Hafnium (ppm)	6.00	0.581	5.55	6.45	5.11	6.89
Ho, Holmium (ppm)	0.51	0.05	0.49	0.53	IND	IND
K, Potassium (wt.%)	2.68	0.075	2.62	2.74	2.62	2.75
La, Lanthanum (ppm)	21.2	1.33	20.2	22.2	20.3	22.1
Lu, Lutetium (ppm)	0.24	0.04	0.21	0.27	0.21	0.28
Mg, Magnesium (wt.%)	0.250	0.008	0.245	0.255	0.242	0.258
Mn, Manganese (wt.%)	0.075	0.004	0.071	0.078	IND	IND
Mo, Molybdenum (ppm)	6.93	1.36	5.91	7.96	IND	IND
Nd, Neodymium (ppm)	19.5	0.88	18.7	20.3	18.3	20.6
P, Phosphorus (wt.%)	0.022	0.003	0.020	0.025	IND	IND
Pr, Praseodymium (ppm)	5.15	0.345	4.85	5.45	4.88	5.42
Rb, Rubidium (ppm)	87	2.7	84	89	85	88

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note 1: intervals may appear asymmetric due to rounding.
Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 1 continued.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Borate / Peroxide Fusion ICP continued						
Sm, Samarium (ppm)	3.87	0.225	3.71	4.04	3.59	4.16
Sr, Strontium (ppm)	156	4	153	159	153	160
Tb, Terbium (ppm)	0.46	0.036	0.42	0.49	0.40	0.51
Th, Thorium (ppm)	5.73	0.328	5.58	5.89	5.25	6.22
Ti, Titanium (wt.%)	0.253	0.009	0.247	0.259	0.243	0.263
Tm, Thulium (ppm)	0.21	0.010	0.20	0.22	0.18	0.23
U, Uranium (ppm)	853	35	825	881	831	874
V, Vanadium (ppm)	24.2	1.98	22.0	26.4	21.5	27.0
Y, Yttrium (ppm)	13.6	0.85	13.0	14.1	12.3	14.8
Yb, Ytterbium (ppm)	1.47	0.092	1.42	1.52	IND	IND
4-Acid Digestion						
Al, Aluminium (wt.%)	4.57	0.247	4.43	4.72	4.47	4.67
As, Arsenic (ppm)	5.19	0.67	4.84	5.54	4.54	5.83
Ba, Barium (ppm)	1015	54	987	1042	989	1040
Be, Beryllium (ppm)	1.74	0.135	1.66	1.82	1.65	1.83
Ca, Calcium (wt.%)	0.101	0.006	0.098	0.104	0.097	0.106
Ce, Cerium (ppm)	46.0	2.91	44.5	47.6	43.7	48.4
Co, Cobalt (ppm)	4.49	0.252	4.34	4.63	4.21	4.76
Cr, Chromium (ppm)	37.2	6.3	33.5	40.9	34.8	39.6
Cs, Cesium (ppm)	0.76	0.055	0.73	0.79	0.71	0.80
Dy, Dysprosium (ppm)	2.45	0.150	2.30	2.59	2.18	2.71
Fe, Iron (wt.%)	1.60	0.053	1.57	1.63	1.56	1.64
Ga, Gallium (ppm)	10.9	1.04	10.4	11.5	10.5	11.4
Hf, Hafnium (ppm)	1.53	0.17	1.43	1.63	IND	IND
In, Indium (ppm)	0.014	0.002	0.013	0.015	IND	IND
K, Potassium (wt.%)	2.58	0.148	2.49	2.68	2.52	2.65
La, Lanthanum (ppm)	20.7	1.25	20.2	21.3	19.5	22.0
Li, Lithium (ppm)	4.66	0.451	4.46	4.86	4.37	4.95
Mg, Magnesium (wt.%)	0.244	0.018	0.232	0.255	0.238	0.249
Mn, Manganese (wt.%)	0.075	0.003	0.073	0.076	0.072	0.077
Mo, Molybdenum (ppm)	7.44	0.373	7.28	7.60	7.11	7.78
Na, Sodium (wt.%)	0.245	0.027	0.229	0.260	0.238	0.251
Nb, Niobium (ppm)	7.67	0.469	7.40	7.93	7.36	7.98
Ni, Nickel (ppm)	9.65	0.658	9.34	9.95	8.91	10.38
P, Phosphorus (wt.%)	0.022	0.002	0.021	0.023	0.021	0.023
Pb, Lead (ppm)	18.3	0.85	18.0	18.5	17.4	19.1

