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CERTIFICATE OF ANALYSIS FOR

GOLD-SILVER ORE
CERTIFIED REFERENCE MATERIAL
OREAS 61f

Summary Statistics for Key Analytes.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fire Assay						
Au, Gold (ppm)	4.60	0.134	4.55	4.65	4.57*	4.64*
Aqua Regia Digestion (sample weights 10-50g)						
Au, Gold (ppm)	4.53	0.137	4.48	4.57	4.49†	4.57†
4-Acid Digestion						
Ag, Silver (ppm)	3.64	0.148	3.59	3.68	3.50	3.78
S, Sulphur (wt.%)	0.406	0.017	0.400	0.413	0.396	0.417
Aqua Regia Digestion						
Ag, Silver (ppm)	3.61	0.171	3.53	3.69	3.51	3.71

*Gold Tolerance Limits for typical 30g fire assay charge weight determined from 20 x 1g INAA results and the Sampling Constant (Ingamells & Switzer, 1973); †Gold Tolerance Limits for typical 25g aqua regia sample weight determined as above; Note: intervals may appear asymmetric due to rounding; Full certified elements list available in Table 1 below.

Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 61f.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fire Assay						
Au, Gold (ppm)	4.60	0.134	4.55	4.65	4.57*	4.64*
Aqua Regia Digestion (sample weights 10-50g)						
Au, Gold (ppm)	4.53	0.137	4.48	4.57	4.49†	4.57†
4-Acid Digestion						
Ag, Silver (ppm)	3.64	0.148	3.59	3.68	3.50	3.78
Al, Aluminium (wt.%)	5.37	0.238	5.27	5.47	5.26	5.48
As, Arsenic (ppm)	12.2	1.17	11.7	12.7	11.6	12.9
Ba, Barium (ppm)	257	8	254	260	253	262
Be, Beryllium (ppm)	0.76	0.068	0.74	0.78	0.70	0.82
Bi, Bismuth (ppm)	0.10	0.02	0.09	0.12	IND	IND
Ca, Calcium (wt.%)	7.54	0.302	7.41	7.66	7.39	7.68
Cd, Cadmium (ppm)	0.13	0.02	0.13	0.14	IND	IND
Ce, Cerium (ppm)	22.5	1.15	22.0	23.0	21.7	23.2
Co, Cobalt (ppm)	9.85	0.885	9.42	10.29	9.53	10.18
Cr, Chromium (ppm)	22.0	3.8	20.5	23.5	20.3	23.8
Cs, Cesium (ppm)	3.90	0.155	3.83	3.97	3.79	4.02
Cu, Copper (ppm)	40.2	2.71	39.0	41.3	38.5	41.8
Dy, Dysprosium (ppm)	2.02	0.128	1.94	2.10	1.90	2.14
Er, Erbium (ppm)	1.19	0.071	1.14	1.25	1.14	1.24
Eu, Europium (ppm)	0.69	0.047	0.65	0.72	0.65	0.72
Fe, Iron (wt.%)	2.67	0.125	2.62	2.72	2.62	2.73
Ga, Gallium (ppm)	11.5	0.91	11.0	12.0	11.1	11.9
Gd, Gadolinium (ppm)	2.33	0.161	2.22	2.44	2.21	2.45
Hf, Hafnium (ppm)	1.88	0.181	1.79	1.96	1.79	1.97
Ho, Holmium (ppm)	0.40	0.032	0.38	0.43	0.37	0.43
In, Indium (ppm)	0.032	0.005	0.029	0.035	0.028	0.036
K, Potassium (wt.%)	1.54	0.073	1.51	1.57	1.51	1.57
La, Lanthanum (ppm)	10.5	0.45	10.3	10.7	10.1	10.8
Li, Lithium (ppm)	35.7	2.34	34.7	36.6	34.4	36.9
Lu, Lutetium (ppm)	0.17	0.011	0.16	0.18	IND	IND
Mg, Magnesium (wt.%)	1.00	0.056	0.98	1.03	0.98	1.02
Mn, Manganese (wt.%)	0.065	0.003	0.064	0.067	0.064	0.067
Mo, Molybdenum (ppm)	2.08	0.152	2.02	2.15	1.96	2.21
Na, Sodium (wt.%)	1.28	0.060	1.25	1.30	1.25	1.30
Nb, Niobium (ppm)	2.28	0.24	2.17	2.39	2.14	2.42
Nd, Neodymium (ppm)	12.2	0.68	11.7	12.6	11.8	12.6
Ni, Nickel (ppm)	15.4	1.8	14.7	16.2	14.9	16.0
P, Phosphorus (wt.%)	0.065	0.003	0.063	0.066	0.063	0.066
Pb, Lead (ppm)	10.1	1.2	9.6	10.6	9.5	10.8
Pr, Praseodymium (ppm)	2.90	0.167	2.78	3.03	2.77	3.04
Rb, Rubidium (ppm)	60	3.3	59	62	58	62

*Gold Tolerance Limits for typical 30g fire assay charge weight determined from 20 x 1g INAA results and the Sampling Constant (Ingamells & Switzer, 1973); †Gold Tolerance Limits for typical 25g aqua regia sample weight determined as above; Note: intervals may appear asymmetric due to rounding.

