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**CERTIFICATE OF ANALYSIS FOR**

**Rhyodacite Blank Chip**

**(Mt Dandenong Igneous Complex, Victoria, Australia)**

**CERTIFIED REFERENCE MATERIAL**

**OREAS C27f**



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**Table 1. Certified Values and Performance Gates for OREAS C27f.**

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>Pb Fire Assay</b>											
Au, ppb	< 3	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
<b>4-Acid Digestion</b>											
Ag, ppm	0.167	0.019	0.129	0.205	0.110	0.224	11.45%	22.89%	34.34%	0.158	0.175
Al, wt. %	7.23	0.212	6.81	7.66	6.59	7.87	2.93%	5.86%	8.80%	6.87	7.59
As, ppm	5.77	0.489	4.80	6.75	4.31	7.24	8.47%	16.94%	25.41%	5.49	6.06
Ba, ppm	2493	94	2304	2682	2210	2777	3.79%	7.58%	11.37%	2368	2618
Be, ppm	3.12	0.245	2.63	3.61	2.39	3.86	7.85%	15.70%	23.55%	2.97	3.28
Bi, ppm	0.40	0.06	0.29	0.51	0.23	0.57	14.22%	28.45%	42.67%	0.38	0.42
Ca, wt. %	1.23	0.059	1.11	1.35	1.05	1.40	4.77%	9.54%	14.31%	1.17	1.29
Cd, ppm	0.46	0.06	0.34	0.58	0.28	0.64	13.06%	26.12%	39.18%	0.44	0.48
Ce, ppm	87	4.5	78	96	73	101	5.20%	10.40%	15.60%	83	91
Co, ppm	4.82	0.229	4.36	5.28	4.14	5.51	4.75%	9.51%	14.26%	4.58	5.06
Cr, ppm	383	53	277	490	224	543	13.89%	27.78%	41.67%	364	402
Cs, ppm	7.34	0.265	6.81	7.87	6.55	8.14	3.61%	7.21%	10.82%	6.98	7.71
Cu, ppm	29.2	4.9	19.4	39.0	14.5	44.0	16.81%	33.63%	50.44%	27.8	30.7
Fe, wt. %	2.26	0.071	2.11	2.40	2.04	2.47	3.14%	6.28%	9.41%	2.14	2.37
Ga, ppm	21.0	0.67	19.7	22.4	19.0	23.0	3.18%	6.36%	9.54%	20.0	22.1
Hf, ppm	4.16	0.211	3.73	4.58	3.52	4.79	5.07%	10.15%	15.22%	3.95	4.36
In, ppm	0.087	0.011	0.066	0.108	0.055	0.119	12.22%	24.44%	36.66%	0.083	0.091
K, wt. %	3.17	0.092	2.98	3.35	2.89	3.44	2.92%	5.83%	8.75%	3.01	3.32
La, ppm	41.7	2.71	36.3	47.1	33.6	49.8	6.50%	12.99%	19.49%	39.6	43.8
Li, ppm	38.0	1.50	35.0	41.0	33.5	42.5	3.96%	7.92%	11.88%	36.1	39.9
Mg, wt. %	0.366	0.013	0.341	0.392	0.328	0.405	3.48%	6.96%	10.44%	0.348	0.385
Mn, wt. %	0.026	0.001	0.023	0.028	0.021	0.030	5.56%	11.13%	16.69%	0.024	0.027
Mo, ppm	2.75	0.34	2.07	3.43	1.74	3.76	12.29%	24.58%	36.87%	2.61	2.89
Na, wt. %	2.08	0.055	1.97	2.19	1.92	2.25	2.65%	5.30%	7.95%	1.98	2.19
Nb, ppm	16.6	0.50	15.6	17.6	15.1	18.1	3.00%	5.99%	8.99%	15.8	17.4
Ni, ppm	13.6	0.81	12.0	15.2	11.2	16.0	5.92%	11.85%	17.77%	12.9	14.3
P, wt. %	0.060	0.002	0.055	0.065	0.053	0.068	4.09%	8.19%	12.28%	0.057	0.063
Pb, ppm	27.8	1.15	25.5	30.1	24.4	31.3	4.14%	8.27%	12.41%	26.4	29.2
Rb, ppm	164	8	148	180	140	188	4.80%	9.61%	14.41%	156	172
Re, ppm	< 0.002	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
S, wt. %	0.055	0.005	0.046	0.064	0.041	0.069	8.53%	17.06%	25.60%	0.052	0.058
Sb, ppm	1.18	0.074	1.03	1.33	0.96	1.41	6.29%	12.59%	18.88%	1.12	1.24
Sc, ppm	4.45	0.323	3.80	5.10	3.48	5.42	7.26%	14.53%	21.79%	4.23	4.67
Se, ppm	< 5	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Sn, ppm	4.21	0.200	3.81	4.61	3.61	4.81	4.74%	9.48%	14.23%	4.00	4.42
Sr, ppm	187	6	175	198	170	204	3.08%	6.17%	9.25%	178	196
Ta, ppm	1.22	0.032	1.15	1.28	1.12	1.31	2.65%	5.29%	7.94%	1.16	1.28
Tb, ppm	0.77	0.044	0.68	0.86	0.64	0.90	5.66%	11.31%	16.97%	0.73	0.81

