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CERTIFICATE OF ANALYSIS FOR

PORPHYRY COPPER-GOLD ORE
CERTIFIED REFERENCE MATERIAL
OREAS 152b

Table 1. Certified Values, SD's, 95% Confidence and Tolerance Limits for OREAS 152b.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fire Assay						
Au, Gold (ppb)	134	5	132	136	130*	139*
4-Acid Digestion						
Ag, Silver (ppm)	0.861	0.096	0.821	0.900	0.752	0.970
Al, Aluminium (wt.%)	8.02	0.331	7.86	8.18	7.80	8.23
As, Arsenic (ppm)	37.7	3.73	35.9	39.5	36.0	39.4
Ba, Barium (ppm)	101	2.7	100	102	98	104
Be, Beryllium (ppm)	0.52	0.05	0.49	0.55	IND	IND
Bi, Bismuth (ppm)	1.30	0.113	1.22	1.38	1.24	1.37
Ca, Calcium (wt.%)	1.97	0.080	1.93	2.01	1.92	2.02
Cd, Cadmium (ppm)	0.23	0.03	0.20	0.25	0.20	0.26
Ce, Cerium (ppm)	12.9	2.5	10.8	15.1	12.5	13.3
Co, Cobalt (ppm)	12.5	1.5	11.8	13.2	12.1	12.9
Cr, Chromium (ppm)	18.7	1.58	17.8	19.5	16.6	20.7
Cs, Cesium (ppm)	0.41	0.037	0.39	0.43	IND	IND
Cu, Copper (wt.%)	0.375	0.008	0.372	0.379	0.367	0.384
Dy, Dysprosium (ppm)	2.29	0.157	2.20	2.39	2.11	2.48
Er, Erbium (ppm)	1.29	0.127	1.14	1.45	1.18	1.41
Eu, Europium (ppm)	0.70	0.049	0.64	0.75	IND	IND
Fe, Iron (wt.%)	3.73	0.157	3.66	3.80	3.63	3.83
Ga, Gallium (ppm)	18.5	1.42	17.7	19.3	18.0	19.0
Gd, Gadolinium (ppm)	2.35	0.134	2.24	2.45	IND	IND
Hf, Hafnium (ppm)	< 0.5	IND	IND	IND	IND	IND

Note: intervals may appear asymmetric due to rounding; *determined from RSD of gold INAA data for 30g analytical subsample weight.

