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OREAS
Certified Reference Materials

CERTIFICATE OF ANALYSIS FOR

PORPHYRY COPPER-GOLD-MOLYBDENUM REFERENCE MATERIAL

OREAS 504b

Summary Statistics for Key Analytes

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fire Assay						
Au, Gold (ppm)	1.61	0.04	1.59	1.62	*1.54	*1.67
4-Acid Digestion						
Ag, Silver (ppm)	3.07	0.22	2.97	3.16	2.95	3.19
Cu, Copper (wt.%)	1.11	0.042	1.09	1.12	1.08	1.13
Mo, Molybdenum (ppm)	499	22.9	488	509	485	513

Note: intervals may appear asymmetric due to rounding; *Tolerance Limits are calculated for a 30g sample weight from 20 x INAA analyses on 1g subsamples using the reduced analytical subsample method which utilises the known relationship between SD and sample weight (Ingamells and Switzer, 1973).

Table 1. Fire Assay - Certified Values, SDs, 95% Confidence & Tolerance Limits for OREAS 504b.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Au, Gold (ppm)	1.61	0.04	1.59	1.62	*1.54	*1.67

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

Table 2. 4-Acid Digest - Certified Values, SDs, 95% Confidence & Tolerance Limits for OREAS 504b.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Ag, Silver (ppm)	3.07	0.22	2.97	3.16	2.95	3.19
Al, Aluminium (wt.%)	6.91	0.244	6.80	7.01	6.71	7.11
As, Arsenic (ppm)	10.3	1.7	9.6	10.9	9.7	10.9
Ba, Barium (ppm)	711	48.8	692	731	682	741
Be, Beryllium (ppm)	1.57	0.109	1.52	1.62	1.40	1.73
Bi, Bismuth (ppm)	4.92	0.374	4.71	5.13	4.74	5.10
Ca, Calcium (wt.%)	2.74	0.084	2.70	2.77	2.67	2.80
Ce, Cerium (ppm)	38.6	2.60	37.3	39.9	36.9	40.3
Co, Cobalt (ppm)	20.9	1.62	20.3	21.5	19.8	22.0
Cr, Chromium (ppm)	70	7	67	74	68	73
Cs, Cesium (ppm)	5.03	0.254	4.92	5.15	4.80	5.27
Cu, Copper (wt.%)	1.11	0.042	1.09	1.12	1.08	1.13
Dy, Dysprosium (ppm)	3.29	0.264	3.01	3.57	3.13	3.44
Er, Erbium (ppm)	1.82	0.129	1.68	1.95	1.70	1.93
Eu, Europium (ppm)	0.95	0.086	0.86	1.04	0.85	1.05
Fe, Iron (wt.%)	7.33	0.338	7.19	7.48	7.16	7.51
Ga, Gallium (ppm)	16.7	0.94	16.2	17.1	15.6	17.7
Gd, Gadolinium (ppm)	3.46	0.235	3.24	3.69	3.26	3.67
Hf, Hafnium (ppm)	1.82	0.140	1.75	1.89	1.69	1.95
Ho, Holmium (ppm)	0.65	0.047	0.60	0.70	0.61	0.69
In, Indium (ppm)	0.73	0.062	0.70	0.76	0.69	0.76
K, Potassium (wt.%)	2.93	0.166	2.86	3.00	2.85	3.01
La, Lanthanum (ppm)	19.6	0.91	19.1	20.0	18.8	20.3
Li, Lithium (ppm)	23.3	1.63	22.6	24.1	22.3	24.4
Lu, Lutetium (ppm)	0.28	0.03	0.26	0.31	0.26	0.31
Mg, Magnesium (wt.%)	1.66	0.067	1.63	1.69	1.62	1.70
Mn, Manganese (ppm)	540	26.7	530	551	527	553
Mo, Molybdenum (ppm)	499	22.9	488	509	485	513
Na, Sodium (wt.%)	2.02	0.099	1.98	2.07	1.96	2.09
Nb, Niobium (ppm)	10.0	1.0	9.6	10.5	9.4	10.6
Nd, Neodymium (ppm)	17.7	1.35	16.2	19.1	17.0	18.3
Ni, Nickel (ppm)	34.5	2.74	33.5	35.5	32.7	36.3
P, Phosphorus (wt.%)	0.096	0.004	0.095	0.098	0.093	0.099
Pb, Lead (ppm)	26.2	2.58	25.1	27.3	25.1	27.3
Pr, Praseodymium (ppm)	4.55	0.295	4.16	4.94	4.42	4.68
Rb, Rubidium (ppm)	106	6.0	103	109	101	110
Re, Rhenium (ppm)	0.010	0.001	0.009	0.011	IND	IND
S, Sulphur (wt.%)	1.31	0.061	1.28	1.34	1.27	1.35

Note: intervals may appear asymmetric due to rounding.