SI unit equivalents: ppm (parts per million;  $1 \times 10^6$ )  $\equiv$  mg/kg; ppb (parts per billion;  $1 \times 10^9$ )  $\equiv$   $\mu$ g/g; wt. % (weight per cent)  $\equiv$  % (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 1 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>											
Te, ppm	< 0.05	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Th, ppm	15.5	0.81	13.9	17.1	13.0	17.9	5.25%	10.50%	15.76%	14.7	16.3
Ti, wt.%	0.160	0.004	0.152	0.168	0.148	0.172	2.46%	4.93%	7.39%	0.152	0.168
Tl, ppm	0.95	0.046	0.86	1.04	0.81	1.09	4.88%	9.75%	14.63%	0.90	1.00
U, ppm	4.87	0.245	4.38	5.36	4.13	5.60	5.04%	10.08%	15.12%	4.62	5.11
V, ppm	23.2	1.12	21.0	25.5	19.9	26.6	4.83%	9.66%	14.49%	22.1	24.4
W, ppm	2.10	0.153	1.79	2.40	1.64	2.55	7.30%	14.60%	21.90%	1.99	2.20
Y, ppm	13.7	0.78	12.1	15.3	11.4	16.1	5.71%	11.41%	17.12%	13.0	14.4
Yb, ppm	0.66	0.050	0.56	0.76	0.51	0.81	7.54%	15.08%	22.62%	0.63	0.70
Zn, ppm	115	6	103	128	97	134	5.38%	10.75%	16.13%	109	121
Zr, ppm	136	9	119	153	110	162	6.26%	12.52%	18.77%	129	143

SI unit equivalents: ppm (parts per million;  $1 \times 10^6 \equiv \text{mg/kg}$ ); ppb (parts per billion;  $1 \times 10^9 \equiv \mu\text{g/g}$ ); wt.% (weight per cent)  $\equiv \%$  (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 2. Indicative Values for OREAS C27f.**