Table 1 continued.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
4-Acid Digestion						
S, Sulphur (wt.%)	0.406	0.017	0.400	0.413	0.396	0.417
Sb, Antimony (ppm)	1.60	0.118	1.54	1.65	1.50	1.69
Sc, Scandium (ppm)	10.6	0.79	10.3	10.9	10.3	10.9
Sm, Samarium (ppm)	2.53	0.113	2.44	2.62	2.40	2.66
Sn, Tin (ppm)	0.71	0.10	0.66	0.76	0.65	0.77
Sr, Strontium (ppm)	359	15	353	365	352	366
Tb, Terbium (ppm)	0.35	0.028	0.33	0.37	0.32	0.37
Te, Tellurium (ppm)	1.18	0.14	1.12	1.24	1.06	1.30
Th, Thorium (ppm)	2.00	0.146	1.93	2.06	1.89	2.10
Ti, Titanium (wt.%)	0.263	0.009	0.259	0.266	0.256	0.270
Tl, Thallium (ppm)	0.60	0.036	0.58	0.62	0.57	0.63
Tm, Thulium (ppm)	0.15	0.02	0.14	0.17	IND	IND
U, Uranium (ppm)	0.53	0.037	0.51	0.54	0.50	0.56
V, Vanadium (ppm)	88	3.7	86	89	86	89
W, Tungsten (ppm)	2.04	0.25	1.92	2.16	1.86	2.22
Y, Yttrium (ppm)	10.2	0.52	10.0	10.5	9.9	10.6
Yb, Ytterbium (ppm)	1.10	0.055	1.07	1.13	1.06	1.14
Zn, Zinc (ppm)	51	2.6	50	52	49	52
Zr, Zirconium (ppm)	72	5.7	69	74	70	74
Aqua Regia Digestion						
Ag, Silver (ppm)	3.61	0.171	3.53	3.69	3.51	3.71
Al, Aluminium (wt.%)	1.52	0.121	1.46	1.58	1.47	1.57
As, Arsenic (ppm)	11.6	0.82	11.2	11.9	11.2	11.9
Ba, Barium (ppm)	37.4	2.19	36.3	38.6	36.3	38.5
Be, Beryllium (ppm)	0.49	0.037	0.48	0.51	0.46	0.52
Bi, Bismuth (ppm)	0.093	0.007	0.089	0.097	IND	IND
Ca, Calcium (wt.%)	6.64	0.350	6.48	6.81	6.52	6.77
Cd, Cadmium (ppm)	0.12	0.011	0.11	0.12	0.11	0.13
Ce, Cerium (ppm)	20.0	0.97	19.5	20.5	19.4	20.6
Co, Cobalt (ppm)	9.12	0.420	8.91	9.32	8.91	9.33
Cr, Chromium (ppm)	20.3	2.1	19.4	21.3	19.8	20.9
Cs, Cesium (ppm)	2.16	0.32	1.98	2.34	2.10	2.22
Cu, Copper (ppm)	39.2	2.20	38.3	40.0	38.2	40.1
Dy, Dysprosium (ppm)	1.50	0.089	1.42	1.57	1.44	1.56
Er, Erbium (ppm)	0.76	0.043	0.71	0.82	0.73	0.79
Fe, Iron (wt.%)	2.40	0.093	2.36	2.43	2.34	2.45
Ga, Gallium (ppm)	5.58	0.488	5.32	5.83	5.39	5.77
Gd, Gadolinium (ppm)	1.86	0.065	1.82	1.90	1.79	1.94
Hg, Mercury (ppm)	0.099	0.007	0.097	0.102	IND	IND
In, Indium (ppm)	0.024	0.004	0.022	0.026	0.020	0.028
K, Potassium (wt.%)	0.184	0.020	0.175	0.194	0.178	0.190
La, Lanthanum (ppm)	9.19	0.477	8.96	9.42	8.97	9.41

Note: intervals may appear asymmetric due to rounding.

