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CERTIFICATE OF ANALYSIS FOR

Granodiorite Blank

(Bulla Granodiorite Complex, Victoria, Australia)

CERTIFIED REFERENCE MATERIAL

OREAS 23c

Accredited for compliance with ISO 17034

ISO 9001

COA-1790-OREAS23c-R0 BUP-70-10-01 Ver:2.0	12-Nov-2024

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Table 1. Certified Value, Uncertainty & Tolerance Intervals for OREAS 23c.

Constituent	Certified Value†	95 % Expanded Uncertainty		95 % Tolerance Limits	
		Low	High	Low	High
Pb Fire Assay					
Au, Gold (ppb)	< 10	IND	IND	IND	IND
4-Acid Digestion					
Ag, Silver (ppm)	0.091	0.073	0.109	IND	IND
Al, Aluminium (wt.%)	7.92	7.56	8.27	7.78	8.05
As, Arsenic (ppm)	18.1	17.1	19.2	16.7	19.6
Ba, Barium (ppm)	1064	1013	1115	1042	1086
Be, Beryllium (ppm)	2.97	2.78	3.16	2.87	3.06
Bi, Bismuth (ppm)	0.66	0.52	0.79	0.53	0.78
Ca, Calcium (wt.%)	2.03	1.95	2.12	2.00	2.07
Cd, Cadmium (ppm)	0.17	0.15	0.19	IND	IND
Ce, Cerium (ppm)	83	79	86	78	87
Co, Cobalt (ppm)	9.77	8.97	10.57	9.29	10.25
Cr, Chromium (ppm)	53	45	61	50	56
Cs, Caesium (ppm)	12.6	12.0	13.2	12.3	12.9
Cu, Copper (ppm)	28.0	26.0	30.0	26.6	29.4
Fe, Iron (wt.%)	3.22	3.13	3.32	3.14	3.30
Ga, Gallium (ppm)	21.2	19.9	22.4	20.1	22.2
Hf, Hafnium (ppm)	2.24	2.09	2.40	2.09	2.40
In, Indium (ppm)	0.066	0.055	0.076	0.058	0.073
K, Potassium (wt.%)	3.04	2.96	3.12	2.97	3.11
La, Lanthanum (ppm)	38.7	35.4	42.1	36.8	40.7
Li, Lithium (ppm)	51	48	54	49	53
Mg, Magnesium (wt.%)	0.921	0.890	0.952	0.900	0.942
Mn, Manganese (wt.%)	0.042	0.040	0.043	0.041	0.043
Mo, Molybdenum (ppm)	3.20	2.89	3.51	2.78	3.62
Na, Sodium (wt.%)	2.09	1.99	2.19	2.06	2.13
Nb, Niobium (ppm)	15.6	14.8	16.5	15.0	16.3
Ni, Nickel (ppm)	23.8	22.4	25.2	22.7	25.0
P, Phosphorus (wt.%)	0.091	0.088	0.094	0.089	0.093
Pb, Lead (ppm)	23.4	21.4	25.4	22.7	24.2
Rb, Rubidium (ppm)	185	178	192	177	193
S, Sulphur (wt.%)	0.117	0.108	0.126	IND	IND
Sb, Antimony (ppm)	0.34	0.30	0.38	0.32	0.37
Sc, Scandium (ppm)	9.85	9.70	10.01	9.64	10.07
Sn, Tin (ppm)	4.85	4.49	5.20	4.58	5.11

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).

†These operationally defined measurands meet the requirements of ISO 17034 and all participating laboratories comply with the requirements of ISO 17025.

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

Table 1. continued.

Constituent	Certified Value†	95 % Expanded Uncertainty		95 % Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion continued					
Sr, Strontium (ppm)	202	192	211	197	207
Ta, Tantalum (ppm)	1.30	1.20	1.40	1.25	1.34
Th, Thorium (ppm)	16.4	15.0	17.8	15.8	17.1
Ti, Titanium (wt.%)	0.419	0.411	0.426	0.409	0.429
Tl, Thallium (ppm)	1.02	0.96	1.07	0.99	1.05
U, Uranium (ppm)	4.60	3.98	5.21	4.18	5.01
V, Vanadium (ppm)	75	71	80	72	78
W, Tungsten (ppm)	10.3	8.7	11.9	9.2	11.4
Y, Yttrium (ppm)	18.8	18.3	19.3	18.2	19.4
Zn, Zinc (ppm)	80	76	84	77	83
Zr, Zirconium (ppm)	71	66	76	67	75

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

†These operationally defined measurands meet the requirements of ISO 17034 and all participating laboratories comply with the requirements of ISO 17025.