Table 1 continued.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
4-Acid Digestion continued						
Ho, Holmium (ppm)	0.47	0.07	0.38	0.55	0.43	0.50
In, Indium (ppm)	0.20	0.012	0.19	0.20	0.18	0.22
K, Potassium (wt.%)	1.06	0.057	1.03	1.08	1.03	1.08
La, Lanthanum (ppm)	5.75	0.96	5.12	6.38	5.54	5.96
Li, Lithium (ppm)	5.77	0.359	5.60	5.93	5.38	6.15
Lu, Lutetium (ppm)	0.16	0.02	0.14	0.18	IND	IND
Mg, Magnesium (wt.%)	1.69	0.079	1.66	1.72	1.65	1.73
Mn, Manganese (wt.%)	0.031	0.001	0.031	0.032	0.030	0.032
Mo, Molybdenum (ppm)	81	3.4	79	83	79	83
Na, Sodium (wt.%)	2.34	0.093	2.30	2.38	2.28	2.40
Nb, Niobium (ppm)	1.41	0.20	1.25	1.56	IND	IND
Nd, Neodymium (ppm)	8.44	0.711	7.55	9.33	8.07	8.81
Ni, Nickel (ppm)	11.3	1.5	10.7	11.8	10.7	11.8
P, Phosphorus (wt.%)	0.055	0.004	0.053	0.057	0.053	0.057
Pb, Lead (ppm)	11.7	1.4	11.2	12.3	11.3	12.2
Pr, Praseodymium (ppm)	1.95	0.135	1.82	2.08	1.87	2.03
Rb, Rubidium (ppm)	18.4	0.90	17.6	19.1	17.6	19.1
Re, Rhenium (ppm)	0.18	0.017	0.16	0.19	0.16	0.20
S, Sulphur (wt.%)	0.988	0.028	0.977	1.000	0.964	1.012
Sb, Antimony (ppm)	1.14	0.083	1.09	1.19	1.09	1.18
Sc, Scandium (ppm)	16.9	1.15	16.3	17.4	16.4	17.4
Se, Selenium (ppm)	5.93	0.80	5.26	6.61	IND	IND
Sm, Samarium (ppm)	2.16	0.23	1.88	2.43	1.89	2.42
Sn, Tin (ppm)	3.53	0.39	3.32	3.75	3.33	3.73
Sr, Strontium (ppm)	163	6.6	160	167	159	168
Ta, Tantalum (ppm)	< 0.5	IND	IND	IND	IND	IND
Tb, Terbium (ppm)	0.38	0.029	0.36	0.41	0.36	0.41
Te, Tellurium (ppm)	0.18	0.03	0.15	0.20	IND	IND
Th, Thorium (ppm)	0.49	0.07	0.45	0.53	0.46	0.52
Ti, Titanium (wt.%)	0.284	0.038	0.266	0.302	0.271	0.298
Tl, Thallium (ppm)	0.14	0.03	0.13	0.15	IND	IND
Tm, Thulium (ppm)	0.19	0.02	0.17	0.21	IND	IND
U, Uranium (ppm)	0.11	0.02	0.10	0.12	IND	IND
V, Vanadium (ppm)	216	10.6	212	220	209	222
W, Tungsten (ppm)	1.95	0.38	1.68	2.21	1.67	2.22
Y, Yttrium (ppm)	11.8	1.03	11.2	12.4	11.4	12.1
Yb, Ytterbium (ppm)	1.22	0.18	1.05	1.40	1.08	1.37
Zn, Zinc (ppm)	105	5.2	103	108	102	109
Aqua Regia Digestion						
Ag, Silver (ppm)	0.865	0.067	0.836	0.894	0.822	0.909
Al, Aluminium (wt.%)	2.42	0.103	2.37	2.47	2.34	2.50
As, Arsenic (ppm)	38.3	1.98	37.6	39.0	36.4	40.2

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						
Au, Gold (ppb)	133	9	130	137	128*	138*
B, Boron (ppm)	< 10	IND	IND	IND	IND	IND
Ba, Barium (ppm)	23.4	3.5	21.8	25.1	22.2	24.7
Be, Beryllium (ppm)	0.20	0.012	0.19	0.21	IND	IND
Bi, Bismuth (ppm)	1.48	0.22	1.31	1.66	1.42	1.55
Ca, Calcium (wt.%)	1.43	0.056	1.41	1.46	1.40	1.47
Cd, Cadmium (ppm)	0.24	0.04	0.21	0.27	0.23	0.25
Ce, Cerium (ppm)	10.1	1.1	9.2	11.1	9.9	10.4
Co, Cobalt (ppm)	11.7	0.80	11.4	12.0	11.2	12.2
Cr, Chromium (ppm)	16.3	1.08	15.8	16.8	15.7	16.9
Cs, Cesium (ppm)	0.24	0.04	0.20	0.27	0.22	0.26
Cu, Copper (wt.%)	0.377	0.008	0.374	0.380	0.369	0.384
Dy, Dysprosium (ppm)	2.03	0.32	1.61	2.45	1.91	2.14
Eu, Europium (ppm)	0.61	0.11	0.46	0.76	0.57	0.64
Fe, Iron (wt.%)	3.53	0.166	3.46	3.61	3.47	3.60
Ga, Gallium (ppm)	7.14	0.539	6.81	7.47	6.89	7.39
Hg, Mercury (ppm)	< 1	IND	IND	IND	IND	IND
In, Indium (ppm)	0.19	0.011	0.18	0.19	0.18	0.20
K, Potassium (wt.%)	0.320	0.030	0.306	0.334	0.309	0.330
La, Lanthanum (ppm)	4.10	0.303	3.94	4.25	3.93	4.27
Li, Lithium (ppm)	3.17	0.42	2.82	3.52	3.01	3.34
Lu, Lutetium (ppm)	0.10	0.02	0.09	0.12	IND	IND
Mg, Magnesium (wt.%)	1.51	0.062	1.49	1.54	1.48	1.54
Mn, Manganese (wt.%)	0.027	0.002	0.026	0.028	0.026	0.028
Mo, Molybdenum (ppm)	78	4.8	76	80	76	80
Na, Sodium (wt.%)	0.157	0.009	0.153	0.161	0.148	0.165
Nd, Neodymium (ppm)	6.94	0.489	6.34	7.55	6.63	7.26
Ni, Nickel (ppm)	10.2	0.77	9.9	10.5	9.9	10.6
P, Phosphorus (wt.%)	0.049	0.002	0.048	0.049	0.047	0.050
Pb, Lead (ppm)	11.4	0.75	11.1	11.7	10.8	12.0
Rb, Rubidium (ppm)	6.26	0.67	5.69	6.83	5.97	6.55
Re, Rhenium (ppm)	0.18	0.02	0.16	0.20	IND	IND
S, Sulphur (wt.%)	0.972	0.040	0.953	0.991	0.956	0.989
Sb, Antimony (ppm)	0.78	0.12	0.69	0.87	0.72	0.84
Sc, Scandium (ppm)	9.61	0.731	9.25	9.96	9.31	9.91
Se, Selenium (ppm)	5.78	0.557	5.48	6.08	5.31	6.25
Sm, Samarium (ppm)	1.87	0.124	1.76	1.98	1.75	1.98
Sn, Tin (ppm)	2.79	0.258	2.58	3.01	2.64	2.94
Sr, Strontium (ppm)	34.6	1.45	33.9	35.2	33.6	35.6
Tb, Terbium (ppm)	0.32	0.017	0.31	0.34	0.31	0.34
Te, Tellurium (ppm)	0.13	0.03	0.12	0.15	IND	IND
Th, Thorium (ppm)	0.34	0.04	0.32	0.37	0.32	0.37