Table 1 continued.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Aqua Regia Digestion continued						
Li, Lithium (ppm)	11.6	0.43	11.4	11.9	11.3	12.0
Lu, Lutetium (ppm)	0.091	0.003	0.090	0.092	IND	IND
Mg, Magnesium (wt.%)	0.834	0.023	0.823	0.844	0.818	0.849
Mn, Manganese (wt.%)	0.061	0.003	0.060	0.062	0.060	0.062
Mo, Molybdenum (ppm)	1.96	0.075	1.92	1.99	1.91	2.00
Na, Sodium (wt.%)	0.151	0.013	0.144	0.157	0.143	0.158
Nd, Neodymium (ppm)	10.6	0.33	10.3	10.9	10.4	10.8
Ni, Nickel (ppm)	13.1	0.96	12.6	13.5	12.7	13.4
P, Phosphorus (wt.%)	0.059	0.004	0.057	0.061	0.058	0.060
Pb, Lead (ppm)	7.95	0.529	7.66	8.24	7.65	8.25
Pr, Praseodymium (ppm)	2.45	0.080	2.37	2.53	2.40	2.50
Rb, Rubidium (ppm)	8.79	1.25	8.08	9.49	8.59	8.98
S, Sulphur (wt.%)	0.398	0.017	0.391	0.406	0.390	0.407
Sb, Antimony (ppm)	0.33	0.04	0.30	0.35	0.29	0.37
Sc, Scandium (ppm)	7.00	0.426	6.78	7.22	6.82	7.18
Sm, Samarium (ppm)	2.11	0.072	2.04	2.17	2.04	2.17
Sn, Tin (ppm)	0.47	0.06	0.44	0.50	0.43	0.52
Sr, Strontium (ppm)	159	15	152	166	155	163
Tb, Terbium (ppm)	0.27	0.011	0.26	0.28	0.26	0.28
Te, Tellurium (ppm)	1.13	0.094	1.09	1.18	1.09	1.17
Th, Thorium (ppm)	1.06	0.074	1.02	1.09	0.99	1.12
Ti, Titanium (wt.%)	0.090	0.006	0.087	0.093	0.088	0.092
Tl, Thallium (ppm)	0.13	0.02	0.12	0.14	IND	IND
U, Uranium (ppm)	0.21	0.013	0.20	0.21	0.19	0.22
V, Vanadium (ppm)	63	4.2	61	65	61	64
Y, Yttrium (ppm)	7.70	0.391	7.52	7.88	7.54	7.87
Yb, Ytterbium (ppm)	0.67	0.059	0.63	0.71	0.62	0.71
Zn, Zinc (ppm)	44.4	2.59	43.3	45.6	43.1	45.7

Note: intervals may appear asymmetric due to rounding.

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.

SOURCE MATERIALS

OREAS 61f was prepared from coarse reject splits of gold-silver ore samples blended with barren andesite. The gold-silver ore was sourced from the Cracow mine located 500km northwest of Brisbane in Queensland, Australia. The barren andesite was sourced from the Carboniferous Blair Duguid Hypersthene Andesite intrusive, located 70kms northwest of Newcastle, Australia. Cracow is a low sulphidation epithermal deposit hosted by meta-andesitic volcanics. High grade gold mineralisation occurs within fissure quartz veins and is associated with zones of silicification, present as quartz lode breccia and as quartz vein breccia. OREAS 61f is one of a suite of three CRMs ranging in gold content from 2.47 to 9.71ppm.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 61f was prepared in the following manner:

- Drying to constant mass at 105°C;
- Crushing and milling of the barren andesite to >98% minus 75 microns;
- Crushing and multi stage milling of the ore materials to 100% passing 35 microns;
- Blending in appropriate proportions to achieve the desired grades;
- Packaging in 60g units sealed in laminated foil pouches and 500g units in plastic jars.

ANALYTICAL PROGRAM

Twenty-seven commercial analytical laboratories participated in the program to certify the 108 elements reported in Table 1. The following methods were employed:

- Au by fire assay with AAS (23 labs) or ICP-OES (3 laboratories) finish;
- Instrumental neutron activation analysis for Au on 20 x 1g subsamples to confirm homogeneity (1 laboratory);
- Gold by aqua regia digestion on 10-50g sample weights with ICP-MS (11 laboratories), AAS (9 laboratories) or ICP-OES (1 laboratory) finish;
- 4-acid (HF-HNO_3-$HClO_4$-HCl) digestion for full ICP-OES and ICP-MS elemental suites (up to 24 laboratories depending on the element);
- Aqua regia digestion for full ICP-OES and ICP-MS elemental suites (up to 23 laboratories depending on the element).

It is important to note that in the analytical industry there is no standardisation of the aqua regia digestion process. Aqua regia is a partial empirical digest and differences in recoveries for various analytes are commonplace. These are caused by variations in the digest conditions which can include the ratio of nitric to hydrochloric acids, acid strength, temperatures, leach times and secondary digestions. Recoveries for sulphide-hosted base metal sulphides approach total values, however, other analytes, in particular the lithophile elements, show greater sensitivity to method parameters. This can result in lack of consensus in an inter-laboratory certification program for these elements. The approach applied here is to report certified values in those instances where reasonable agreement exists amongst a majority of participating laboratories. The results of specific laboratories may differ significantly from the certified values, but will, nonetheless, be valid and reproducible in the context of the specifics of the aqua regia method in use. Users of this reference material should, therefore, be mindful of this limitation when applying the certified values in a quality control program.