Note: intervals may appear asymmetric due to rounding; IND = indeterminate (due to limited reading resolution of the methods employed).

Table 2. Indicative Values for OREAS 23c.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
4-Acid Digestion								
Dy	ppm	*4.51*	Lu	ppm	*0.25*	Tb	ppm	*0.87*
Er	ppm	*1.95*	Nd	ppm	*36.9*	Te	ppm	*0.020*
Eu	ppm	*1.53*	Pr	ppm	*10.0*	Tm	ppm	*0.27*
Gd	ppm	*6.50*	Re	ppm	*0.001*	Yb	ppm	*1.62*
Ge	ppm	*0.19*	Se	ppm	*0.36*			
Ho	ppm	*0.75*	Sm	ppm	*7.54*			
Borate Fusion XRF								
Al_2O_3	wt.%	*15.30*	Fe	wt.%	*3.32*	S	wt.%	*0.111*
As	ppm	*7.50*	K_2O	wt.%	*3.64*	SiO_2	wt.%	*67.03*
Ba	ppm	*1040*	MgO	wt.%	*1.60*	Sn	ppm	*10.0*
CaO	wt.%	*2.81*	MnO	wt.%	*0.054*	Sr	ppm	*230*
Cl	ppm	*50*	Na_2O	wt.%	*2.76*	TiO_2	wt.%	*0.718*
Co	ppm	*20.0*	Ni	ppm	*30.0*	V	ppm	*80*
Cr	ppm	*65*	P	wt.%	*0.091*	Zn	ppm	*90*
Cu	ppm	*40.0*	Pb	ppm	*35.0*	Zr	ppm	*265*
Thermogravimetry								
LOI^{1000}	wt.%	*0.720*						
Laser Ablation ICP-MS								
Ag	ppm	*< 0.1*	Hf	ppm	*7.27*	Sm	ppm	*8.07*
As	ppm	*15.6*	Ho	ppm	*1.17*	Sn	ppm	*4.70*
Ba	ppm	*1040*	In	ppm	*0.038*	Sr	ppm	*198*

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

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

Table 2. continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Laser Ablation ICP-MS continued								
Be	ppm	*3.30*	La	ppm	*40.6*	Ta	ppm	*1.29*
Bi	ppm	*0.58*	Lu	ppm	*0.41*	Tb	ppm	*1.07*
Cd	ppm	*0.10*	Mn	wt.%	*0.040*	Te	ppm	*< 0.2*
Ce	ppm	*80*	Mo	ppm	*3.40*	Th	ppm	*17.6*
Co	ppm	*10.3*	Nb	ppm	*15.7*	Ti	wt.%	*0.417*
Cr	ppm	*65*	Nd	ppm	*37.3*	Tl	ppm	*1.20*
Cs	ppm	*12.3*	Ni	ppm	*23.0*	Tm	ppm	*0.46*
Cu	ppm	*28.0*	Pb	ppm	*23.5*	U	ppm	*5.07*
Dy	ppm	*5.84*	Pr	ppm	*9.85*	V	ppm	*77*
Er	ppm	*3.03*	Rb	ppm	*184*	W	ppm	*10.3*
Eu	ppm	*1.52*	Re	ppm	*< 0.01*	Y	ppm	*30.3*
Ga	ppm	*19.5*	Sb	ppm	*0.35*	Yb	ppm	*2.91*
Gd	ppm	*6.88*	Sc	ppm	*10.2*	Zn	ppm	*78*
Ge	ppm	*1.18*	Se	ppm	*< 5*	Zr	ppm	*266*

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

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

INTRODUCTION

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

OREAS reference materials enable users to successfully achieve process control of these tasks because the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself. In evaluating laboratory performance with this CRM, the section headed 'Instructions for correct use' should be read carefully.

Table 1 provides the certified values and their associated 95 % expanded uncertainty and tolerance intervals, Table 2 shows indicative values, Table 3 provides some indicative physical properties and Table 4 presents the performance gate intervals for all certified values. Tabulated results of all analytes together with uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of lab means from the corrected mean of means (PDM^3) are presented in the detailed certification data for this CRM (**OREAS 23c-DataPack.1.0.240202_064813.xlsx**).