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						
Ti, Titanium (wt.%)	0.044	0.008	0.040	0.048	0.042	0.045
Tl, Thallium (ppm)	0.056	0.006	0.052	0.060	IND	IND
Tm, Thulium (ppm)	0.13	0.012	0.12	0.14	0.12	0.14
U, Uranium (ppm)	0.055	0.006	0.052	0.059	IND	IND
V, Vanadium (ppm)	148	6.4	144	151	144	151
W, Tungsten (ppm)	< 0.7	IND	IND	IND	IND	IND
Y, Yttrium (ppm)	9.56	0.498	9.26	9.85	9.24	9.87
Yb, Ytterbium (ppm)	0.85	0.054	0.80	0.89	0.78	0.91
Zn, Zinc (ppm)	100	4.2	98	101	97	102
Zr, Zirconium (ppm)	0.90	0.17	0.72	1.08	IND	IND
Cyanide Leach#						
Cu-Sol, Copper Soluble (wt.%)	0.060	0.003	0.058	0.061	0.058	0.062

Note: intervals may appear asymmetric due to rounding; #Cyanide leach methodology is shown below in the 'Analytical Program' section.

INTRODUCTION

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

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

SOURCE MATERIALS

OREAS 152b is one of three (second generation) porphyry Cu-Au certified reference materials (CRMs). It has been prepared from copper ore drilling reject material from 27 drill holes from the Waisoi district, Viti Levu, Fiji, with the addition of a minor quantity of Cu concentrate (0.6%). The two deposits in the Waisoi district are the Waisoi East deposit (quartz porphyry) and the Waisoi West deposit (diorite porphyry). Copper mineralisation in the region is accompanied by stockwork quartz veinlets and is characterised by bornite-chalcopyrite-pyrite assemblages formed under a high sulphidation environment.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 152b was prepared in the following manner:

- drying to constant mass at 105°C;

- crushing and milling of the ore and concentrate material to 100% minus 30 microns;
- blending in appropriate proportions to achieve the desired grade;
- packaging in 60g units sealed in laminated foil pouches and 500g units in plastic jars.

ANALYTICAL PROGRAM

Twenty eight commercial analytical laboratories participated in the program to certify the 115 elements reported in Table 1. The following methods were employed:

- Gold by 25-40g fire assay with AAS (12 labs) or ICP-OES (9 labs) finish;
- Instrumental neutron activation analysis for Au on 1g subsamples to confirm homogeneity (1 laboratory).
- Gold by 15-40g aqua regia digestion with ICP-MS (11 labs), AAS (5 labs) or graphite furnace AAS (1 lab) finish;
- Aqua regia digestion for full elemental suite ICP-OES and ICP-MS (up to 21 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.
- 4-Acid digestion for full elemental suite ICP-OES and ICP-MS (up to 21 laboratories depending on the element);
- Copper soluble by cyanide leach with AAS finish (13 labs) employing the following specified methodology:
    - 0.5% NaCN solution is added to the sample and tumbled for 90 minutes at room temperature. The solution containing dissolved copper sulphide minerals is measured via AAS.