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note 1: intervals may appear asymmetric due to rounding.
Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 1 continued.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
4-Acid Digestion continued						
Rb, Rubidium (ppm)	88	4.3	85	90	84	92
Sb, Antimony (ppm)	0.085	0.017	0.071	0.098	IND	IND
Sc, Scandium (ppm)	2.98	0.117	2.89	3.07	2.79	3.17
Sn, Tin (ppm)	0.70	0.056	0.68	0.71	IND	IND
Sr, Strontium (ppm)	154	6	151	157	150	158
Ta, Tantalum (ppm)	0.55	0.06	0.52	0.58	0.49	0.61
Tb, Terbium (ppm)	0.46	0.06	0.40	0.52	0.42	0.51
Th, Thorium (ppm)	5.56	0.472	5.34	5.78	5.11	6.01
Ti, Titanium (wt.%)	0.247	0.014	0.239	0.255	0.237	0.257
Tl, Thallium (ppm)	0.42	0.029	0.40	0.43	0.39	0.45
U, Uranium (ppm)	825	35	806	843	805	844
V, Vanadium (ppm)	22.5	1.47	21.6	23.3	21.3	23.7
W, Tungsten (ppm)	0.52	0.07	0.49	0.55	IND	IND
Y, Yttrium (ppm)	11.0	0.79	10.6	11.4	10.6	11.4
Yb, Ytterbium (ppm)	1.17	0.102	1.08	1.26	IND	IND
Zn, Zinc (ppm)	13.8	1.9	12.7	14.8	12.7	14.8
Zr, Zirconium (ppm)	47.5	5.2	44.2	50.8	43.8	51.1
Infrared Combustion						
C, Carbon (wt.%)	0.052	0.010	0.046	0.057	IND	IND
Thermogravimetry						
LOI^{1000}, Loss on ignition @1000°C (wt.%)	2.24	0.31	2.04	2.43	2.16	2.32

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note 1: intervals may appear asymmetric due to rounding.
Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 2. Indicative Values for OREAS 123.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Borate Fusion XRF								
Na_2O	wt.%	*0.353*	S	wt.%	*< 0.01*			
Rb	ppm	*98*	Zr	ppm	*203*			
Borate / Peroxide Fusion ICP								
B	ppm	*< 20*	Nb	ppm	*8.28*	Si	wt.%	*37.43*
Be	ppm	*1.56*	Ni	ppm	*12.7*	Sn	ppm	*< 1*
Co	ppm	*4.37*	Pb	ppm	*18.6*	Ta	ppm	*0.55*
In	ppm	*< 0.2*	Re	ppm	*< 0.1*	Tl	ppm	*0.43*
Li	ppm	*4.13*	S	wt.%	*< 0.01*	W	ppm	*< 1*
Na	wt.%	*0.244*	Sc	ppm	*3.02*	Zr	ppm	*253*

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: the number of significant figures reported is not a reflection of the level of certainty of stated values. They are instead an artefact of ORE's in-house CRM-specific LIMS.

Table 2 continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
4-Acid Digestion								
Ag	ppm	*0.050*	Ge	ppm	*0.22*	Ru	ppm	*< 0.1*
Au	ppm	*0.008*	Hg	ppm	*0.043*	S	wt.%	*< 0.01*
Bi	ppm	*0.035*	Ho	ppm	*0.46*	Se	ppm	*1.29*
Cd	ppm	*< 0.02*	Lu	ppm	*0.19*	Sm	ppm	*4.03*
Cu	ppm	*3.61*	Nd	ppm	*21.6*	Te	ppm	*< 0.05*
Er	ppm	*1.25*	Pr	ppm	*5.27*	Tm	ppm	*0.19*
Gd	ppm	*3.33*	Re	ppm	*0.002*			
Infrared Combustion								
S	wt.%	*0.008*						
Thermogravimetry								
H_2O-	wt.%	*1.62*						
Pressed Powder Pellet XRF								
U	ppm	*941*						

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: the number of significant figures reported is not a reflection of the level of certainty of stated values. They are instead an artefact of ORE's in-house CRM-specific LIMS.