Table 2. 4-Acid Digest continued.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Sb, Antimony (ppm)	1.19	0.118	1.13	1.26	1.13	1.25
Sc, Scandium (ppm)	14.5	0.62	14.3	14.8	13.9	15.1
Se, Selenium (ppm)	12.4	1.3	11.6	13.1	11.5	13.2
Sm, Samarium (ppm)	3.61	0.258	3.34	3.87	3.30	3.91
Sn, Tin (ppm)	11.4	0.72	11.0	11.7	10.8	12.0
Sr, Strontium (ppm)	423	17.7	415	430	411	434
Ta, Tantalum (ppm)	0.68	0.10	0.62	0.73	0.63	0.72
Tb, Terbium (ppm)	0.54	0.033	0.52	0.57	0.51	0.57
Te, Tellurium (ppm)	0.38	0.06	0.35	0.41	0.34	0.42
Th, Thorium (ppm)	8.27	0.387	8.11	8.42	7.93	8.61
Ti, Titanium (wt.%)	0.364	0.017	0.357	0.371	0.355	0.373
Tl, Thallium (ppm)	0.49	0.023	0.47	0.50	0.46	0.52
Tm, Thulium (ppm)	0.26	0.025	0.24	0.29	0.24	0.29
U, Uranium (ppm)	2.33	0.141	2.26	2.39	2.21	2.44
V, Vanadium (ppm)	149	8.6	145	153	145	153
W, Tungsten (ppm)	3.13	0.32	2.98	3.29	2.98	3.29
Y, Yttrium (ppm)	17.7	1.19	17.2	18.3	17.2	18.3
Yb, Ytterbium (ppm)	1.82	0.060	1.77	1.87	1.72	1.92
Zn, Zinc (ppm)	108	5.8	105	111	104	113
Zr, Zirconium (ppm)	60	6	57	63	56	64

Note: intervals may appear asymmetric due to rounding.

Table 3. Aqua Regia Digest - Certified Values, SDs, 95% Confidence & Tolerance Limits for OREAS 504b.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Ag, Silver (ppm)	2.98	0.21	2.89	3.08	2.88	3.09
Al, Aluminium (wt.%)	1.93	0.098	1.89	1.98	1.87	2.00
As, Arsenic (ppm)	9.86	0.910	9.55	10.17	9.55	10.17
Au, Gold (ppm)	1.56	0.06	1.53	1.60	1.52	1.61
Ba, Barium (ppm)	166	16.2	158	173	159	173
Be, Beryllium (ppm)	0.49	0.07	0.44	0.54	0.46	0.52
Bi, Bismuth (ppm)	5.13	0.283	4.97	5.28	4.98	5.28
Ca, Calcium (wt.%)	1.64	0.116	1.58	1.69	1.59	1.68
Ce, Cerium (ppm)	32.6	2.36	31.2	33.9	31.7	33.5
Co, Cobalt (ppm)	18.7	1.43	18.1	19.4	18.2	19.3
Cr, Chromium (ppm)	67	3.4	65	68	65	69
Cs, Cesium (ppm)	4.04	0.336	3.85	4.23	3.92	4.16
Cu, Copper (wt.%)	1.10	0.022	1.09	1.11	1.08	1.12
Fe, Iron (wt.%)	6.71	0.444	6.51	6.91	6.56	6.86
Ga, Gallium (ppm)	9.36	0.548	9.08	9.64	8.94	9.77
Ge, Germanium (ppm)	0.21	0.03	0.18	0.24	0.19	0.23
Hf, Hafnium (ppm)	0.50	0.06	0.46	0.53	0.47	0.52
In, Indium (ppm)	0.69	0.054	0.66	0.72	0.66	0.72
K, Potassium (wt.%)	0.550	0.037	0.533	0.568	0.535	0.566
La, Lanthanum (ppm)	16.1	1.37	15.5	16.7	15.7	16.5

Note: intervals may appear asymmetric due to rounding.