      Steps -
        - Weigh 0.3 g of sample into a 20 mL PS tube;
        - Dispense 12 mL of 0.5% NaCN solution into sample tube;
        - Place sample tube into tumbler and tumble/ agitate for 90 minutes;
        - Stand sample upright and allow to settle for 90 minutes;
        - Analyse sample by AAS.

For the round robin program twenty 1kg test units were taken at predetermined intervals during the bagging stage, immediately following final blending and are considered representative of the entire batch. The six samples received by each laboratory were obtained by taking two 110g scoop splits from each of three separate 1kg test units. This format enabled nested ANOVA treatment of the results to evaluate homogeneity, i.e. to ascertain whether between-unit variance is greater than within-unit variance. Table 1 presents the 115 certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 shows 86 indicative values. Table 3 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 152b Datapack.xlsx**).

STATISTICAL ANALYSIS

Certified Values, Confidence Limits, Standard Deviations and Tolerance Limits (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. 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. The INAA data is omitted from determination of the certified value for Au and is used solely for the calculation of Tolerance Limits and homogeneity evaluation of OREAS 152b.

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.

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

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 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.

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

Table 2. Indicative Values for OREAS 152b.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Fire Assay								
Pd	ppb	*20*	Pt	ppb	*13*			
Borate Fusion XRF								
Al_2O_3	wt.%	*15.94*	Fe_2O_3	wt.%	*5.47*	Pb	ppm	*< 10*
As	ppm	*50*	K_2O	wt.%	*1.32*	SiO_2	wt.%	*62.27*
Ba	ppm	*105*	MgO	wt.%	*2.96*	Sn	ppm	*< 10*
CaO	wt.%	*2.84*	MnO	wt.%	*0.050*	SO_3	wt.%	*2.45*
Co	ppm	*15.0*	Na_2O	wt.%	*3.24*	TiO_2	wt.%	*0.597*
Cr	ppm	*10.0*	Ni	ppm	*< 10*	U	ppm	*< 10*
Cu	ppm	*3730*	P_2O_5	wt.%	*0.132*	Zn	ppm	*105*

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
Thermogravimetry								
LOI^{1000}	wt.%	*3.60*						
Laser Ablation ICP-MS								
Ag	ppm	*0.750*	Ho	ppm	*0.66*	Sn	ppm	*5.20*
As	ppm	*38.6*	In	ppm	*0.15*	Sr	ppm	*160*
Ba	ppm	*99*	La	ppm	*6.46*	Ta	ppm	*0.13*
Be	ppm	*0.60*	Lu	ppm	*0.31*	Tb	ppm	*0.47*
Bi	ppm	*1.40*	Mn	wt.%	*0.033*	Te	ppm	*0.40*
Cd	ppm	*0.075*	Mo	ppm	*80*	Th	ppm	*0.68*
Ce	ppm	*12.9*	Nb	ppm	*1.81*	Ti	wt.%	*0.362*
Co	ppm	*13.3*	Nd	ppm	*8.46*	Tl	ppm	*< 0.2*
Cr	ppm	*24.0*	Ni	ppm	*13.0*	Tm	ppm	*0.25*
Cs	ppm	*0.36*	Pb	ppm	*11.5*	U	ppm	*0.33*
Cu	ppm	*3725*	Pr	ppm	*2.01*	V	ppm	*232*
Dy	ppm	*2.89*	Rb	ppm	*17.3*	W	ppm	*2.28*
Er	ppm	*1.97*	Re	ppm	*0.25*	Y	ppm	*17.3*
Eu	ppm	*0.74*	Sb	ppm	*1.30*	Yb	ppm	*1.80*
Ga	ppm	*17.9*	Sc	ppm	*15.8*	Zn	ppm	*98*
Gd	ppm	*2.79*	Se	ppm	*< 5*	Zr	ppm	*72*
Hf	ppm	*2.37*	Sm	ppm	*2.25*			
4-Acid Digestion								
Ge	ppm	*0.28*	Hg	ppm	*0.047*	Zr	ppm	*6.88*
Aqua Regia Digestion								
Er	ppm	*1.03*	Ho	ppm	*0.36*	Pr	ppm	*1.44*
Gd	ppm	*2.01*	Nb	ppm	*< 0.2*	Pt	ppb	*< 5*
Ge	ppm	*< 0.1*	Os	ppm	*< 1*	Ru	ppm	*0.010*
Hf	ppm	*< 0.05*	Pd	ppb	*7*	Ta	ppm	*< 0.05*

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.