Table 2. Indicative Values for OREAS 61f.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Pb Fire Assay								
Pd	ppm	< 0.003	Pt	ppm	< 0.005			
4-Acid Digestion								
Ge	ppm	0.12	Pt	ppm	< 0.01	Se	ppm	< 2
Hg	ppm	0.15	Re	ppm	< 0.002	Ta	ppm	0.15
Ir	ppm	< 0.01	Rh	ppm	< 0.02			
Pd	ppm	< 0.01	Ru	ppm	< 0.02			
Aqua Regia Digestion								
B	ppm	14.3	Nb	ppm	< 0.05	Se	ppm	0.26
Eu	ppm	0.49	Pd	ppm	< 0.01	Ta	ppm	< 0.01
Ge	ppm	0.095	Pt	ppm	< 0.005	Tm	ppm	0.10
Hf	ppm	0.37	Re	ppm	0.001	W	ppm	0.36
Ho	ppm	0.28	Ru	ppm	< 0.005	Zr	ppm	11.7
Borate Fusion XRF								
Al_2O_3	wt.%	10.26	K_2O	wt.%	1.85	P_2O_5	wt.%	0.155
BaO	ppm	300	MgO	wt.%	1.73	S	wt.%	0.388
CaO	wt.%	10.69	MnO	wt.%	0.090	SiO_2	wt.%	59.52
Fe_2O_3	wt.%	3.86	Na_2O	wt.%	1.74	TiO_2	wt.%	0.440
Thermogravimetry								
H_2O-	wt.%	1.24	LOI^{1000}	wt.%	9.03			
Laser Ablation ICP-MS								
Ag	ppm	3.50	Hf	ppm	1.92	Sm	ppm	2.53
As	ppm	12.0	Ho	ppm	0.41	Sn	ppm	0.70
Ba	ppm	256	In	ppm	< 0.05	Sr	ppm	355
Be	ppm	1.00	La	ppm	10.3	Ta	ppm	0.13
Bi	ppm	0.080	Lu	ppm	0.16	Tb	ppm	0.34
Cd	ppm	< 0.1	Mn	wt.%	0.065	Te	ppm	1.20
Ce	ppm	21.8	Mo	ppm	2.40	Th	ppm	2.15
Co	ppm	10.7	Nb	ppm	2.30	Ti	wt.%	0.267
Cr	ppm	24.0	Nd	ppm	11.8	Tl	ppm	0.70
Cs	ppm	3.93	Ni	ppm	17.0	Tm	ppm	0.17
Cu	ppm	41.0	Pb	ppm	9.50	U	ppm	0.53
Dy	ppm	1.99	Pr	ppm	2.85	V	ppm	91
Er	ppm	1.13	Rb	ppm	59	W	ppm	2.00
Eu	ppm	0.67	Re	ppm	< 0.01	Y	ppm	11.0
Ga	ppm	11.0	Sb	ppm	1.35	Yb	ppm	1.10
Gd	ppm	2.26	Sc	ppm	11.6	Zn	ppm	40.0
Ge	ppm	0.75	Se	ppm	< 5	Zr	ppm	72
Infrared Combustion								
C	wt.%	2.01	S	wt.%	0.344			

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.

For the round robin program samples were taken at 20 predetermined sampling intervals during packaging and are considered representative of the entire batch of OREAS 61f. Six 120g samples were submitted to each laboratory for analysis. Table 1 presents the certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 shows 94 indicative values including the major and trace element composition.

Gold homogeneity has been evaluated and confirmed by instrumental neutron activation analysis (INAA) on twenty 1 gram sample portions (see Table 3) and by a nested ANOVA program for both fire assay and aqua regia digestion (see '**nested ANOVA**' on page 12). Table 4 provides performance gate intervals for the certified values of each method group based on their pooled 1SD's. Tabulated results of all elements (including Au INAA analyses) 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 presented in the detailed certification data for this CRM (**OREAS 61f DataPack.xlsx**).

Table 3. Neutron Activation Analysis of Au (ppm) on 20 x 1g subsamples.

Replicate No	Au ppm
1	4.43
2	4.38
3	4.41
4	4.43
5	4.46
6	4.41
7	4.46
8	4.40
9	4.54
10	4.53
11	4.31
12	4.55
13	4.42
14	4.46
15	4.49
16	4.51
17	4.44
18	4.53
19	4.46
20	4.48
Mean	4.46
Median	4.46
Std Dev.	0.060
Rel.Std.Dev.	1.35%
PDM[3]	-3.24%

The 1RSD of 1.35% (or 0.252% at a 30g charge weight via the Sampling Constant (Ingamells & Switzer, 1973)) confirms the high level of gold homogeneity in OREAS 61f.

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. *Confidence and Tolerance Limits should not be used as control limits for laboratory performance.*

Indicative (uncertified) values (Table 2) are provided for the major and trace elements determined by borate fusion XRF (Al_2O_3 to Zn) and laser ablation with ICP-MS (Ag to Zr) and are the means of duplicate assays from Bureau Veritas, Perth. Additional indicative values by other analytical methods are 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 values (1SDs) are reported in Table 1 and 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. The SD's 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 SD values thus include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability. OREAS prepared reference materials have a level of homogeneity such that the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself.

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 any 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.**

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-lab 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.

Performance Gates (Table 4) are 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 per cent 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.

Table 4. Performance Gates for OREAS 61f.