INTRODUCTION

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

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

SOURCE MATERIAL

Reference material OREAS 123 is one of a suite of five uranium CRMs prepared from material sourced from trenching at Mantra Resources Nyota Prospect, Tanzania. The Nyota Prospect is a Karoo sandstone-hosted tabular deposit. Mineralisation is secondary and typically concentrated within medium to very coarse grained sandstone units interbedded with greywackes, siltstones or mudstones. The distribution of mineralisation is controlled by primary sedimentary features, consistent with fluid migrating along permeable coarse grained units, along bedding planes, up cross bedding and with preferential deposition occurring around ferruginous concretions and claystone clasts. Supergene enrichment is interpreted to have contributed to the high grade nature of the secondary mineralisation observed in the trenches.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 123 was prepared in the following manner:

- Drying to constant mass at 105°C;
- Crushing;
- Milling to 100% minus 30 microns;
- Homogenisation;
- Packaging into 10g units in laminated foil pouches.

ANALYTICAL PROGRAM

Seventeen commercial analytical laboratories participated in the program to characterise the elements reported in Table 1 and 2. The following methods were employed:

- Lithium borate fusion with X-ray fluorescence (9 laboratories)
- Sodium peroxide fusion or lithium borate fusion with ICP-OES and ICP-MS (10 laboratories)
- Four acid digestion with ICP-OES and ICP-MS (16 laboratories)
- Thermogravimetry for Loss On Ignition (12 laboratories)
- Infra-red combustion furnace for carbon and sulphur (11 laboratories)
- Pressed powder pellet XRF for U (2 laboratories)

For the round robin program ten 450g test units were taken at predetermined intervals during the bagging stage, immediately following final blending, and are considered representative of the entire batch. The six samples received by each laboratory were obtained by taking two 25g scoop splits from each of three separate 450g test units. This format enabled nested ANOVA treatment of the results to evaluate homogeneity.

Tabulated results, together with uncorrected means, medians, standard deviations, relative standard deviations and percent deviation of lab means from the corrected mean of means (PDM^3) are available upon request for this CRM (**OREAS 123 DataPack-2.1.190215_143729.xlsx**).

Results are also presented in scatter plot for uranium by fusion ICP method in Figure 1, together with ±3SD (magenta) and ±5% (yellow) control lines and certified value (green line). Accepted individual results are coloured blue and individual and dataset outliers are identified in red and violet, respectively.

STATISTICAL ANALYSIS

Certified Values, Standard Deviations, Confidence and Tolerance Limits have been determined for each analytical method following removal of individual and laboratory outliers (Table 1). Certified Values are the mean of means after outlier filtering. The 95% Confidence Limit is a measure of the reliability of the certified value, i.e. the narrower the Confidence Interval the greater the certainty in the Certified Value. It should not be used as a control limit for laboratory performance.

95% Confidence Limits are inversely proportional to the number of participating laboratories and inter-laboratory agreement. It is a measure of the reliability of the certified value. A 95% confidence interval indicates a 95% probability that the true value of the analyte under consideration lies between the upper and lower limits. *95% Confidence Limits should not be used as control limits for laboratory performance.*

Indicative (uncertified) values (Table 2) are provided where i) the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification; ii) interlaboratory consensus is poor; or iii) a significant proportion of results are outlying or reported as less than detection limits.

Standard Deviation values (1SDs) are reported in Table 1. They provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this CRM in a QA/QC program. They take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability.

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

As a guide two or more analytical results lying outside the 2SD window may be regarded as warning or rejection, and rejection for single results lying outside the 3SD window in QC monitoring, although their precise application should be at the discretion of the QC manager concerned.

Table 3 shows **Performance Gates** calculated for two and three standard deviations. As a guide these intervals may be regarded as warning or rejection for multiple 2SD outliers, or rejection for individual 3SD outliers in QC monitoring, although their precise application should be at the discretion of the QC manager concerned. A second method utilises a 5% window calculated directly from the certified value. Standard deviation is also shown in relative percent for one, two and three relative standard deviations (1RSD, 2RSD and 3RSD) to facilitate an appreciation of the magnitude of these numbers and a comparison with the 5% window. Caution should be exercised when concentration levels approach lower limits of detection of the analytical methods employed as performance gates calculated from standard deviations tend to be excessively wide whereas those determined by the 5% method are too narrow. One approach used at commercial laboratories is to set the acceptance criteria at twice the detection level (DL) ± 10%.

i.e. Certified Value ± 10% ± 2DL (adapted from Govett, 1983)

Table 3. Performance Gates for OREAS 123.