Table 3. Aqua Regia Digest continued.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Li, Lithium (ppm)	21.7	1.69	20.9	22.6	21.1	22.4
Lu, Lutetium (ppm)	0.18	0.02	0.16	0.19	0.17	0.19
Mg, Magnesium (wt.%)	1.30	0.061	1.27	1.32	1.27	1.33
Mn, Manganese (ppm)	406	23.0	396	415	396	415
Mo, Molybdenum (ppm)	476	19.4	467	485	467	484
Na, Sodium (wt.%)	0.183	0.025	0.172	0.195	0.168	0.199
Nb, Niobium (ppm)	0.81	0.15	0.72	0.91	0.68	0.94
Nd, Neodymium (ppm)	15.2	0.52	14.6	15.7	14.2	16.1
Ni, Nickel (ppm)	30.0	2.19	29.1	31.0	29.0	31.1
P, Phosphorus (wt.%)	0.092	0.007	0.089	0.095	0.089	0.095
Pb, Lead (ppm)	20.1	0.92	19.8	20.5	19.4	20.9
Rb, Rubidium (ppm)	51	2.8	50	53	49	53
Re, Rhenium (ppm)	0.010	0.001	0.009	0.010	IND	IND
S, Sulphur (wt.%)	1.31	0.088	1.27	1.35	1.28	1.34
Sb, Antimony (ppm)	0.71	0.09	0.65	0.77	0.68	0.74
Sc, Scandium (ppm)	7.88	1.16	7.36	8.39	7.56	8.19
Se, Selenium (ppm)	11.6	1.00	11.1	12.0	11.2	11.9
Sn, Tin (ppm)	10.4	0.79	10.0	10.8	10.0	10.8
Sr, Strontium (ppm)	110	8.3	106	115	106	115
Tb, Terbium (ppm)	0.41	0.026	0.38	0.43	0.39	0.42
Te, Tellurium (ppm)	0.38	0.04	0.36	0.40	0.35	0.40
Th, Thorium (ppm)	7.79	0.439	7.55	8.03	7.50	8.09
Ti, Titanium (wt.%)	0.220	0.023	0.210	0.230	0.213	0.228
Tl, Thallium (ppm)	0.29	0.015	0.28	0.30	0.28	0.30
U, Uranium (ppm)	2.00	0.145	1.92	2.08	1.83	2.17
V, Vanadium (ppm)	128	8.2	124	131	124	131
W, Tungsten (ppm)	1.64	0.25	1.50	1.78	1.58	1.70
Y, Yttrium (ppm)	12.2	0.80	11.8	12.6	11.9	12.6
Yb, Ytterbium (ppm)	1.20	0.089	1.12	1.28	1.14	1.26
Zn, Zinc (ppm)	96	5.2	94	99	94	99
Zr, Zirconium (ppm)	14.2	1.7	13.4	15.1	13.8	14.7

Note: intervals may appear asymmetric due to rounding.

Table 4. Indicative Values for OREAS 504b.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Fire Assay								
Pd	ppb	*26*	Pt	ppb	*8*			
Borate Fusion XRF								
Al_2O_3	wt.%	*14.99*	Fe_2O_3	wt.%	*6.61*	Pb	ppm	*30.0*
As	ppm	*20.0*	K_2O	wt.%	*3.80*	SiO_2	wt.%	*62.16*
Ba	ppm	*1000*	MgO	wt.%	*2.57*	Sn	ppm	*20.0*
CaO	wt.%	*3.91*	MnO	wt.%	*0.080*	SO_3	wt.%	*0.888*
Co	ppm	*25.0*	Na_2O	wt.%	*2.83*	TiO_2	wt.%	*0.805*
Cr	ppm	*100*	Ni	ppm	*50*	U	ppm	*20.0*
Cu	ppm	*2555*	P_2O_5	wt.%	*0.243*	Zn	ppm	*95*