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
Fire Assay											
Au, ppm	4.60	0.134	4.34	4.87	4.20	5.01	2.91%	5.82%	8.73%	4.37	4.83
Aqua Regia Digestion (sample weights 10-50g)											
Au, ppm	4.53	0.137	4.26	4.80	4.12	4.94	3.02%	6.03%	9.05%	4.30	4.76
4-Acid Digestion											
Ag, ppm	3.64	0.148	3.34	3.93	3.19	4.08	4.06%	8.12%	12.19%	3.45	3.82
Al, wt.%	5.37	0.238	4.90	5.85	4.66	6.09	4.43%	8.86%	13.29%	5.10	5.64
As, ppm	12.2	1.17	9.9	14.6	8.7	15.8	9.57%	19.14%	28.72%	11.6	12.9
Ba, ppm	257	8	241	274	233	282	3.19%	6.38%	9.57%	244	270
Be, ppm	0.76	0.068	0.62	0.90	0.56	0.96	8.89%	17.78%	26.67%	0.72	0.80
Bi, ppm	0.10	0.02	0.07	0.14	0.05	0.16	18.53%	37.05%	55.58%	0.10	0.11
Ca, wt.%	7.54	0.302	6.93	8.14	6.63	8.44	4.01%	8.03%	12.04%	7.16	7.91
Cd, ppm	0.13	0.02	0.08	0.18	0.06	0.20	17.94%	35.88%	53.82%	0.12	0.14
Ce, ppm	22.5	1.15	20.2	24.8	19.0	25.9	5.11%	10.23%	15.34%	21.3	23.6
Co, ppm	9.85	0.885	8.08	11.62	7.20	12.51	8.98%	17.96%	26.95%	9.36	10.35
Cr, ppm	22.0	3.8	14.4	29.7	10.5	33.5	17.36%	34.72%	52.08%	20.9	23.1
Cs, ppm	3.90	0.155	3.59	4.21	3.44	4.37	3.98%	7.96%	11.94%	3.71	4.10
Cu, ppm	40.2	2.71	34.7	45.6	32.0	48.3	6.75%	13.49%	20.24%	38.2	42.2
Dy, ppm	2.02	0.128	1.76	2.28	1.64	2.40	6.34%	12.68%	19.02%	1.92	2.12
Er, ppm	1.19	0.071	1.05	1.33	0.98	1.41	5.97%	11.93%	17.90%	1.13	1.25
Eu, ppm	0.69	0.047	0.59	0.78	0.55	0.83	6.87%	13.73%	20.60%	0.65	0.72
Fe, wt.%	2.67	0.125	2.42	2.92	2.30	3.05	4.67%	9.35%	14.02%	2.54	2.81
Ga, ppm	11.5	0.91	9.7	13.3	8.8	14.2	7.91%	15.82%	23.73%	10.9	12.1
Gd, ppm	2.33	0.161	2.01	2.66	1.85	2.82	6.92%	13.84%	20.77%	2.22	2.45
Hf, ppm	1.88	0.181	1.52	2.24	1.34	2.42	9.63%	19.26%	28.90%	1.78	1.97
Ho, ppm	0.40	0.032	0.34	0.47	0.30	0.50	8.04%	16.07%	24.11%	0.38	0.42
In, ppm	0.032	0.005	0.021	0.043	0.016	0.048	16.84%	33.69%	50.53%	0.031	0.034
K, wt.%	1.54	0.073	1.39	1.68	1.32	1.76	4.74%	9.47%	14.21%	1.46	1.62
La, ppm	10.5	0.45	9.6	11.4	9.1	11.8	4.25%	8.50%	12.75%	9.9	11.0
Li, ppm	35.7	2.34	31.0	40.3	28.6	42.7	6.57%	13.14%	19.70%	33.9	37.4
Lu, ppm	0.17	0.011	0.15	0.19	0.14	0.20	6.59%	13.17%	19.76%	0.16	0.18
Mg, wt.%	1.00	0.056	0.89	1.11	0.83	1.17	5.59%	11.17%	16.76%	0.95	1.05
Mn, wt.%	0.065	0.003	0.060	0.071	0.057	0.074	4.23%	8.45%	12.68%	0.062	0.069
Mo, ppm	2.08	0.152	1.78	2.39	1.63	2.54	7.27%	14.54%	21.81%	1.98	2.19

Note: intervals may appear asymmetric due to rounding.