SOURCE MATERIAL

OREAS 23c has been prepared from S-Type granodiorite sourced from the Devonian Bulla Granodiorite Complex located north of Melbourne, Australia. It is characterised by low background gold of less than 10 parts per billion.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 23c was prepared in the following manner:

- Drying to constant mass at 105 °C;
- Milling to 98 % minus 75 µm;
- Homogenisation using OREAS' novel processing technologies;
- Packaging in 10 g and 60 g units in laminated foil pouches and 500 g units in plastic wide-mouth jars.

PHYSICAL PROPERTIES

OREAS 23c was tested at ORE Research & Exploration Pty Ltd's onsite facility for various physical properties. Table 3 presents the findings that should be used for informational purposes only.

Table 3. Physical properties of OREAS 23c.

Bulk Density (g/L)	Moisture (%)	Munsell Notation‡	Munsell Colour‡
755	0.38	N8	Very 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.

ANALYTICAL PROGRAM

Ten commercial analytical laboratories participated in the program to certify the analytes reported in Table 1. The following methods were employed:

- Gold by low-level (1 ppb detection limit) 25-50 g lead collection fire assay with ICP-OES (6 laboratories), ICP-MS (3 laboratories) or AAS (1 laboratory) finish;
- Four acid digestion with full ICP-OES and ICP-MS elemental suites (up to 10 laboratories depending on the element).

For the round robin program twelve 1.2 kg test units (sampling lots) were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire prepared batch. Six 110 g pulp samples were received by each laboratory and consisted of either every even numbered sampling lot or every odd numbered sampling lot.

Major and trace element characterisation was also undertaken by one laboratory (see Table 2 above and further description under the 'Indicative (uncertified) values' section 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).

For individual outliers within a laboratory batch the z-score test is used in combination with a second method that determines the per cent deviation of the individual value from the batch median. Outliers in general are selected on the basis of z-scores > 2.5 and with per cent deviations (i) > 3 and (ii) more than three times the average absolute per cent deviation for the batch. Each laboratory data set mean is tested for outlying status based on z-score discrimination and rejected if > 2.5. After individual and laboratory data set (batch) outliers have been eliminated a non-iterative 3 standard deviation filter is applied, with those values lying outside this window also relegated to outlying status. However, while statistics are taken into account, the exercise of a statistician's prerogative plays a significant role in identifying outliers.

Certified Values are the means of accepted laboratory means after outlier filtering and are the present best estimate of the true value.

The 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 in ISO Guides [5,15]. All known or suspected sources of bias have been investigated or taken into account.

Indicative (uncertified) values (Table 2) are provided for the major and trace elements determined by borate fusion XRF (Al_2O_3 to Zn and including LOI at 1000 °C) and laser ablation with ICP-MS (Ag to Zr) and are the means of duplicate assays from Bureau Veritas, Perth. Additional indicative values by 4-acid digestion methods are also present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where inter-laboratory consensus is poor.

Standard Deviation intervals (Table 4) provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this CRM in a QA/QC program. They take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability.

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

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

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

PERFORMANCE GATES

Table 4 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 (adapted from Govett, 1983 [1]).

Table 4. Performance Gates for OREAS 23c.

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	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
4-Acid Digestion											
Ag, ppm	0.091	0.011	0.070	0.112	0.060	0.123	11.54%	23.09%	34.63%	0.087	0.096
Al, wt.%	7.92	0.221	7.47	8.36	7.25	8.58	2.79%	5.59%	8.38%	7.52	8.31
As, ppm	18.1	0.98	16.2	20.1	15.2	21.1	5.42%	10.84%	16.26%	17.2	19.0
Ba, ppm	1064	36	992	1136	956	1172	3.37%	6.75%	10.12%	1011	1117
Be, ppm	2.97	0.157	2.65	3.28	2.49	3.44	5.30%	10.60%	15.90%	2.82	3.11
Bi, ppm	0.66	0.07	0.52	0.80	0.45	0.87	10.74%	21.47%	32.21%	0.62	0.69
Ca, wt.%	2.03	0.072	1.89	2.18	1.82	2.25	3.53%	7.06%	10.59%	1.93	2.14
Cd, ppm	0.17	0.012	0.15	0.20	0.13	0.21	7.21%	14.43%	21.64%	0.16	0.18
Ce, ppm	83	4.1	74	91	70	95	5.02%	10.03%	15.05%	78	87
Co, ppm	9.77	0.344	9.08	10.46	8.74	10.80	3.52%	7.04%	10.56%	9.28	10.26
Cr, ppm	53	8	37	69	29	77	15.09%	30.19%	45.28%	50	56
Cs, ppm	12.6	0.27	12.1	13.2	11.8	13.4	2.17%	4.35%	6.52%	12.0	13.3
Cu, ppm	28.0	1.54	24.9	31.1	23.4	32.6	5.50%	11.00%	16.49%	26.6	29.4
Fe, wt.%	3.22	0.086	3.05	3.40	2.96	3.48	2.68%	5.36%	8.03%	3.06	3.38
Ga, ppm	21.2	0.81	19.6	22.8	18.7	23.6	3.81%	7.62%	11.43%	20.1	22.2
Hf, ppm	2.24	0.111	2.02	2.47	1.91	2.58	4.96%	9.91%	14.87%	2.13	2.36
In, ppm	0.066	0.005	0.055	0.076	0.050	0.081	8.03%	16.06%	24.09%	0.062	0.069
K, wt.%	3.04	0.075	2.89	3.19	2.81	3.26	2.48%	4.95%	7.43%	2.89	3.19