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 4. Indicative Values continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Thermogravimetry								
LOI^{1000}	wt.%	*1.11*						
Laser Ablation ICP-MS								
Ag	ppm	*0.750*	Ho	ppm	*0.91*	Sn	ppm	*7.40*
As	ppm	*19.7*	In	ppm	*0.25*	Sr	ppm	*347*
Ba	ppm	*1045*	La	ppm	*38.7*	Ta	ppm	*1.46*
Be	ppm	*2.60*	Lu	ppm	*0.44*	Tb	ppm	*0.82*
Bi	ppm	*1.51*	Mn	wt.%	*0.058*	Te	ppm	*0.25*
Cd	ppm	*0.25*	Mo	ppm	*99*	Th	ppm	*19.0*
Ce	ppm	*69*	Nb	ppm	*18.1*	Ti	wt.%	*0.503*
Co	ppm	*17.3*	Nd	ppm	*30.7*	Tl	ppm	*0.90*
Cr	ppm	*114*	Ni	ppm	*45.0*	Tm	ppm	*0.38*
Cs	ppm	*12.0*	Pb	ppm	*22.0*	U	ppm	*5.25*
Cu	ppm	*2675*	Pr	ppm	*8.51*	V	ppm	*132*
Dy	ppm	*4.67*	Rb	ppm	*201*	W	ppm	*3.65*
Er	ppm	*2.84*	Re	ppm	*< 0.01*	Y	ppm	*27.6*
Eu	ppm	*1.59*	Sb	ppm	*0.90*	Yb	ppm	*2.67*
Ga	ppm	*19.3*	Sc	ppm	*14.7*	Zn	ppm	*80*
Gd	ppm	*5.41*	Se	ppm	*< 5*	Zr	ppm	*252*
Hf	ppm	*7.41*	Sm	ppm	*6.44*			
4-Acid Digestion								
B	ppm	*23.3*	Ge	ppm	*0.20*	Si	wt.%	*27.20*
Cd	ppm	*0.41*	Hg	ppm	*< 1*			
Aqua Regia Digestion								
B	ppm	*35.1*	Gd	ppm	*2.69*	Pt	ppb	*< 5*
Cd	ppm	*0.35*	Hg	ppm	*0.052*	Si	wt.%	*0.038*
Dy	ppm	*2.38*	Ho	ppm	*0.49*	Sm	ppm	*3.03*
Er	ppm	*1.31*	Pd	ppb	*23*	Ta	ppm	*0.96*
Eu	ppm	*0.49*	Pr	ppm	*3.90*	Tm	ppm	*0.20*

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.

SOURCE MATERIALS

OREAS 504b was prepared from porphyry copper-gold ore and waste samples from a mine deposit located in central western New South Wales, Australia with the addition of a minor quantity of Cu-Mo concentrate.

Mineralisation in the region is hosted by a sequence of late Ordovician to Early Silurian volcanics, intrusives and sediments that occur within the Bogan Gate Synclinorial Zone of the Lachlan Fold Belt. The western portion of this zone is dominated by volcanics and host to the Late Ordovician Goonumbla porphyry copper-gold deposits. These volcanics are interpreted to have erupted from shallow water to partly emergent volcanic centres and show a broad range in composition from shoshonite through to latite to trachyte. Coeval sub-volcanic quartz monzonite porphyries (and attendant mineralisation) have intruded the volcanics. They are generally small, sub-vertical, pipe-like intrusives. Typically the mineralised porphyries contain plagioclase and quartz phenocrysts in a matrix of fine-grained potassium feldspar and quartz with minor biotite and hornblende.

Copper-gold mineralisation occurs as stockwork quartz veins and disseminations associated with potassic alteration. This alteration is intimately associated spatially and temporally with the small finger-like quartz monzonite porphyries that intrude the Goonumbla Volcanics. Sulphides are zoned laterally from the centres of mineralisation. The central portions are bornite-rich with minor chalcopyrite, zoning outward through equal concentrations of bornite and chalcopyrite, to an outermost chalcopyrite-rich zone. Pyrite increases outward at the expense of bornite.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 504b was prepared in the following manner:

- jaw crushing to minus 3mm;
- drying to constant mass at 105°C;
- multi-stage milling of ore to 100% minus 30 microns;
- milling of waste material to 98% minus 75 microns;
- combining in appropriate proportions to achieve target grades;
- homogenisation and bagging into 125kg sublots;
- packaging into 10 and 60g units in laminated foil pouches and 1kg units in plastic jars.

ANALYTICAL PROGRAM

Twenty seven commercial analytical laboratories participated in the program to characterise the elements reported in Tables 1 to 4. The following methods were employed:

- Gold via 25-40g fire assay with AAS (20 labs) or ICP-OES (5 labs) finish;
- Gold via 15-50g aqua regia digestion with ICP-MS (8 labs), AAS (3 labs) or solvent extraction AAS finish (1 lab);
- Four acid digestion for full elemental suite ICP-OES and ICP-MS (25 laboratories);
- Aqua regia digestion for full elemental suite ICP-OES and ICP-MS (23 laboratories);
- Instrumental neutron activation analysis for Au on 1g subsamples to confirm homogeneity (1 laboratory).

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. Tables 1-3 present the certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 4 shows 94 indicative values for 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 5) and by a nested ANOVA program for both fire assay and aqua regia digestion (see '**nested ANOVA**' section). Tables 6-8 provide 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 504b DataPack.xlsx**).

STATISTICAL ANALYSIS

Certified Values, Confidence Limits, Standard Deviations and Tolerance Limits (Tables 1 to 3) 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 NAA data (see Table 5) 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 504b.