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 Fusion XRF											
Al_2O_3, wt.%	9.07	0.140	8.79	9.35	8.65	9.49	1.54%	3.09%	4.63%	8.61	9.52
BaO, ppm	1114	41	1032	1196	991	1237	3.69%	7.37%	11.06%	1058	1169
CaO, wt.%	0.140	0.007	0.127	0.154	0.120	0.160	4.81%	9.62%	14.43%	0.133	0.147
Fe_2O_3, wt.%	2.32	0.030	2.26	2.38	2.23	2.41	1.29%	2.58%	3.87%	2.21	2.44
K_2O, wt.%	3.27	0.039	3.20	3.35	3.16	3.39	1.18%	2.37%	3.55%	3.11	3.44
MgO, wt.%	0.427	0.021	0.385	0.468	0.365	0.489	4.85%	9.70%	14.55%	0.405	0.448
MnO, wt.%	0.100	0.004	0.092	0.107	0.088	0.111	3.82%	7.63%	11.45%	0.095	0.105
P_2O_5, wt.%	0.052	0.004	0.043	0.060	0.039	0.065	8.26%	16.51%	24.77%	0.049	0.054
SiO_2, wt.%	81.79	0.343	81.11	82.48	80.76	82.82	0.42%	0.84%	1.26%	77.70	85.88
TiO_2, wt.%	0.442	0.016	0.411	0.473	0.395	0.489	3.54%	7.09%	10.63%	0.420	0.464
U, ppm	858	30	799	917	769	947	3.46%	6.92%	10.37%	815	901
Borate / Peroxide Fusion ICP											
Al, wt.%	4.60	0.191	4.21	4.98	4.02	5.17	4.16%	8.33%	12.49%	4.37	4.83
Ba, ppm	1001	49	903	1099	854	1148	4.90%	9.80%	14.70%	951	1051
Ca, wt.%	0.099	0.003	0.093	0.106	0.089	0.109	3.36%	6.71%	10.07%	0.094	0.104
Ce, ppm	46.7	2.50	41.7	51.7	39.2	54.2	5.35%	10.70%	16.05%	44.4	49.0
Cr, ppm	54	8	38	70	29	78	15.00%	30.01%	45.01%	51	56
Cs, ppm	0.75	0.071	0.61	0.89	0.54	0.97	9.39%	18.79%	28.18%	0.72	0.79
Dy, ppm	2.57	0.157	2.26	2.88	2.10	3.04	6.09%	12.19%	18.28%	2.44	2.70
Er, ppm	1.45	0.097	1.25	1.64	1.16	1.74	6.68%	13.37%	20.05%	1.37	1.52
Eu, ppm	1.09	0.100	0.89	1.29	0.79	1.39	9.16%	18.32%	27.48%	1.03	1.14
Fe, wt.%	1.61	0.033	1.55	1.68	1.51	1.71	2.02%	4.04%	6.06%	1.53	1.69
Ga, ppm	10.6	0.55	9.5	11.7	9.0	12.3	5.16%	10.32%	15.47%	10.1	11.2
Gd, ppm	3.13	0.44	2.24	4.02	1.80	4.46	14.18%	28.36%	42.53%	2.97	3.29
Hf, ppm	6.00	0.581	4.84	7.16	4.26	7.74	9.69%	19.38%	29.07%	5.70	6.30
Ho, ppm	0.51	0.05	0.40	0.62	0.35	0.67	10.35%	20.70%	31.04%	0.48	0.54
K, wt.%	2.68	0.075	2.53	2.83	2.46	2.91	2.81%	5.62%	8.43%	2.55	2.82
La, ppm	21.2	1.33	18.6	23.9	17.2	25.2	6.26%	12.51%	18.77%	20.1	22.3
Lu, ppm	0.24	0.04	0.16	0.32	0.13	0.36	16.05%	32.10%	48.15%	0.23	0.25
Mg, wt.%	0.250	0.008	0.235	0.265	0.227	0.273	3.06%	6.12%	9.18%	0.238	0.263
Mn, wt.%	0.075	0.004	0.066	0.083	0.061	0.088	5.88%	11.75%	17.63%	0.071	0.078
Mo, ppm	6.93	1.36	4.21	9.66	2.85	11.02	19.65%	39.30%	58.95%	6.59	7.28
Nd, ppm	19.5	0.88	17.7	21.2	16.8	22.1	4.53%	9.07%	13.60%	18.5	20.4
P, wt.%	0.022	0.003	0.016	0.029	0.013	0.032	14.39%	28.78%	43.16%	0.021	0.024
Pr, ppm	5.15	0.345	4.46	5.84	4.12	6.19	6.70%	13.39%	20.09%	4.90	5.41
Rb, ppm	87	2.7	81	92	79	95	3.10%	6.21%	9.31%	82	91
Sm, ppm	3.87	0.225	3.42	4.32	3.20	4.55	5.80%	11.60%	17.39%	3.68	4.07
Sr, ppm	156	4	149	163	145	167	2.29%	4.57%	6.86%	148	164
Tb, ppm	0.46	0.036	0.38	0.53	0.35	0.56	7.95%	15.89%	23.84%	0.43	0.48
Th, ppm	5.73	0.328	5.08	6.39	4.75	6.72	5.72%	11.43%	17.15%	5.45	6.02
Ti, wt.%	0.253	0.009	0.235	0.270	0.227	0.279	3.44%	6.87%	10.31%	0.240	0.265