SI unit equivalents: ppb (parts per billion; 1 x 10^{-9}) ≡ µg/g; ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
IND: indeterminate; Note 1: intervals may appear asymmetric due to rounding.
Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 4 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											
La, ppm	38.7	1.92	34.9	42.6	33.0	44.5	4.96%	9.93%	14.89%	36.8	40.7
Li, ppm	51	2.0	47	55	45	57	4.02%	8.03%	12.05%	48	54
Mg, wt.%	0.921	0.036	0.849	0.992	0.813	1.028	3.89%	7.78%	11.67%	0.875	0.967
Mn, wt.%	0.042	0.001	0.039	0.044	0.038	0.046	3.26%	6.52%	9.78%	0.040	0.044
Mo, ppm	3.20	0.299	2.61	3.80	2.31	4.10	9.33%	18.65%	27.98%	3.04	3.36
Na, wt.%	2.09	0.089	1.92	2.27	1.83	2.36	4.25%	8.50%	12.75%	1.99	2.20
Nb, ppm	15.6	0.77	14.1	17.2	13.3	17.9	4.91%	9.82%	14.73%	14.9	16.4
Ni, ppm	23.8	0.85	22.1	25.5	21.3	26.4	3.56%	7.12%	10.67%	22.6	25.0
P, wt.%	0.091	0.002	0.086	0.095	0.084	0.098	2.58%	5.15%	7.73%	0.086	0.095
Pb, ppm	23.4	1.43	20.6	26.3	19.1	27.8	6.12%	12.24%	18.35%	22.3	24.6
Rb, ppm	185	7	171	199	164	206	3.75%	7.50%	11.25%	176	194
S, wt.%	0.117	0.009	0.100	0.134	0.091	0.143	7.37%	14.73%	22.10%	0.111	0.123
Sb, ppm	0.34	0.022	0.30	0.38	0.28	0.41	6.31%	12.62%	18.92%	0.32	0.36
Sc, ppm	9.85	0.220	9.41	10.29	9.19	10.51	2.24%	4.47%	6.71%	9.36	10.34
Sn, ppm	4.85	0.254	4.34	5.36	4.08	5.61	5.25%	10.50%	15.75%	4.60	5.09
Sr, ppm	202	4	194	209	190	213	1.86%	3.72%	5.58%	191	212
Ta, ppm	1.30	0.079	1.14	1.46	1.06	1.54	6.12%	12.24%	18.36%	1.23	1.36
Th, ppm	16.4	1.44	13.6	19.3	12.1	20.8	8.76%	17.53%	26.29%	15.6	17.3
Ti, wt.%	0.419	0.008	0.402	0.435	0.394	0.444	1.99%	3.99%	5.98%	0.398	0.440
Tl, ppm	1.02	0.047	0.92	1.11	0.87	1.16	4.63%	9.27%	13.90%	0.96	1.07
U, ppm	4.60	0.377	3.84	5.35	3.46	5.73	8.20%	16.41%	24.61%	4.37	4.83
V, ppm	75	2.5	70	80	68	83	3.35%	6.70%	10.04%	72	79
W, ppm	10.3	0.82	8.7	11.9	7.8	12.7	7.95%	15.90%	23.86%	9.8	10.8
Y, ppm	18.8	0.71	17.4	20.2	16.7	20.9	3.76%	7.51%	11.27%	17.9	19.7
Zn, ppm	80	2.7	75	86	72	89	3.37%	6.73%	10.10%	76	84
Zr, ppm	71	4.5	62	80	58	85	6.35%	12.69%	19.04%	68	75

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

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.

Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) 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 copper (by 4-acid digestion), where 99 % of the time (1-α=0.99) at least 95 % of subsamples (ρ=0.95) will have concentrations lying between 26.6 and 29.4 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.