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

Indicative (uncertified) values (Table 4) 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.

Tables 6-8 show **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.

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 1.08 and 1.13 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 (IS0 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 1.30% (calculated for a typical 30g charge weight) confirms the high level of gold homogeneity in OREAS 504b. The homogeneity is of a level such that ***sampling error is minor*** for a conventional fire assay or aqua regia determination.

Please note that these 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 504b has also been evaluated in a **nested ANOVA** of the round robin program. Each of the twenty-seven 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 504b. The test was performed using the following parameters:

- Gold fire assay – 150 samples (25 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 66 samples (11 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 1.00 for Au by fire assay and 0.94 for Au by aqua regia digestion. Both *p*-values are insignificant and the Null Hypothesis is retained. Additionally, none of the other 108 certified values showed significant *p*-values.

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 504b 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 504b is fit-for-purpose as a certified reference material (see 'Intended Use' below).

Table 5. Neutron Activation Analysis of Au (ppm) on 20 x 1g subsamples.

Replicate No	Au ppm
1	1.43
2	1.48
3	1.39
4	1.44
5	1.59
6	1.34
7	1.40
8	1.56
9	1.67
10	1.42
11	1.47
12	1.44
13	1.49
14	1.44
15	1.44
16	1.62
17	1.36
18	1.47
19	1.55
20	1.74
Mean	1.49
Median	1.46
Std Dev.	0.104
Rel.Std.Dev.	7.02%
PDM[3]	-7.43%

Table 6. Fire Assay - Performance Gates for OREAS 504b.

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
Au, ppm	1.61	0.04	1.53	1.68	1.50	1.72	2.30%	4.59%	6.89%	1.53	1.69

Note: intervals may appear asymmetric due to rounding.

Table 7. 4-Acid Digestion - Performance Gates for OREAS 504b.

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
Ag, ppm	3.07	0.22	2.62	3.52	2.39	3.74	7.32%	14.64%	21.96%	2.92	3.22
Al, wt.%	6.91	0.244	6.42	7.39	6.17	7.64	3.53%	7.07%	10.60%	6.56	7.25
As, ppm	10.3	1.7	6.8	13.7	5.1	15.5	16.80%	33.60%	50.40%	9.8	10.8
Ba, ppm	711	49	614	809	565	858	6.86%	13.71%	20.57%	676	747
Be, ppm	1.57	0.109	1.35	1.78	1.24	1.89	6.94%	13.88%	20.83%	1.49	1.65
Bi, ppm	4.92	0.374	4.17	5.67	3.80	6.04	7.60%	15.20%	22.80%	4.67	5.16
Ca, wt.%	2.74	0.084	2.57	2.90	2.48	2.99	3.09%	6.17%	9.26%	2.60	2.87
Ce, ppm	38.6	2.60	33.4	43.8	30.8	46.4	6.74%	13.48%	20.22%	36.7	40.5
Co, ppm	20.9	1.62	17.6	24.1	16.0	25.8	7.78%	15.56%	23.33%	19.8	21.9
Cr, ppm	70	7	56	85	48	92	10.38%	20.76%	31.14%	67	74
Cs, ppm	5.03	0.254	4.53	5.54	4.27	5.80	5.05%	10.11%	15.16%	4.78	5.29
Cu, wt.%	1.11	0.042	1.02	1.19	0.98	1.23	3.83%	7.65%	11.48%	1.05	1.16
Dy, ppm	3.29	0.264	2.76	3.82	2.50	4.08	8.02%	16.03%	24.05%	3.12	3.45
Er, ppm	1.82	0.129	1.56	2.08	1.43	2.21	7.10%	14.21%	21.31%	1.73	1.91
Eu, ppm	0.95	0.086	0.78	1.12	0.69	1.21	9.03%	18.06%	27.09%	0.90	1.00
Fe, wt.%	7.33	0.338	6.66	8.01	6.32	8.35	4.61%	9.22%	13.82%	6.97	7.70
Ga, ppm	16.7	0.94	14.8	18.5	13.8	19.5	5.67%	11.34%	17.01%	15.8	17.5
Gd, ppm	3.46	0.235	2.99	3.93	2.76	4.17	6.77%	13.55%	20.32%	3.29	3.64
Hf, ppm	1.82	0.140	1.54	2.10	1.40	2.24	7.72%	15.44%	23.16%	1.73	1.91
Ho, ppm	0.65	0.047	0.55	0.74	0.51	0.79	7.21%	14.42%	21.63%	0.61	0.68
In, ppm	0.73	0.062	0.60	0.85	0.54	0.92	8.56%	17.13%	25.69%	0.69	0.76
K, wt.%	2.93	0.166	2.60	3.26	2.43	3.43	5.67%	11.33%	17.00%	2.78	3.08
La, ppm	19.6	0.91	17.7	21.4	16.8	22.3	4.65%	9.29%	13.94%	18.6	20.5
Li, ppm	23.3	1.63	20.1	26.6	18.4	28.2	6.99%	13.98%	20.97%	22.2	24.5
Lu, ppm	0.28	0.03	0.21	0.35	0.18	0.38	12.06%	24.12%	36.18%	0.27	0.30
Mg, wt.%	1.66	0.067	1.53	1.80	1.46	1.86	4.06%	8.13%	12.19%	1.58	1.74
Mn, ppm	540	27	487	594	460	620	4.95%	9.90%	14.85%	513	567