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 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 0.367 and 0.384 wt.%. 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 1.0 gram was employed and the 1RSD of 5.69% (or 1.07% at a 30g charge weight) confirms the high level of gold homogeneity in OREAS 152b.

The homogeneity of OREAS 152b has also been evaluated in an ANOVA study for all certified analytes. This study tests the null hypothesis that no statistically significant difference exists between the *between-unit variance* and the *within-unit variance* (i.e. p-values <0.05 indicate rejection of the null hypothesis). Of the 115 certified values, no failures were observed indicating no evidence to reject the null hypothesis.

Based on the statistical analysis of the results of the inter-laboratory certification program it can be concluded that OREAS 152b is fit-for-purpose as a certified reference material (see 'Intended Use' below).

Table 3. Performance Gates for OREAS 152b.

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, ppb	134	5	123	145	118	151	4.07%	8.14%	12.22%	128	141
4-Acid Digestion											
Ag, ppm	0.861	0.096	0.669	1.053	0.573	1.148	11.13%	22.26%	33.39%	0.818	0.904
Al, wt.%	8.02	0.331	7.35	8.68	7.02	9.01	4.13%	8.27%	12.40%	7.62	8.42
As, ppm	37.7	3.73	30.3	45.2	26.5	48.9	9.88%	19.77%	29.65%	35.8	39.6
Ba, ppm	101	3	96	106	93	109	2.63%	5.26%	7.89%	96	106
Be, ppm	0.52	0.05	0.42	0.62	0.36	0.68	10.02%	20.04%	30.06%	0.49	0.55
Bi, ppm	1.30	0.113	1.08	1.53	0.96	1.64	8.71%	17.42%	26.12%	1.24	1.37
Ca, wt.%	1.97	0.080	1.81	2.13	1.73	2.21	4.09%	8.17%	12.26%	1.87	2.07
Cd, ppm	0.23	0.03	0.18	0.28	0.15	0.30	11.00%	22.00%	33.00%	0.22	0.24
Ce, ppm	12.9	2.5	7.9	17.9	5.4	20.5	19.37%	38.73%	58.10%	12.3	13.6
Co, ppm	12.5	1.5	9.5	15.6	7.9	17.1	12.21%	24.42%	36.64%	11.9	13.2
Cr, ppm	18.7	1.58	15.5	21.8	13.9	23.4	8.44%	16.88%	25.33%	17.7	19.6
Cs, ppm	0.41	0.037	0.34	0.48	0.30	0.52	9.01%	18.01%	27.02%	0.39	0.43
Cu, wt.%	0.375	0.008	0.359	0.392	0.350	0.400	2.22%	4.45%	6.67%	0.357	0.394
Dy, ppm	2.29	0.157	1.98	2.61	1.82	2.76	6.84%	13.68%	20.52%	2.18	2.41
Er, ppm	1.29	0.127	1.04	1.55	0.91	1.68	9.85%	19.70%	29.54%	1.23	1.36
Eu, ppm	0.70	0.049	0.60	0.80	0.55	0.84	6.99%	13.98%	20.97%	0.66	0.73
Fe, wt.%	3.73	0.157	3.42	4.04	3.26	4.20	4.22%	8.44%	12.66%	3.54	3.92
Ga, ppm	18.5	1.42	15.6	21.3	14.2	22.8	7.70%	15.40%	23.10%	17.6	19.4
Gd, ppm	2.35	0.134	2.08	2.61	1.94	2.75	5.71%	11.42%	17.13%	2.23	2.46
Hf, ppm	< 0.5	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Ho, ppm	0.47	0.07	0.33	0.60	0.27	0.67	14.36%	28.73%	43.09%	0.44	0.49
In, ppm	0.20	0.012	0.17	0.22	0.16	0.23	5.84%	11.68%	17.52%	0.19	0.21
K, wt.%	1.06	0.057	0.94	1.17	0.89	1.23	5.41%	10.82%	16.23%	1.00	1.11

Note: intervals may appear asymmetric due to rounding.