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											
Na, wt.%	1.28	0.060	1.16	1.40	1.10	1.46	4.67%	9.34%	14.01%	1.21	1.34
Nb, ppm	2.28	0.24	1.80	2.76	1.57	2.99	10.44%	20.87%	31.31%	2.17	2.39
Nd, ppm	12.2	0.68	10.8	13.6	10.1	14.2	5.60%	11.20%	16.79%	11.6	12.8
Ni, ppm	15.4	1.8	11.8	19.1	10.0	20.9	11.80%	23.61%	35.41%	14.7	16.2
P, wt.%	0.065	0.003	0.058	0.071	0.054	0.075	5.29%	10.58%	15.87%	0.061	0.068
Pb, ppm	10.1	1.2	7.8	12.5	6.6	13.7	11.64%	23.28%	34.92%	9.6	10.6
Pr, ppm	2.90	0.167	2.57	3.24	2.40	3.40	5.75%	11.49%	17.24%	2.76	3.05
Rb, ppm	60	3.3	54	67	50	70	5.50%	11.00%	16.49%	57	63
S, wt.%	0.406	0.017	0.373	0.440	0.357	0.456	4.08%	8.17%	12.25%	0.386	0.427
Sb, ppm	1.60	0.118	1.36	1.83	1.24	1.95	7.37%	14.74%	22.11%	1.52	1.68
Sc, ppm	10.6	0.79	9.0	12.2	8.3	13.0	7.40%	14.81%	22.21%	10.1	11.1
Sm, ppm	2.53	0.113	2.30	2.75	2.19	2.87	4.46%	8.92%	13.37%	2.40	2.65
Sn, ppm	0.71	0.10	0.50	0.91	0.40	1.02	14.54%	29.07%	43.61%	0.67	0.74
Sr, ppm	359	15	328	390	313	405	4.27%	8.54%	12.81%	341	377
Tb, ppm	0.35	0.028	0.29	0.40	0.26	0.43	8.09%	16.17%	24.26%	0.33	0.36
Te, ppm	1.18	0.14	0.90	1.46	0.75	1.61	12.04%	24.07%	36.11%	1.12	1.24
Th, ppm	2.00	0.146	1.70	2.29	1.56	2.43	7.30%	14.61%	21.91%	1.90	2.10
Ti, wt.%	0.263	0.009	0.244	0.282	0.234	0.291	3.61%	7.23%	10.84%	0.250	0.276
Tl, ppm	0.60	0.036	0.53	0.67	0.49	0.71	6.04%	12.09%	18.13%	0.57	0.63
Tm, ppm	0.15	0.02	0.11	0.19	0.09	0.21	13.42%	26.85%	40.27%	0.14	0.16
U, ppm	0.53	0.037	0.45	0.60	0.42	0.64	6.99%	13.97%	20.96%	0.50	0.55
V, ppm	88	3.7	80	95	77	99	4.21%	8.41%	12.62%	83	92
W, ppm	2.04	0.25	1.54	2.54	1.29	2.79	12.26%	24.51%	36.77%	1.94	2.14
Y, ppm	10.2	0.52	9.2	11.3	8.7	11.8	5.04%	10.07%	15.11%	9.7	10.7
Yb, ppm	1.10	0.055	0.99	1.21	0.93	1.26	4.97%	9.94%	14.91%	1.04	1.15
Zn, ppm	51	2.6	46	56	43	59	5.09%	10.17%	15.26%	48	53
Zr, ppm	72	5.7	61	83	55	89	7.86%	15.73%	23.59%	68	75
Aqua Regia Digestion											
Ag, ppm	3.61	0.171	3.27	3.95	3.10	4.12	4.72%	9.45%	14.17%	3.43	3.79
Al, wt.%	1.52	0.121	1.28	1.76	1.16	1.88	7.98%	15.95%	23.93%	1.44	1.60
As, ppm	11.6	0.82	9.9	13.2	9.1	14.0	7.09%	14.19%	21.28%	11.0	12.1
Ba, ppm	37.4	2.19	33.1	41.8	30.9	44.0	5.85%	11.69%	17.54%	35.6	39.3
Be, ppm	0.49	0.037	0.42	0.57	0.38	0.60	7.46%	14.92%	22.38%	0.47	0.52
Bi, ppm	0.093	0.007	0.078	0.108	0.071	0.115	7.94%	15.87%	23.81%	0.089	0.098
Ca, wt.%	6.64	0.350	5.94	7.35	5.59	7.70	5.27%	10.54%	15.81%	6.31	6.98
Cd, ppm	0.12	0.011	0.10	0.14	0.09	0.15	9.21%	18.43%	27.64%	0.11	0.13
Ce, ppm	20.0	0.97	18.1	22.0	17.1	22.9	4.84%	9.68%	14.52%	19.0	21.0
Co, ppm	9.12	0.420	8.28	9.96	7.86	10.38	4.60%	9.20%	13.80%	8.66	9.57

Note: intervals may appear asymmetric due to rounding.