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
<b>Pb Fire Assay</b>								
Pd	ppb	< 5	Pt	ppb	< 5			
<b>4-Acid Digestion</b>								
Dy	ppm	3.37	Ge	ppm	0.18	Pr	ppm	10.3
Er	ppm	1.01	Ho	ppm	0.46	Sm	ppm	8.04
Eu	ppm	1.48	Lu	ppm	0.100	Tm	ppm	0.10
Gd	ppm	6.22	Nd	ppm	39.2			
<b>Borate Fusion XRF</b>								
Al <sub>2</sub> O <sub>3</sub>	wt.%	14.00	K <sub>2</sub> O	wt.%	3.84	P <sub>2</sub> O <sub>5</sub>	wt.%	0.139
CaO	wt.%	1.65	MgO	wt.%	0.640	SiO <sub>2</sub>	wt.%	70.53
Cl	ppm	9.17	MnO	wt.%	0.033	SO <sub>3</sub>	wt.%	0.129
Fe <sub>2</sub> O <sub>3</sub>	wt.%	3.27	Na <sub>2</sub> O	wt.%	2.86	TiO <sub>2</sub>	wt.%	0.263
<b>Laser Ablation ICP-MS</b>								
Ag	ppm	0.200	Hf	ppm	6.32	Sm	ppm	8.50
As	ppm	5.33	Ho	ppm	0.51	Sn	ppm	4.13
Ba	ppm	2595	In	ppm	0.083	Sr	ppm	194
Be	ppm	3.23	La	ppm	45.1	Ta	ppm	1.37
Bi	ppm	0.53	Lu	ppm	0.10	Tb	ppm	0.86
Cd	ppm	0.52	Mn	wt.%	0.026	Te	ppm	< 0.2
Ce	ppm	89	Mo	ppm	2.77	Th	ppm	16.7
Co	ppm	5.05	Nb	ppm	17.8	Ti	wt.%	0.171
Cr	ppm	503	Nd	ppm	41.6	Tl	ppm	1.00
Cs	ppm	7.41	Ni	ppm	15.3	Tm	ppm	0.14

SI unit equivalents: ppm (parts per million;  $1 \times 10^6 \equiv \text{mg/kg}$ ); ppb (parts per billion;  $1 \times 10^9 \equiv \mu\text{g/g}$ ); 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.

Table 2. continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
<b>Laser Ablation ICP-MS continued</b>								
Cu	ppm	30.7	Pb	ppm	29.2	U	ppm	5.25
Dy	ppm	3.56	Pr	ppm	11.0	V	ppm	24.9
Er	ppm	1.08	Rb	ppm	168	W	ppm	2.33
Eu	ppm	1.62	Re	ppm	< 0.01	Y	ppm	14.9
Ga	ppm	21.1	Sb	ppm	1.18	Yb	ppm	0.76
Gd	ppm	6.57	Sc	ppm	5.02	Zn	ppm	114
Ge	ppm	1.27	Se	ppm	< 5	Zr	ppm	203
<b>Thermogravimetry</b>								
LOI <sup>1000</sup>	wt.%	2.12						
<b>Infrared Combustion</b>								
C	wt.%	0.303	S	wt.%	0.042			

SI unit equivalents: ppm (parts per million;  $1 \times 10^6$ )  $\equiv$  mg/kg; ppb (parts per billion;  $1 \times 10^9$ )  $\equiv$   $\mu$ g/g; 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.

## 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 performance gate intervals for the certified values, Table 2 shows indicative values, Table 3 provides an indicative particle size distribution, Table 4 provides some indicative physical properties and Table 5 presents the 95% expanded uncertainty and tolerance limits 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 C27f-DataPack.1.0.220509\_221122.xlsx**).

## SOURCE MATERIAL

- OREAS C27f is a rhyodacite blank chip certified reference material (CRM). The material was sourced from a quarry containing a rhyodacitic unit of the Mt Dandenong Igneous Complex located approximately 34km east of Melbourne (Victoria), Australia. OREAS 27f has a nominal particle size of minus 8mm to simulate RC drill chip samples.

## PERFORMANCE GATES

Table 1 above 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 (adapted from Govett, 1983).*

## PHYSICAL PROPERTIES

OREAS C27f was tested at ORE Research & Exploration Pty Ltd's onsite facility for various physical properties. A sieve analysis was performed on a 1kg sample to determine the particle size distribution of OREAS C27f. Table 3 presents the findings that should be used for informational purposes only.