Table 3 continued.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
4-Acid Digestion continued											
La, ppm	5.75	0.96	3.83	7.67	2.88	8.62	16.65%	33.31%	49.96%	5.46	6.04
Li, ppm	5.77	0.359	5.05	6.48	4.69	6.84	6.22%	12.45%	18.67%	5.48	6.05
Lu, ppm	0.16	0.02	0.12	0.21	0.10	0.23	13.48%	26.96%	40.44%	0.15	0.17
Mg, wt.%	1.69	0.079	1.53	1.85	1.45	1.93	4.68%	9.36%	14.04%	1.61	1.78
Mn, wt.%	0.031	0.001	0.029	0.034	0.027	0.035	4.23%	8.47%	12.70%	0.030	0.033
Mo, ppm	81	3.4	74	88	71	91	4.14%	8.28%	12.42%	77	85
Na, wt.%	2.34	0.093	2.15	2.52	2.06	2.62	3.97%	7.94%	11.91%	2.22	2.46
Nb, ppm	1.41	0.20	1.01	1.80	0.82	1.99	13.94%	27.88%	41.82%	1.34	1.48
Nd, ppm	8.44	0.711	7.02	9.86	6.31	10.57	8.42%	16.84%	25.27%	8.02	8.86
Ni, ppm	11.3	1.5	8.2	14.3	6.7	15.8	13.58%	27.16%	40.74%	10.7	11.8
P, wt.%	0.055	0.004	0.048	0.062	0.044	0.066	6.46%	12.92%	19.38%	0.052	0.058
Pb, ppm	11.7	1.4	9.0	14.5	7.6	15.9	11.77%	23.54%	35.31%	11.2	12.3
Pr, ppm	1.95	0.135	1.68	2.22	1.55	2.36	6.93%	13.87%	20.80%	1.85	2.05
Rb, ppm	18.4	0.90	16.6	20.2	15.6	21.1	4.92%	9.85%	14.77%	17.4	19.3
Re, ppm	0.18	0.017	0.15	0.21	0.13	0.23	9.44%	18.88%	28.32%	0.17	0.19
S, wt.%	0.988	0.028	0.933	1.043	0.905	1.071	2.80%	5.59%	8.39%	0.939	1.038
Sb, ppm	1.14	0.083	0.97	1.30	0.89	1.39	7.31%	14.63%	21.94%	1.08	1.19
Sc, ppm	16.9	1.15	14.6	19.1	13.4	20.3	6.80%	13.60%	20.40%	16.0	17.7
Se, ppm	5.93	0.80	4.33	7.53	3.53	8.33	13.48%	26.96%	40.45%	5.64	6.23
Sm, ppm	2.16	0.23	1.71	2.61	1.48	2.83	10.45%	20.90%	31.35%	2.05	2.26
Sn, ppm	3.53	0.39	2.76	4.31	2.38	4.69	10.91%	21.83%	32.74%	3.36	3.71
Sr, ppm	163	7	150	177	144	183	4.05%	8.09%	12.14%	155	172
Ta, ppm	< 0.5	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Tb, ppm	0.38	0.029	0.33	0.44	0.30	0.47	7.52%	15.04%	22.56%	0.37	0.40
Te, ppm	0.18	0.03	0.11	0.24	0.08	0.27	17.99%	35.98%	53.98%	0.17	0.19
Th, ppm	0.49	0.07	0.34	0.64	0.27	0.71	15.07%	30.13%	45.20%	0.46	0.51
Ti, wt.%	0.284	0.038	0.208	0.360	0.170	0.399	13.39%	26.78%	40.17%	0.270	0.299
Tl, ppm	0.14	0.03	0.08	0.19	0.06	0.22	19.28%	38.57%	57.85%	0.13	0.14
Tm, ppm	0.19	0.02	0.15	0.23	0.13	0.25	10.03%	20.05%	30.08%	0.18	0.20
U, ppm	0.11	0.02	0.08	0.14	0.07	0.16	13.73%	27.45%	41.18%	0.11	0.12
V, ppm	216	11	195	237	184	248	4.90%	9.81%	14.71%	205	227
W, ppm	1.95	0.38	1.18	2.71	0.80	3.09	19.57%	39.14%	58.71%	1.85	2.04

Note: intervals may appear asymmetric due to rounding.