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
Aqua Regia Digestion continued											
Cr, ppm	20.3	2.1	16.1	24.6	14.0	26.7	10.37%	20.73%	31.10%	19.3	21.4
Cs, ppm	2.16	0.32	1.51	2.81	1.19	3.13	14.99%	29.97%	44.96%	2.05	2.27
Cu, ppm	39.2	2.20	34.8	43.5	32.6	45.7	5.61%	11.22%	16.83%	37.2	41.1
Dy, ppm	1.50	0.089	1.32	1.67	1.23	1.76	5.96%	11.93%	17.89%	1.42	1.57
Er, ppm	0.76	0.043	0.68	0.85	0.63	0.89	5.67%	11.34%	17.01%	0.72	0.80
Fe, wt.%	2.40	0.093	2.21	2.58	2.12	2.67	3.87%	7.75%	11.62%	2.28	2.52
Ga, ppm	5.58	0.488	4.60	6.55	4.11	7.04	8.75%	17.51%	26.26%	5.30	5.86
Gd, ppm	1.86	0.065	1.73	1.99	1.67	2.06	3.48%	6.96%	10.43%	1.77	1.96
Hg, ppm	0.099	0.007	0.085	0.114	0.077	0.121	7.35%	14.70%	22.05%	0.094	0.104
In, ppm	0.024	0.004	0.015	0.033	0.011	0.037	18.09%	36.18%	54.27%	0.023	0.025
K, wt.%	0.184	0.020	0.143	0.225	0.123	0.245	11.06%	22.12%	33.18%	0.175	0.193
La, ppm	9.19	0.477	8.24	10.14	7.76	10.62	5.19%	10.38%	15.57%	8.73	9.65
Li, ppm	11.6	0.43	10.8	12.5	10.3	12.9	3.72%	7.45%	11.17%	11.0	12.2
Lu, ppm	0.091	0.003	0.084	0.097	0.081	0.100	3.43%	6.87%	10.30%	0.086	0.095
Mg, wt.%	0.834	0.023	0.787	0.881	0.763	0.904	2.81%	5.62%	8.43%	0.792	0.875
Mn, wt.%	0.061	0.003	0.055	0.066	0.053	0.069	4.47%	8.94%	13.41%	0.058	0.064
Mo, ppm	1.96	0.075	1.81	2.11	1.73	2.18	3.85%	7.69%	11.54%	1.86	2.06
Na, wt.%	0.151	0.013	0.125	0.176	0.112	0.189	8.50%	16.99%	25.49%	0.143	0.158
Nd, ppm	10.6	0.33	9.9	11.3	9.6	11.6	3.13%	6.26%	9.39%	10.1	11.1
Ni, ppm	13.1	0.96	11.1	15.0	10.2	15.9	7.33%	14.65%	21.98%	12.4	13.7
P, wt.%	0.059	0.004	0.051	0.067	0.047	0.071	6.62%	13.24%	19.87%	0.056	0.062
Pb, ppm	7.95	0.529	6.89	9.01	6.36	9.54	6.65%	13.31%	19.96%	7.55	8.35
Pr, ppm	2.45	0.080	2.29	2.61	2.21	2.69	3.27%	6.54%	9.80%	2.33	2.58
Rb, ppm	8.79	1.25	6.28	11.29	5.02	12.55	14.27%	28.54%	42.81%	8.35	9.22
S, wt.%	0.398	0.017	0.365	0.432	0.348	0.449	4.20%	8.39%	12.59%	0.379	0.418
Sb, ppm	0.33	0.04	0.24	0.41	0.20	0.45	12.79%	25.58%	38.38%	0.31	0.34
Sc, ppm	7.00	0.426	6.15	7.85	5.72	8.28	6.09%	12.18%	18.27%	6.65	7.35
Sm, ppm	2.11	0.072	1.96	2.25	1.89	2.32	3.41%	6.81%	10.22%	2.00	2.21
Sn, ppm	0.47	0.06	0.36	0.58	0.31	0.64	11.78%	23.57%	35.35%	0.45	0.50
Sr, ppm	159	15	129	188	115	203	9.29%	18.58%	27.86%	151	167
Tb, ppm	0.27	0.011	0.25	0.29	0.24	0.30	4.17%	8.34%	12.50%	0.26	0.28
Te, ppm	1.13	0.094	0.94	1.32	0.85	1.41	8.28%	16.56%	24.84%	1.07	1.19
Th, ppm	1.06	0.074	0.91	1.20	0.83	1.28	7.01%	14.03%	21.04%	1.00	1.11
Ti, wt.%	0.090	0.006	0.078	0.102	0.071	0.108	6.86%	13.73%	20.59%	0.085	0.094
Tl, ppm	0.13	0.02	0.10	0.16	0.08	0.18	12.85%	25.70%	38.55%	0.12	0.14
U, ppm	0.21	0.013	0.18	0.23	0.17	0.24	6.23%	12.46%	18.69%	0.20	0.22
V, ppm	63	4.2	54	71	50	75	6.65%	13.30%	19.95%	59	66
Y, ppm	7.70	0.391	6.92	8.48	6.53	8.87	5.07%	10.15%	15.22%	7.32	8.09

Note: intervals may appear asymmetric due to rounding.

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
Aqua Regia Digestion continued											
Yb, ppm	0.67	0.059	0.55	0.79	0.49	0.84	8.89%	17.78%	26.68%	0.63	0.70
Zn, ppm	44.4	2.59	39.2	49.6	36.7	52.2	5.83%	11.65%	17.48%	42.2	46.6

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 silver 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 3.50 and 3.78ppm. 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).

For gold the tolerance has been determined by INAA using the reduced analytical subsample method which utilises the known relationship between standard deviation and analytical subsample weight (Ingamells and Switzer, 1973). In this approach the sample aliquot is substantially reduced to a point where most of the variability in replicate assays should be due to inhomogeneity of the reference material and measurement error becomes negligible. In this instance a subsample weight of 1 gram was employed and the 1RSD of 0.252% calculated for a 30g fire assay or aqua regia sample (1.35% at 1g weights) confirms the high level of gold homogeneity in OREAS 61f. The homogeneity is of a level such that ***sampling error is negligible*** for a conventional fire assay or aqua regia determination.