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 3 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											
Tm, ppm	0.21	0.010	0.19	0.23	0.18	0.24	5.03%	10.06%	15.09%	0.20	0.22
U, ppm	853	35	783	923	748	958	4.11%	8.21%	12.32%	810	896
V, ppm	24.2	1.98	20.3	28.2	18.3	30.2	8.17%	16.33%	24.50%	23.0	25.4
Y, ppm	13.6	0.85	11.9	15.3	11.0	16.1	6.28%	12.57%	18.85%	12.9	14.3
Yb, ppm	1.47	0.092	1.29	1.65	1.19	1.74	6.24%	12.49%	18.73%	1.40	1.54
4-Acid Digestion											
Al, wt.%	4.57	0.247	4.08	5.07	3.83	5.31	5.40%	10.79%	16.19%	4.34	4.80
As, ppm	5.19	0.67	3.84	6.53	3.17	7.20	12.97%	25.94%	38.91%	4.93	5.45
Ba, ppm	1015	54	907	1123	853	1177	5.32%	10.64%	15.97%	964	1065
Be, ppm	1.74	0.135	1.47	2.01	1.34	2.14	7.73%	15.46%	23.19%	1.65	1.83
Ca, wt.%	0.101	0.006	0.090	0.113	0.084	0.119	5.76%	11.53%	17.29%	0.096	0.106
Ce, ppm	46.0	2.91	40.2	51.9	37.3	54.8	6.32%	12.65%	18.97%	43.7	48.3
Co, ppm	4.49	0.252	3.98	4.99	3.73	5.24	5.62%	11.24%	16.85%	4.26	4.71
Cr, ppm	37.2	6.3	24.6	49.8	18.3	56.0	16.90%	33.81%	50.71%	35.3	39.0
Cs, ppm	0.76	0.055	0.65	0.87	0.59	0.92	7.22%	14.44%	21.66%	0.72	0.79
Dy, ppm	2.45	0.150	2.15	2.75	2.00	2.90	6.13%	12.27%	18.40%	2.32	2.57
Fe, wt.%	1.60	0.053	1.49	1.70	1.44	1.76	3.29%	6.59%	9.88%	1.52	1.68
Ga, ppm	10.9	1.04	8.9	13.0	7.8	14.0	9.47%	18.93%	28.40%	10.4	11.5
Hf, ppm	1.53	0.17	1.19	1.87	1.02	2.04	11.05%	22.10%	33.15%	1.46	1.61
In, ppm	0.014	0.002	0.009	0.019	0.007	0.022	16.93%	33.87%	50.80%	0.014	0.015
K, wt.%	2.58	0.148	2.29	2.88	2.14	3.03	5.72%	11.43%	17.15%	2.46	2.71
La, ppm	20.7	1.25	18.2	23.2	17.0	24.5	6.03%	12.07%	18.10%	19.7	21.8
Li, ppm	4.66	0.451	3.76	5.56	3.30	6.01	9.69%	19.38%	29.06%	4.43	4.89
Mg, wt.%	0.244	0.018	0.207	0.280	0.189	0.298	7.43%	14.87%	22.30%	0.231	0.256
Mn, wt.%	0.075	0.003	0.069	0.080	0.067	0.083	3.57%	7.14%	10.70%	0.071	0.078
Mo, ppm	7.44	0.373	6.70	8.19	6.32	8.56	5.02%	10.04%	15.05%	7.07	7.82
Na, wt.%	0.245	0.027	0.191	0.298	0.164	0.325	10.96%	21.93%	32.89%	0.232	0.257
Nb, ppm	7.67	0.469	6.73	8.60	6.26	9.07	6.12%	12.23%	18.35%	7.28	8.05
Ni, ppm	9.65	0.658	8.33	10.96	7.67	11.62	6.82%	13.64%	20.46%	9.17	10.13
P, wt.%	0.022	0.002	0.018	0.025	0.016	0.027	8.37%	16.73%	25.10%	0.021	0.023
Pb, ppm	18.3	0.85	16.6	20.0	15.7	20.8	4.64%	9.28%	13.92%	17.3	19.2
Rb, ppm	88	4.3	79	96	75	101	4.88%	9.75%	14.63%	83	92
Sb, ppm	0.085	0.017	0.051	0.118	0.035	0.134	19.56%	39.11%	58.67%	0.080	0.089
Sc, ppm	2.98	0.117	2.75	3.21	2.63	3.33	3.91%	7.83%	11.74%	2.83	3.13
Sn, ppm	0.70	0.056	0.58	0.81	0.53	0.86	8.03%	16.07%	24.10%	0.66	0.73
Sr, ppm	154	6	141	167	135	173	4.12%	8.23%	12.35%	146	162
Ta, ppm	0.55	0.06	0.44	0.66	0.38	0.72	10.20%	20.41%	30.61%	0.52	0.58
Tb, ppm	0.46	0.06	0.35	0.58	0.29	0.64	12.50%	24.99%	37.49%	0.44	0.49
Th, ppm	5.56	0.472	4.62	6.50	4.14	6.98	8.49%	16.98%	25.47%	5.28	5.84
Ti, wt.%	0.247	0.014	0.218	0.276	0.204	0.290	5.82%	11.64%	17.45%	0.235	0.259
Tl, ppm	0.42	0.029	0.36	0.47	0.33	0.50	6.96%	13.93%	20.89%	0.40	0.44