**Table 3. Particle size distribution of OREAS C27f.**

Distribution	% (mass fraction)
Above 12.7mm	0.0
Under 12.7mm; Above 6.35mm	38.2
Under 6.35mm; Above 3.18mm	41.3
Under 3.18mm; Above 2mm	7.9
Under 2mm; Above 1.27mm	4.9
Under 1.27mm; Above 0.5mm	3.4
Under 0.5mm	4.4

Table 4 presents the bulk density, moisture percentage and Munsell colour code for OREAS C27f. These findings should be used for informational purposes only.

**Table 4. Physical properties of OREAS C27f.**

Bulk Density (g/L)	Moisture (%)	Munsell Notation <sup>‡</sup>	Munsell Colour <sup>‡</sup>
856	1.17	N8	Vert Light Gray

<sup>‡</sup>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.

## COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS C27f was prepared in the following manner:

- Drying to constant mass at 105° C;
- Crushing to achieve a nominal particle size of minus 8mm to simulate RC drill chip samples;
- Homogenisation using a rotary splitter;
- Packaging in 500g units into sealed robust barrier bags and 200kg units into 44-gallon (166L) drums.

## ANALYTICAL PROGRAM

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

- Au via 25-40g fire assay with ICP-MS (4 laboratories) and ICP-OES (6 laboratories) finish;
- Full elemental suite by four acid digestion (HNO<sub>3</sub>-HClO<sub>4</sub>-HCl-HF) with ICP-OES and ICP-MS finish (10 laboratories).

Major and trace elements were also characterised by Bureau Veritas Geoanalytical (Perth, Australia) using borate fusion XRF (Al<sub>2</sub>O<sub>3</sub> to TiO<sub>2</sub>), laser ablation with ICP-MS (Ag to Zr), LOI at 1000°C and C+S by infrared combustion furnace (see Table 2 'Indicative Values').

For the round robin program ten 1kg samples were taken at 10 predetermined sampling intervals during rotary splitting and are considered representative of the entire prepared batch of OREAS C27f. These 10 x 1kg samples were pulverised (to 95% passing 75 microns), homogenised and each split into six 110g subsamples. Six 110g samples were submitted to each laboratory for analysis. The samples received by each laboratory were obtained by taking two samples from each of three separate 1kg test units. This format enabled a nested ANOVA treatment of the results to evaluate homogeneity, i.e., to ascertain whether between-unit variance is greater than within-unit variance (see 'Homogeneity Evaluation' section).

## STATISTICAL ANALYSIS

**Certified Values and their uncertainty intervals** (Table 5) 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. In certain instances, statistician's prerogative has been employed in discriminating outliers.

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.

**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 [6,16]. 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. These major and trace element characterisation values are presented for informational purposes only.