Please note that these INAA derived RSD's and tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.

The gold homogeneity of OREAS 61f has also been evaluated in a **nested ANOVA** of the round robin program. Each of the twenty-four round robin laboratories received six samples per CRM and these samples were made up of paired samples from three different, non-adjacent sampling intervals. The purpose of the ANOVA evaluation is to test that no statistically significant difference exists in the variance between-units to that of the variance within-units. This allows an assessment of homogeneity across the entire prepared batch of OREAS 61f. The test was performed using the following parameters:

- Gold fire assay – 156 samples (26 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 126 samples (21 laboratories each providing analyses on 3 pairs of samples);
- Null Hypothesis, H_0: Between-unit variance is no greater than within-unit variance (reject H_0 if p-value < 0.05);
- Alternative Hypothesis, H_1: Between-unit variance is greater than within-unit variance.

P-values are a measure of probability where values less than 0.05 indicate a greater than 95% probability that the observed differences in within-unit and between-unit variances are real. The dataset was filtered for both individual and laboratory data set (batch) outliers prior to the calculation of the *p*-value. This process derived *p*-values of 0.71 for Au by fire assay and 0.72 for Au by aqua regia digestion. Both *p*-values are insignificant and support the Null Hypothesis. Nine of the other 106 certified values showed significant *p*-values (Ag, Gd, K, Ni, P and Sm by aqua regia digestion and Cu, Sr and Ti by four acid digestion) and these are interpreted as false positives ('statistically significant' *p*-values that are in fact meaningless). Usually data becomes more reliable and meaningful when the concentration levels are at least twenty times the lower level of detection (LLD) of the methods employed. The false positives are most likely due to i) acute differences in reading resolution where one or more laboratories report to a reduced number of significant figures resulting in an amplified effect on variance or ii) random statistical probability given the 5% significance level. As there is no other supporting evidence to suspect greater between-unit variance compared with within-unit variance the null hypothesis is retained.

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 61f 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 61f is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. Actlabs, Kamloops, BC, Canada
3. Alex Stewart International, Mendoza, Argentina
4. ALS, Brisbane, QLD, Australia
5. ALS, Loughrea, Galway, Ireland
6. ALS, Perth, WA, Australia
7. ALS, Townsville, QLD, Australia
8. ALS, Vancouver, BC, Canada
9. American Assay Laboratories, Sparks, Nevada, USA
10. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
11. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
12. Bureau Veritas Geoanalytical, Perth, WA, Australia
13. Gekko Assay Labs, Ballarat, VIC, Australia
14. Inspectorate (BV), Lima, Peru
15. Intertek Genalysis, Perth, WA, Australia
16. Intertek Tarkwa, Tarkwa, Ghana
17. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
18. MinAnalytical Services, Perth, WA, Australia

19. North Austalian Laboratories, Pine Creek, NT, Australia
20. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
21. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
22. PT SGS Indo Assay Laboratories, Jakarta, Indonesia
23. SGS Australia Mineral Services, Perth, WA, Australia
24. SGS del Peru, Lima, Peru
25. SGS Mineral Services, Townsville, QLD, Australia
26. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
27. Zarazma Mineral Studies Company, Tehran, Iran

PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

Reference material OREAS 61f has been prepared and certified by:

ORE Research & Exploration Pty Ltd	Tel:	+613-9729 0333
37A Hosie Street	Fax:	+613-9729 8338
Bayswater North VIC 3153	Web:	www.ore.com.au
AUSTRALIA	Email:	info@ore.com.au

It has been packaged in 60g units into laminated foil pouches and 500g units in plastic jars.

INTENDED USE

OREAS 61f is intended for the following uses:

- For the monitoring of laboratory performance in the analysis of analytes reported in Table 1 in geological samples;
- For the verification 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.

STABILITY AND STORAGE INSTRUCTIONS

OREAS 61f has been prepared from primary gold-silver ore samples from the Cracow mine blended with barren andesite. It is low in reactive sulphide (0.406% S) and in its unopened state and under normal conditions of storage 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 THE CORRECT USE

The certified values for OREAS 61f refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis.

HANDLING INSTRUCTIONS

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

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.

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.

Lloyd's Register LRQA

LLOYD'S REGISTER · LRQA ISO 9001 JAS-ANZ

CERTIFYING OFFICER

14th February, 2018

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

REFERENCES

Ingamells, C. O. and Switzer, P. (1973), Talanta 20, 547-568.

ISO Guide 30 (2015), Terms and definitions used in connection with reference materials.

ISO Guide 31 (2015), Reference materials – Contents of certificates and labels.

ISO Guide 3207 (1975), Statistical interpretation of data - Determination of a statistical tolerance interval.

ISO Guide 35 (2017), Certification of reference materials - General and statistical principals.