Table 3 continued.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
4-Acid Digestion continued											
Y, ppm	11.8	1.03	9.7	13.8	8.7	14.9	8.75%	17.51%	26.26%	11.2	12.4
Yb, ppm	1.22	0.18	0.86	1.58	0.68	1.76	14.69%	29.37%	44.06%	1.16	1.29
Zn, ppm	105	5	95	116	90	121	4.96%	9.91%	14.87%	100	111
Aqua Regia Digestion											
Ag, ppm	0.865	0.067	0.731	0.999	0.665	1.066	7.73%	15.46%	23.19%	0.822	0.909
Al, wt.%	2.42	0.103	2.21	2.63	2.11	2.73	4.27%	8.54%	12.82%	2.30	2.54
As, ppm	38.3	1.98	34.3	42.2	32.3	44.2	5.18%	10.35%	15.53%	36.4	40.2
Au, ppb	133	9	116	150	107	159	6.42%	12.83%	19.25%	126	140
B, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Ba, ppm	23.4	3.5	16.4	30.5	12.8	34.0	15.08%	30.16%	45.24%	22.3	24.6
Be, ppm	0.20	0.012	0.17	0.22	0.16	0.23	6.11%	12.23%	18.34%	0.19	0.21
Bi, ppm	1.48	0.22	1.04	1.93	0.82	2.15	14.93%	29.86%	44.79%	1.41	1.56
Ca, wt.%	1.43	0.056	1.32	1.54	1.26	1.60	3.92%	7.84%	11.76%	1.36	1.50
Cd, ppm	0.24	0.04	0.15	0.33	0.11	0.37	17.94%	35.89%	53.83%	0.23	0.25
Ce, ppm	10.1	1.1	7.9	12.3	6.8	13.4	10.83%	21.65%	32.48%	9.6	10.6
Co, ppm	11.7	0.80	10.1	13.3	9.3	14.1	6.83%	13.66%	20.49%	11.1	12.3
Cr, ppm	16.3	1.08	14.1	18.5	13.1	19.6	6.63%	13.26%	19.90%	15.5	17.1
Cs, ppm	0.24	0.04	0.16	0.31	0.12	0.35	16.41%	32.83%	49.24%	0.22	0.25
Cu, wt.%	0.377	0.008	0.361	0.393	0.353	0.401	2.09%	4.18%	6.28%	0.358	0.396
Dy, ppm	2.03	0.32	1.38	2.67	1.05	3.00	16.01%	32.03%	48.04%	1.92	2.13
Eu, ppm	0.61	0.11	0.38	0.84	0.27	0.95	18.79%	37.57%	56.36%	0.58	0.64
Fe, wt.%	3.53	0.166	3.20	3.87	3.04	4.03	4.70%	9.40%	14.10%	3.36	3.71
Ga, ppm	7.14	0.539	6.06	8.22	5.52	8.76	7.55%	15.09%	22.64%	6.78	7.50
Hg, ppm	< 1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
In, ppm	0.19	0.011	0.17	0.21	0.15	0.22	6.07%	12.15%	18.22%	0.18	0.20
K, wt.%	0.320	0.030	0.259	0.380	0.229	0.411	9.48%	18.95%	28.43%	0.304	0.336
La, ppm	4.10	0.303	3.49	4.70	3.19	5.00	7.39%	14.78%	22.16%	3.89	4.30
Li, ppm	3.17	0.42	2.33	4.01	1.92	4.43	13.20%	26.41%	39.61%	3.01	3.33
Lu, ppm	0.10	0.02	0.07	0.14	0.05	0.16	17.80%	35.61%	53.41%	0.10	0.11
Mg, wt.%	1.51	0.062	1.39	1.64	1.33	1.70	4.12%	8.23%	12.35%	1.44	1.59
Mn, wt.%	0.027	0.002	0.024	0.030	0.022	0.032	5.64%	11.29%	16.93%	0.026	0.028
Mo, ppm	78	4.8	68	88	64	93	6.20%	12.41%	18.61%	74	82

Note: intervals may appear asymmetric due to rounding.