**Standard Deviation** intervals (Table 1) 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.***



**Table 5. 95% Uncertainty & Tolerance Limits for OREAS C27f.**

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
<b>Pb Fire Assay</b>					
Au, Gold (ppb)	< 3	IND	IND	IND	IND
<b>4-Acid Digestion</b>					
Ag, Silver (ppm)	0.167	0.123	0.210	IND	IND
Al, Aluminium (wt.%)	7.23	6.97	7.49	6.99	7.47
As, Arsenic (ppm)	5.77	4.83	6.72	5.05	6.50
Ba, Barium (ppm)	2493	2399	2588	2421	2565
Be, Beryllium (ppm)	3.12	2.90	3.35	2.96	3.29
Bi, Bismuth (ppm)	0.40	0.23	0.57	0.29	0.51
Ca, Calcium (wt.%)	1.23	1.10	1.36	1.12	1.33
Cd, Cadmium (ppm)	0.46	0.31	0.62	0.35	0.57
Ce, Cerium (ppm)	87	81	93	81	93
Co, Cobalt (ppm)	4.82	4.42	5.23	4.54	5.10
Cr, Chromium (ppm)	383	304	462	309	458
Cs, Caesium (ppm)	7.34	6.88	7.81	6.92	7.76
Cu, Copper (ppm)	29.2	17.9	40.5	20.2	38.2
Fe, Iron (wt.%)	2.26	2.08	2.43	2.17	2.34
Ga, Gallium (ppm)	21.0	20.0	22.0	20.2	21.8
Hf, Hafnium (ppm)	4.16	3.65	4.66	4.00	4.31
In, Indium (ppm)	0.087	0.057	0.116	IND	IND
K, Potassium (wt.%)	3.17	3.02	3.31	3.02	3.31
La, Lanthanum (ppm)	41.7	37.9	45.5	38.1	45.3
Li, Lithium (ppm)	38.0	35.3	40.6	36.0	39.9
Mg, Magnesium (wt.%)	0.366	0.345	0.388	0.350	0.382
Mn, Manganese (wt.%)	0.026	0.022	0.029	0.024	0.027
Mo, Molybdenum (ppm)	2.75	2.19	3.31	2.27	3.23
Na, Sodium (wt.%)	2.08	1.93	2.24	2.02	2.15
Nb, Niobium (ppm)	16.6	15.9	17.3	15.8	17.4
Ni, Nickel (ppm)	13.6	12.1	15.1	12.4	14.9
P, Phosphorus (wt.%)	0.060	0.055	0.065	0.057	0.064
Pb, Lead (ppm)	27.8	25.4	30.2	26.2	29.5
Rb, Rubidium (ppm)	164	156	172	156	172
Re, Rhenium (ppm)	< 0.002	IND	IND	IND	IND
S, Sulphur (wt.%)	0.055	0.040	0.070	IND	IND
Sb, Antimony (ppm)	1.18	0.96	1.40	1.02	1.35
Sc, Scandium (ppm)	4.45	3.84	5.06	4.09	4.81
Se, Selenium (ppm)	< 5	IND	IND	IND	IND
Sn, Tin (ppm)	4.21	3.92	4.51	4.00	4.43

SI unit equivalents: ppm (parts per million;  $1 \times 10^6 \equiv \text{mg/kg}$ ); ppb (parts per billion;  $1 \times 10^9 \equiv \mu\text{g/g}$ ); wt.% (weight per cent)  $\equiv \%$  (mass fraction).

IND: indeterminate; Note: intervals may appear asymmetric due to rounding.

Table 5. continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
<b>4-Acid Digestion continued</b>					
Sr, Strontium (ppm)	187	178	196	181	193
Ta, Tantalum (ppm)	1.22	1.17	1.27	1.18	1.26
Tb, Terbium (ppm)	0.77	0.70	0.84	0.72	0.82
Te, Tellurium (ppm)	< 0.05	IND	IND	IND	IND
Th, Thorium (ppm)	15.5	14.6	16.4	14.7	16.2
Ti, Titanium (wt.%)	0.160	0.152	0.167	0.152	0.167
Tl, Thallium (ppm)	0.95	0.88	1.02	0.89	1.01
U, Uranium (ppm)	4.87	4.56	5.17	4.62	5.11
V, Vanadium (ppm)	23.2	21.3	25.2	21.2	25.3
W, Tungsten (ppm)	2.10	1.91	2.28	1.92	2.27
Y, Yttrium (ppm)	13.7	12.5	14.9	13.0	14.4
Yb, Ytterbium (ppm)	0.66	0.53	0.80	IND	IND
Zn, Zinc (ppm)	115	106	124	110	120
Zr, Zirconium (ppm)	136	122	150	123	149

SI unit equivalents: ppm (parts per million;  $1 \times 10^6$ )  $\equiv$  mg/kg; ppb (parts per billion;  $1 \times 10^9$ )  $\equiv$   $\mu$ g/g; wt.% (weight per cent)  $\equiv$  % (mass fraction).

IND: indeterminate; Note: intervals may appear asymmetric due to rounding.

### Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) in Table 5 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 ( $1-\alpha=0.99$ ) at least 95% of subsamples ( $\rho=0.95$ ) will have concentrations lying between 20.2 and 38.2ppm. Put more precisely, this means that if the same number of subsamples were taken and analysed in the same manner repeatedly, 99% of the tolerance intervals so constructed would cover at least 95% of the total population, and 1% of the tolerance intervals would cover less than 95% of the total population (ISO Guide 35). **Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.**

The homogeneity of OREAS C27f has also been evaluated in an ANOVA study for all certified analytes present in concentrations that are at least 20 times the lower limit of detection. No significant  $p$ -values were found except for Bi and Cu by 4-acid digestion. These isolated cases are most likely due to random\* statistical probability as there is no other supporting evidence to suspect greater between-unit variance compared with within-unit variance. The null hypothesis is therefore retained.

*\*p-values are calculated at the 95% probability level. Therefore, by definition 5% of p-values calculated will naturally fall as 'significant' (<0.05). For every 60 p-values calculated, 3 will 'fail' naturally meaning a significant difference is detected (a false positive) where, in reality, none exists.*

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 C27f and whether the variance between two subsamples from the same unit is statistically distinguishable to the variance from two subsamples taken from any two separate units. A reference material therefore, can possess poor absolute homogeneity

yet still pass a relative homogeneity test if the within-unit heterogeneity is large and similar across all units.

Based on the statistical analysis of the results of the inter-laboratory certification program it can be concluded that OREAS C27f is sufficiently homogenous and is fit-for-purpose as a certified reference material (see 'Intended Use' below).

## PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. ALS, Brisbane, QLD, Australia
3. ALS, Perth, WA, Australia
4. ALS, Vancouver, BC, Canada
5. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
6. Bureau Veritas Geoanalytical, Perth, WA, Australia
7. Intertek Genalysis, Adelaide, SA, Australia
8. Intertek Genalysis, Perth, WA, Australia
9. SGS Australia Mineral Services, Perth, WA, Australia
10. SGS Canada Inc., Vancouver, BC, Canada

## PREPARER AND SUPPLIER

Certified reference material OREAS C27f was prepared, certified and supplied by:



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## METROLOGICAL TRACEABILITY

The analytical samples were selected in a manner representative of the entire batch of the 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 procedure is possible. In this case, it is impossible to demonstrate absence of method bias; therefore, the result is an operationally defined measurand (ISO Guide 35:2017, 9.2.4c).**”* Certification takes place on the basis of agreement among operationally defined, independent measurement results.

## COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving pre-treatment (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 measurement process. Care should be taken to ensure ‘matrix matching’ as close as practically achievable. The matrix and mineralisation style (if applicable) 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 C27f 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 C27f may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS C27f 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.

## PERIOD OF VALIDITY & STORAGE INSTRUCTIONS

The certification of OREAS C27f remains valid, within the specified measurement uncertainties, until March 2037, 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.

## **INSTRUCTIONS FOR HANDLING & CORRECT USE**

### **Single-use 500g bags**

The entire 500g bag of OREAS C27f should be submitted to the laboratory for preparation (to a minimum specification of 85% passing 75 microns), subsampling and analysis. It is the user's responsibility to prevent contamination and avoid prolonged exposure of the sample to the atmosphere prior to analysis.

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

Certified values refer to the concentration levels in the packaged state. There is no need for drying prior to weighing and analysis.

### **Minimum sample size**

As a practical guide, the minimum mass of sample used should match the typical mass that the laboratories used in the interlaboratory certification program. This means that different sample masses should be used depending on the operationally defined methodology.

- Au by fire assay:  $\geq 25\text{g}$ ;
- 4-acid digestion with ICP-OES and/or MS finish:  $\geq 0.25\text{g}$ .

### **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 1 are intended only to be used as a first principle 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	17 <sup>th</sup> May, 2022	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

17<sup>th</sup> May, 2022

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

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