Note: intervals may appear asymmetric due to rounding.

Table 7. 4-Acid Digestion 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
Mo, ppm	499	23	453	544	430	567	4.59%	9.19%	13.78%	474	523
Na, wt.%	2.02	0.099	1.82	2.22	1.73	2.32	4.91%	9.82%	14.73%	1.92	2.12
Nb, ppm	10.0	1.0	8.0	12.1	7.0	13.1	10.10%	20.19%	30.29%	9.5	10.5
Nd, ppm	17.7	1.35	15.0	20.4	13.6	21.7	7.63%	15.25%	22.88%	16.8	18.6
Ni, ppm	34.5	2.74	29.0	40.0	26.3	42.7	7.93%	15.87%	23.80%	32.8	36.2
P, wt.%	0.096	0.004	0.089	0.103	0.085	0.107	3.75%	7.50%	11.25%	0.091	0.101
Pb, ppm	26.2	2.58	21.0	31.4	18.5	34.0	9.86%	19.71%	29.57%	24.9	27.5
Pr, ppm	4.55	0.295	3.96	5.14	3.67	5.43	6.48%	12.95%	19.43%	4.32	4.78
Rb, ppm	106	6	94	118	88	124	5.71%	11.42%	17.14%	101	111
Re, ppm	0.010	0.001	0.007	0.013	0.006	0.014	12.66%	25.32%	37.98%	0.009	0.010
S, wt.%	1.31	0.061	1.19	1.43	1.13	1.49	4.65%	9.30%	13.95%	1.24	1.37
Sb, ppm	1.19	0.118	0.96	1.43	0.84	1.55	9.91%	19.83%	29.74%	1.13	1.25
Sc, ppm	14.5	0.62	13.3	15.8	12.6	16.4	4.28%	8.55%	12.83%	13.8	15.2
Se, ppm	12.4	1.3	9.7	15.0	8.4	16.3	10.62%	21.24%	31.87%	11.8	13.0
Sm, ppm	3.61	0.258	3.09	4.12	2.83	4.38	7.15%	14.30%	21.45%	3.43	3.79
Sn, ppm	11.4	0.72	9.9	12.8	9.2	13.5	6.33%	12.65%	18.98%	10.8	11.9
Sr, ppm	423	18	387	458	369	476	4.20%	8.39%	12.59%	401	444
Ta, ppm	0.68	0.10	0.47	0.88	0.37	0.98	14.92%	29.84%	44.75%	0.64	0.71
Tb, ppm	0.54	0.033	0.48	0.61	0.45	0.64	6.00%	12.00%	18.00%	0.52	0.57
Te, ppm	0.38	0.06	0.27	0.49	0.21	0.55	14.60%	29.20%	43.79%	0.36	0.40
Th, ppm	8.27	0.387	7.49	9.04	7.11	9.43	4.68%	9.36%	14.04%	7.85	8.68
Ti, wt.%	0.364	0.017	0.331	0.397	0.314	0.414	4.56%	9.13%	13.69%	0.346	0.382
Tl, ppm	0.49	0.023	0.44	0.53	0.42	0.56	4.78%	9.57%	14.35%	0.46	0.51
Tm, ppm	0.26	0.025	0.21	0.31	0.19	0.34	9.32%	18.65%	27.97%	0.25	0.28
U, ppm	2.33	0.141	2.04	2.61	1.90	2.75	6.07%	12.14%	18.21%	2.21	2.44
V, ppm	149	9	132	166	123	175	5.77%	11.53%	17.30%	142	156
W, ppm	3.13	0.32	2.50	3.77	2.18	4.09	10.13%	20.26%	30.40%	2.98	3.29
Y, ppm	17.7	1.19	15.4	20.1	14.2	21.3	6.70%	13.39%	20.09%	16.8	18.6
Yb, ppm	1.82	0.060	1.70	1.94	1.64	2.00	3.29%	6.58%	9.87%	1.73	1.91
Zn, ppm	108	6	96	120	90	126	5.41%	10.82%	16.22%	103	113
Zr, ppm	60	6	48	72	41	79	10.29%	20.58%	30.87%	57	63

Note: intervals may appear asymmetric due to rounding.