Based on the statistical analysis of the results of the interlaboratory certification program OREAS 23c is deemed sufficiently homogenous and fit-for-purpose as a certified reference material (see ‘Intended Use’ below).

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. ALS, Lima, Peru
3. ALS, Malaga, WA, Australia
4. ALS, Vancouver, BC, Canada
5. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
6. Bureau Veritas Geoanalytical, Perth, WA, Australia
7. Inspectorate (BV), Lima, Peru
8. Intertek Genalysis, Adelaide, SA, Australia
9. Intertek Genalysis, Perth, WA, Australia
10. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
11. SGS Canada Inc., Vancouver, BC, Canada

PREPARER AND SUPPLIER

Certified reference material OREAS 23c was prepared, certified and supplied by:

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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, as milligrams per kilogram (mg/kg)) or as micrograms per kilogram (µg/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. %), parts per million (ppm) or parts per billion (ppb).

The analytical samples were selected in a manner representative of the entire batch of the prepared 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 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 participating laboratories were chosen on the basis of their competence (from past performance in interlaboratory programs undertaken by ORE Pty Ltd) for a particular analytical method, analyte or analyte suite and sample matrix. These laboratories are accredited to ISO 17025 for Au by fire assay and multi-elements by 4-acid digestion (Table

1). The certified values presented in this report are calculated from the means of accepted data following robust technical and statistical analysis as detailed in this report.

Guide ISO/TR 16476:2016 [7], section 5.3.1 describes metrological traceability in reference materials as it pertains to the transformation of the measurand. In this section it states, *"Although the determination of the property value itself can be made traceable to appropriate units through, for example, calibration of the measurement equipment used, steps like the transformation of the sample from one physical (chemical) state to another cannot. Such transformations may only be compared with a reference (when available), or among themselves. For some transformations, reference methods have been defined and may be used in certification projects to evaluate the uncertainty associated with such a transformation.* ***In other cases, only a comparison among different laboratories using the same procedure is possible. In this case, it is impossible to demonstrate absence of method bias; therefore, the result is an operationally defined measurand*** *(ISO Guide 33405:2024-05, 9.2.4c) [4]."* Certification takes place on the basis of agreement among operationally defined, independent measurement results.

COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving sample preparation and 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 naturally occurring rocks and sediments meaning they will display similar behaviour to routine 'field' samples in the relevant preparation and measurement processes. Care should be taken to ensure 'matrix matching' as close as practically achievable. The matrix 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 23c is intended to cover all activities needed to produce a measurement result. This includes preparation of the sample, extraction, possible separation steps and the actual measurement process (the signal producing step). OREAS 23c may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 23c is intended for the following uses:

- For the monitoring of sample contamination (due to preparation and/or analysis) in the analysis of analytes reported in Table 1 in geological samples;
- For the monitoring of laboratory performance in the analysis of analytes reported in Table 1 in geological samples;
- For the verification 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.

MINIMUM SAMPLE SIZE

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

- Au by fire assay: ≥ 25 g;
- 4-acid digestion with ICP-OES and/or MS finish: ≥ 0.25 g.

PERIOD OF VALIDITY & STORAGE INSTRUCTIONS

The certification of OREAS 23c remains valid, within the specified measurement uncertainties, until Feb 2034, 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.

Single-use sachets

Following analysis, it is the manufacturer's expectation that any remaining material is discarded unless the sachet is promptly resealed. It is the user's responsibility to prevent contamination and minimise exposure to the atmosphere.

Repeat-use packaging (500 g unit)

After taking a subsample, users should replace the lid of the jar promptly and securely to prevent accidental spills and airborne contamination. OREAS 23c 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 4 in this certificate.

The stability of the CRM in regard to oxidation from the breakdown of sulphide minerals to sulphates is negligible given its low sulphur concentration.

*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.

INSTRUCTIONS FOR HANDLING & CORRECT USE

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

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

The certified values for OREAS 23c refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis.

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 inter-laboratory 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 4 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, SD's should be calculated directly from your own laboratory's process. This will enable you to establish more specific performance gates that are fit for purpose for your application as well as the ability to monitor bias. If your long-term trend analysis shows an average value that is within the 95 % expanded uncertainty interval then generally there is no cause for concern in regard to bias.

LEGAL NOTICE

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

DOCUMENT HISTORY

Revision No.	Date	Changes applied
0	12th November, 2024	First publication.

QMS CERTIFICATION

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

CERTIFYING OFFICER

12th November, 2024

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

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