Table 3 continued.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
Aqua Regia Digestion											
Na, wt.%	0.157	0.009	0.139	0.175	0.130	0.184	5.80%	11.60%	17.39%	0.149	0.165
Nd, ppm	6.94	0.489	5.97	7.92	5.48	8.41	7.04%	14.08%	21.12%	6.60	7.29
Ni, ppm	10.2	0.77	8.7	11.8	7.9	12.5	7.51%	15.02%	22.52%	9.7	10.7
P, wt.%	0.049	0.002	0.045	0.052	0.044	0.054	3.40%	6.81%	10.21%	0.046	0.051
Pb, ppm	11.4	0.75	9.9	12.9	9.2	13.7	6.57%	13.15%	19.72%	10.8	12.0
Rb, ppm	6.26	0.67	4.91	7.61	4.24	8.29	10.76%	21.53%	32.29%	5.95	6.58
Re, ppm	0.18	0.02	0.14	0.22	0.13	0.24	10.00%	20.01%	30.01%	0.17	0.19
S, wt.%	0.972	0.040	0.892	1.053	0.852	1.093	4.13%	8.26%	12.40%	0.924	1.021
Sb, ppm	0.78	0.12	0.53	1.03	0.41	1.15	15.95%	31.90%	47.85%	0.74	0.82
Sc, ppm	9.61	0.731	8.14	11.07	7.41	11.80	7.61%	15.23%	22.84%	9.13	10.09
Se, ppm	5.78	0.557	4.67	6.89	4.11	7.45	9.63%	19.27%	28.90%	5.49	6.07
Sm, ppm	1.87	0.124	1.62	2.12	1.50	2.24	6.62%	13.24%	19.87%	1.78	1.96
Sn, ppm	2.79	0.258	2.28	3.31	2.02	3.57	9.23%	18.46%	27.69%	2.65	2.93
Sr, ppm	34.6	1.45	31.7	37.5	30.2	38.9	4.18%	8.36%	12.54%	32.9	36.3
Tb, ppm	0.32	0.017	0.29	0.36	0.27	0.37	5.29%	10.57%	15.86%	0.31	0.34
Te, ppm	0.13	0.03	0.08	0.19	0.05	0.22	20.00%	40.01%	60.01%	0.13	0.14
Th, ppm	0.34	0.04	0.27	0.42	0.23	0.46	11.18%	22.35%	33.53%	0.33	0.36
Ti, wt.%	0.044	0.008	0.027	0.061	0.018	0.069	19.36%	38.71%	58.07%	0.041	0.046
Tl, ppm	0.056	0.006	0.045	0.068	0.039	0.074	10.49%	20.99%	31.48%	0.054	0.059
Tm, ppm	0.13	0.012	0.11	0.15	0.09	0.16	8.96%	17.92%	26.88%	0.12	0.14
U, ppm	0.055	0.006	0.044	0.067	0.039	0.072	10.09%	20.18%	30.27%	0.053	0.058
V, ppm	148	6	135	160	128	167	4.34%	8.69%	13.03%	140	155
W, ppm	< 0.7	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Y, ppm	9.56	0.498	8.56	10.55	8.06	11.05	5.21%	10.42%	15.63%	9.08	10.04
Yb, ppm	0.85	0.054	0.74	0.96	0.68	1.01	6.44%	12.87%	19.31%	0.80	0.89
Zn, ppm	100	4.2	91	108	87	112	4.22%	8.44%	12.65%	95	105
Zr, ppm	0.90	0.17	0.57	1.24	0.41	1.40	18.39%	36.77%	55.16%	0.86	0.95
Cyanide Leach#											
Cu-Sol, wt.%	0.060	0.003	0.053	0.066	0.050	0.069	5.49%	10.97%	16.46%	0.057	0.063

Note: intervals may appear asymmetric due to rounding; #Cyanide leach methodology is described in the 'Analytical Program' section above.

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PREPARER AND SUPPLIER

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It is available in unit sizes of 60g (single-use laminated foil sachet) and 500g (plastic jar).

INTENDED USE

OREAS 152b 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 152b has been prepared from porphyry copper ore and is low in reactive sulphide (0.99% S). In its unopened state and under normal conditions of storage it has a shelf life beyond ten years. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

INSTRUCTIONS FOR CORRECT USE

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CERTIFYING OFFICER

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