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 3 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											
U, ppm	825	35	755	895	720	930	4.25%	8.49%	12.74%	783	866
V, ppm	22.5	1.47	19.5	25.4	18.1	26.9	6.54%	13.09%	19.63%	21.3	23.6
W, ppm	0.52	0.07	0.38	0.66	0.32	0.72	13.07%	26.14%	39.21%	0.49	0.55
Y, ppm	11.0	0.79	9.4	12.6	8.6	13.3	7.21%	14.42%	21.63%	10.4	11.5
Yb, ppm	1.17	0.102	0.97	1.38	0.86	1.48	8.74%	17.49%	26.23%	1.11	1.23
Zn, ppm	13.8	1.9	10.0	17.6	8.1	19.5	13.78%	27.56%	41.34%	13.1	14.5
Zr, ppm	47.5	5.2	37.0	57.9	31.8	63.1	10.99%	21.98%	32.96%	45.1	49.9
Infrared Combustion											
C, wt.%	0.052	0.010	0.032	0.071	0.023	0.081	18.67%	37.33%	56.00%	0.049	0.054
Thermogravimetry											
LOI^{1000}, wt.%	2.24	0.31	1.62	2.86	1.30	3.17	13.89%	27.79%	41.68%	2.13	2.35

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Tolerance Limits (ISO Guide 3207) 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 uranium by lithium borate fusion XRF, where 99% of the time (1-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 844 and 872 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 (ISO Guide 35). *Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.*

ANOVA Study

The homogeneity of OREAS 751 has also been evaluated in an ANOVA study for all certified analytes occurring at least 20 times the lower limit of detection. No significant *p*-values were found indicating that no evidence exists that between-unit variance is greater than within-unit variance.

It is important to note that ANOVA is not an absolute measure of homogeneity. Rather, it establishes whether or not the analytes are distributed in a similar manner throughout the packaging run of OREAS 751 and whether the variance between two subsamples from the same unit is statistically distinguishable to the variance from two subsamples taken from any two separate units. A reference material therefore, can possess poor absolute homogeneity yet still pass a relative homogeneity test if the within-unit heterogeneity is large and similar across all units.

Based on the statistical analysis of the results of the interlaboratory certification program it can be concluded that OREAS 751 is sufficiently homogenous and is fit-for-purpose as a certified reference material (see ‘Intended Use’ below).