Table 8. Aqua Regia Digestion - Performance Gates for OREAS 504b.

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
Ag, ppm	2.98	0.21	2.56	3.41	2.34	3.63	7.18%	14.37%	21.55%	2.84	3.13
Al, wt.%	1.93	0.098	1.74	2.13	1.64	2.23	5.04%	10.08%	15.13%	1.84	2.03
As, ppm	9.86	0.910	8.04	11.68	7.13	12.59	9.23%	18.45%	27.68%	9.37	10.35
Au, ppm	1.56	0.06	1.44	1.69	1.38	1.75	3.91%	7.81%	11.72%	1.49	1.64
Ba, ppm	166	16	133	198	117	215	9.80%	19.59%	29.39%	158	174
Be, ppm	0.49	0.07	0.35	0.63	0.28	0.70	14.11%	28.22%	42.32%	0.47	0.51
Bi, ppm	5.13	0.283	4.56	5.70	4.28	5.98	5.52%	11.03%	16.55%	4.87	5.39
Ca, wt.%	1.64	0.116	1.40	1.87	1.29	1.99	7.09%	14.18%	21.27%	1.56	1.72
Ce, ppm	32.6	2.36	27.9	37.3	25.5	39.7	7.26%	14.51%	21.77%	31.0	34.2
Co, ppm	18.7	1.43	15.9	21.6	14.4	23.0	7.64%	15.29%	22.93%	17.8	19.7
Cr, ppm	67	3.4	60	74	57	77	5.03%	10.05%	15.08%	64	70
Cs, ppm	4.04	0.336	3.37	4.71	3.03	5.05	8.31%	16.63%	24.94%	3.84	4.24
Cu, wt.%	1.10	0.022	1.06	1.15	1.03	1.17	2.02%	4.04%	6.06%	1.05	1.16
Fe, wt.%	6.71	0.444	5.82	7.60	5.38	8.04	6.62%	13.24%	19.86%	6.38	7.05
Ga, ppm	9.36	0.548	8.26	10.45	7.71	11.00	5.86%	11.71%	17.57%	8.89	9.82
Ge, ppm	0.21	0.03	0.15	0.27	0.12	0.30	14.05%	28.11%	42.16%	0.20	0.22
Hf, ppm	0.50	0.06	0.38	0.61	0.32	0.67	11.85%	23.69%	35.54%	0.47	0.52
In, ppm	0.69	0.054	0.58	0.80	0.53	0.85	7.79%	15.58%	23.36%	0.66	0.72
K, wt.%	0.550	0.037	0.476	0.625	0.438	0.662	6.78%	13.57%	20.35%	0.523	0.578
La, ppm	16.1	1.37	13.3	18.8	12.0	20.2	8.54%	17.07%	25.61%	15.3	16.9
Li, ppm	21.7	1.69	18.4	25.1	16.7	26.8	7.78%	15.57%	23.35%	20.7	22.8
Lu, ppm	0.18	0.02	0.14	0.21	0.12	0.23	10.38%	20.76%	31.13%	0.17	0.19
Mg, wt.%	1.30	0.061	1.18	1.42	1.11	1.48	4.73%	9.46%	14.19%	1.23	1.36
Mn, ppm	406	23	360	452	337	475	5.68%	11.35%	17.03%	385	426
Mo, ppm	476	19	437	515	418	534	4.07%	8.14%	12.21%	452	500
Na, wt.%	0.183	0.025	0.134	0.233	0.109	0.257	13.49%	26.98%	40.47%	0.174	0.192
Nb, ppm	0.81	0.15	0.51	1.12	0.36	1.27	18.63%	37.27%	55.90%	0.77	0.86
Nd, ppm	15.2	0.52	14.1	16.2	13.6	16.7	3.44%	6.89%	10.33%	14.4	15.9
Ni, ppm	30.0	2.19	25.7	34.4	23.5	36.6	7.28%	14.56%	21.84%	28.5	31.5
P, wt.%	0.092	0.007	0.079	0.105	0.072	0.112	7.20%	14.40%	21.59%	0.087	0.096
Pb, ppm	20.1	0.92	18.3	22.0	17.4	22.9	4.59%	9.18%	13.76%	19.1	21.2
Rb, ppm	51	2.8	46	57	43	60	5.43%	10.86%	16.29%	49	54
Re, ppm	0.010	0.001	0.008	0.011	0.007	0.012	8.38%	16.75%	25.13%	0.009	0.010

Note: intervals may appear asymmetric due to rounding.