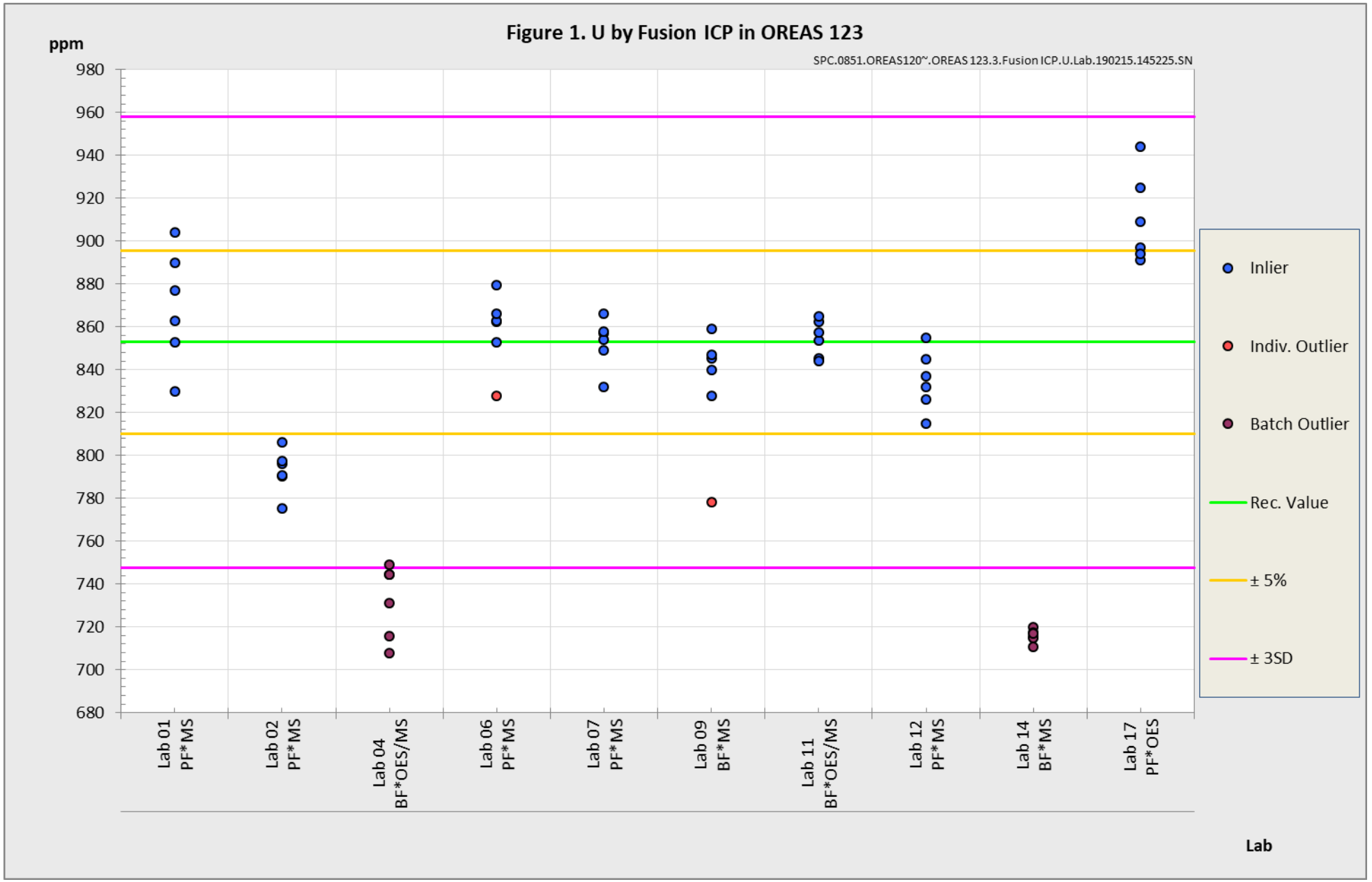
Figure 1. U by Fusion ICP in OREAS 123
SPC.0851.OREAS120~.OREAS 123.3.Fusion ICP.U.Lab.190215.145225.SN
ppm
980
960
940
920
900
880
860
840
820
800
780
760
740
720
700
680
Lab 01 PF*MS
Lab 02 PF*MS
Lab 04 BF*OES/MS
Lab 06 PF*MS
Lab 07 PF*MS
Lab 09 BF*MS
Lab 11 BF*OES/MS
Lab 12 PF*MS
Lab 14 BF*MS
Lab 17 PF*OES
Lab
Inlier
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD

PARTICIPATING LABORATORIES

1. Acme (BV), Vancouver, BC, Canada
2. Actlabs, Ancaster, Ontario, Canada
3. ALS, Brisbane, QLD, Australia
4. ALS, Johannesburg, South Africa
5. ALS, Lima, Peru
6. ALS, Perth, WA, Australia
7. ALS, Vancouver, BC, Canada
8. Amdel (BV), Adelaide, SA, Australia
9. Intertek Genalysis, Perth, WA, Australia
10. Intertek Testing Services, Shunyi, Beijing, China
11. OMAC, Loughrea, Galway, Ireland
12. SGS Australia Mineral Services, Perth (Newburn), WA, Australia
13. SGS Lakefield Research Ltd, Lakefield, Ontario, Canada
14. SGS Mineral Services, Toronto, Ontario, Canada
15. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
16. Ultra Trace Pty Ltd (BV), Perth, WA, Australia
17. Zarazma Mineral Studies Company, Tehran, Iran

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

PREPARER AND SUPPLIER

Certified reference material OREAS 123 was prepared, certified and supplied by:

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It is available in unit sizes of 10g (single-use laminated foil pouches) and 1kg (plastic jars).

METROLOGICAL TRACEABILITY

The analytical samples were selected in a manner to represent the entire batch of prepared CRM. This ‘representivity’ was maintained in each submitted laboratory sample batch and ensures the user that the data is traceable from sample selection through to the analytical results that underlie the consensus values. Each analytical data set has been validated by its assayer through the inclusion of internal reference materials and QC checks during analysis.

The laboratories were chosen on the basis of their competence (from past performance in inter-laboratory programs undertaken by ORE Pty Ltd) for a particular analytical method, analyte or analyte suite, and sample matrix. Most of these laboratories have and maintain ISO 17025 accreditation. The certified values presented in this report are calculated from the means of accepted data following robust statistical treatment as detailed in this report.

Guide ISO/TR 16476:2016, section 5.3.1 describes metrological traceability in reference materials as it pertains to the transformation of the measurand. In this section it states, *"Although the determination of the property value itself can be made traceable to appropriate units through, for example, calibration of the measurement equipment used, steps like the transformation of the sample from one physical (chemical) state to another cannot. Such transformations may only be compared with a reference (when available), or among themselves. For some transformations, reference methods have been defined and may be used in certification projects to evaluate the uncertainty associated with such a transformation. In other cases,* ***only a comparison among different laboratories using the same method is possible. In this case, certification takes place on the basis of agreement among independent measurement results*** *(see ISO Guide 35:2006, Clause 10)."*

COMMUTABILITY

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

INTENDED USE

OREAS 123 is intended for the following uses:

- For the monitoring of laboratory performance in the analysis of analytes reported in Tables 1-5 in geological samples
- For the verification of analytical methods for analytes reported in Tables 1-5
- For the calibration of instruments used in the determination of the concentration of analytes reported in Tables 1-5

STABILITY AND STORAGE INSTRUCTIONS

OREAS 123 has been sourced from samples of secondary uranium mineralisation. In its unopened state and under normal conditions of storage it has a shelf life beyond ten years. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

INSTRUCTIONS FOR CORRECT USE

The certified values for lithium borate fusion XRF and for LOI are on a dry basis whilst all other certified values are reported on an “as received” basis. A moisture content of ~1.6 wt.% has been determined for OREAS 123 in its packaged state.

HANDLING INSTRUCTIONS

Being a fine radioactive powder, safety precautions should be observed when handling OREAS 123 to protect against inhalation and ingestion. Personal Protective Equipment is required for the respiratory system, eyes and skin.

LEGAL NOTICE

Ore Research & Exploration Pty Ltd has prepared and statistically evaluated the property values of this reference material to the best of its ability. The Purchaser by receipt hereof releases and indemnifies Ore Research & Exploration Pty Ltd from and against all liability and costs arising from the use of this material and information.

DOCUMENT HISTORY

Revision No.	Date	Changes applied
1	18th February, 2019	New DataPack generated and new report template was introduced.
0	8th February 2019	First publication.

QMS ACCREDITED

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

CERTIFYING OFFICER

18th February, 2019

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

REFERENCES

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