Table 8. Aqua Regia Digestion 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
S, wt.%	1.31	0.088	1.13	1.49	1.05	1.57	6.71%	13.42%	20.12%	1.25	1.38
Sb, ppm	0.71	0.09	0.53	0.89	0.44	0.98	12.82%	25.65%	38.47%	0.67	0.75
Sc, ppm	7.88	1.16	5.56	10.20	4.40	11.36	14.72%	29.43%	44.15%	7.48	8.27
Se, ppm	11.6	1.00	9.6	13.6	8.6	14.6	8.59%	17.17%	25.76%	11.0	12.2
Sn, ppm	10.4	0.79	8.8	12.0	8.0	12.8	7.65%	15.29%	22.94%	9.9	10.9
Sr, ppm	110	8	94	127	85	135	7.56%	15.11%	22.67%	105	116
Tb, ppm	0.41	0.026	0.36	0.46	0.33	0.49	6.49%	12.97%	19.46%	0.39	0.43
Te, ppm	0.38	0.04	0.30	0.46	0.26	0.50	10.82%	21.63%	32.45%	0.36	0.40
Th, ppm	7.79	0.439	6.91	8.67	6.47	9.11	5.64%	11.27%	16.91%	7.40	8.18
Ti, wt.%	0.220	0.023	0.175	0.266	0.152	0.288	10.33%	20.66%	31.00%	0.209	0.231
Tl, ppm	0.29	0.015	0.26	0.32	0.24	0.33	5.13%	10.27%	15.40%	0.27	0.30
U, ppm	2.00	0.145	1.71	2.29	1.56	2.44	7.27%	14.54%	21.80%	1.90	2.10
V, ppm	128	8	111	144	103	152	6.43%	12.87%	19.30%	121	134
W, ppm	1.64	0.25	1.14	2.14	0.89	2.38	15.18%	30.36%	45.54%	1.56	1.72
Y, ppm	12.2	0.80	10.6	13.8	9.8	14.6	6.59%	13.18%	19.77%	11.6	12.8
Yb, ppm	1.20	0.089	1.02	1.38	0.93	1.46	7.43%	14.85%	22.28%	1.14	1.26
Zn, ppm	96	5.2	86	107	80	112	5.45%	10.90%	16.35%	91	101
Zr, ppm	14.2	1.7	10.9	17.6	9.2	19.2	11.71%	23.43%	35.14%	13.5	15.0

Note: intervals may appear asymmetric due to rounding.

PREPARER AND SUPPLIER

Certified reference material OREAS 504b is prepared, certified and supplied by:

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It is available in unit sizes of 10g and 60g (single-use laminated foil pouches) and 1kg (plastic jars).

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8. ALS, Lima, Peru
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24. SGS Mineral Services, Toronto, Ontario, Canada
25. SGS South Africa Pty Ltd, Booysens, Gauteng, South Africa
26. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
27. Ultra Trace Pty Ltd (BV), Perth, WA, Australia

INTENDED USE

OREAS 504b is intended for the following uses:

- for the monitoring of laboratory performance in the analysis of analytes reported in Tables 1-3 in geological samples;
- for the verification of analytical methods for analytes reported in Tables 1-3;
- for the calibration of instruments used in the determination of the concentration of analytes reported in Tables 1-3.

STABILITY AND STORAGE INSTRUCTIONS

OREAS 504b has been sourced from samples of Au-Cu ore and waste rock samples from a porphyry copper-gold deposit. In its unopened state and under normal conditions of storage it has a shelf life beyond ten years. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

INSTRUCTIONS FOR CORRECT USE

The certified values refer to the concentration level of analytes in their packaged state. The CRM should therefore 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.

TRACEABILITY

The analytical samples were selected in a manner to represent the entire batch of prepared CRM. This 'representivity' was maintained in each submitted laboratory sample batch and ensures the user that the data is traceable from sample selection through to the analytical results that underlie the consensus values. Each analytical data set has been validated by its assayer through the inclusion of internal reference materials and QC checks during analysis. The laboratories were chosen on the basis of their competence (from past performance in inter-laboratory programs) 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.

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CERTIFYING OFFICER

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