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CERTIFICATE OF ANALYSIS FOR

GOLD ORE

CERTIFIED REFERENCE MATERIAL

OREAS 216

Table 1. Certified Values, SD's, 95% Confidence and Tolerance Limits for OREAS 216

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fire Assay						
Au, Gold (ppm)	6.66	0.155	6.62	6.70	6.64*	6.67*
Aqua Regia Digestion						
Au, Gold (ppm)	6.53	0.204	6.46	6.61	6.52†	6.55†

*Gold Tolerance Limits for typical 30g fire assay charge weight determined from 20 x 85mg NAA results and the Sampling Constant (Ingamells & Switzer, 1973);
†Gold Tolerance Limits for typical 25g aqua regia sample weight determined as above;
Please note: intervals may appear asymmetric due to rounding.

The homogeneity of OREAS 216 is of a level such that ***no sampling error exists*** for a conventional fire assay or aqua regia determination.

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

Certified Reference Material (CRM) OREAS 216 was prepared from a blend of Archean greenstone-hosted Wilber Lode primary ore from the Andy Well Gold Mine and barren Cambrian greenstone sourced from a quarry north of Melbourne, Australia. The Wilber Lode is a shear-hosted, narrow vein, quartz lode-style gold deposit situated within the Meekatharra-Wydgee greenstone belt in the Archean Yilgarn Craton of Western Australia. The common primary mineral assemblage, as stated by Mason and Harris (2011, 2012, cited in Hingston et al, 2014), is quartz, calcite, chlorite, fuchsite, pyrite, galena, sphalerite, chalcopyrite and gold. The host rock consists of a complex sequence of Archean meta-basalt and meta-porphyritic rocks derived from a primary mineralogy of albite, actinolite, chlorite, sericite, biotite, calcite, zoisite, muscovite, quartz and titanate. The Andy Well deposit is located approximately 45km north of Meekatharra in the Murchison region of Western Australia.

The approximate major and trace element composition of OREAS 216 is provided in Table 2. The non-certified values contained in this table are the means of duplicate assays from one laboratory.

Table 2. Approximate major and trace element data for OREAS 216.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Fire Assay								
Pd	ppb	*9*	Pt	ppb	*9*			
Borate Fusion ICP								
Al	wt.%	*5.69*	Ho	ppm	*0.43*	Sn	ppm	*0.75*
Ba	ppm	*218*	K	wt.%	*0.623*	Sr	ppm	*85*
Ca	wt.%	*4.55*	La	ppm	*5.35*	Ta	ppm	*0.10*
Ce	ppm	*10.9*	Lu	ppm	*0.20*	Tb	ppm	*0.33*
Cr	ppm	*540*	Mg	wt.%	*4.38*	Th	ppm	*1.45*
Cs	ppm	*0.55*	Mn	wt.%	*0.085*	Ti	wt.%	*0.309*
Dy	ppm	*2.10*	Na	wt.%	*1.39*	Tm	ppm	*0.20*
Er	ppm	*1.39*	Nb	ppm	*2.25*	TOT_ICP	wt.%	*98.66*
Eu	ppm	*0.55*	Nd	ppm	*5.90*	U	ppm	*0.37*
Fe	wt.%	*5.26*	P	wt.%	*0.028*	V	ppm	*168*
Ga	ppm	*12.6*	Pr	ppm	*1.35*	W	ppm	*10.0*
Gd	ppm	*1.92*	Rb	ppm	*22.7*	Y	ppm	*12.1*
Ge	ppm	*< 5*	Si	wt.%	*26.95*	Yb	ppm	*1.39*
Hf	ppm	*1.50*	Sm	ppm	*1.44*	Zr	ppm	*56*
Thermogravimetry								
LOI^{1000}	wt.%	*5.67*						

Table 2 continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Infrared Combustion								
C	wt.%	*0.760*	S	wt.%	*0.760*			
4-Acid Digestion								
Ag	ppm	*1.35*	Li	ppm	*30.0*	Sc	ppm	*25.0*
Cd	ppm	*0.55*	Mo	ppm	*3.00*	Zn	ppm	*81*
Co	ppm	*35.0*	Ni	ppm	*182*			
Cu	ppm	*130*	Pb	ppm	*30.0*			
Aqua Regia Digestion								
As	ppm	*58*	In	ppm	*0.021*	Se	ppm	*0.85*
Bi	ppm	*0.59*	Re	ppm	*0.002*	Te	ppm	*0.30*
Hg	ppm	*0.12*	Sb	ppm	*0.39*	Tl	ppm	*0.11*

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 216 was prepared in the following manner:

- drying to constant mass at 105°C;
- crushing and milling of the barren material to 95% minus 75 microns;
- crushing and milling of the ore material to 100% minus 30 microns;
- blending in appropriate proportions to achieve the desired grade;
- packaging in 60 and 100g units sealed in laminated foil pouches and 1kg units in plastic jars.

ANALYTICAL PROGRAM

Thirty-three commercial analytical laboratories participated in the program to certify gold (as reported in Table 1) by the following methods:

- Gold via 25-40g fire assay with AAS (25 labs) or ICP-OES (7 labs) finish;
- Instrumental neutron activation analysis for Au on 20 x 85mg subsamples to confirm homogeneity (1 laboratory).
- Gold via 15-50g aqua regia digestion with ICP-MS (11 labs), AAS (7 labs) or ICP-OES (1 lab) finish.

For the round robin program, twenty 1.4kg test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire batch. The six samples received by each laboratory were obtained by taking two 120g scoop splits from each of three separate 1.4kg test units. This format enabled a nested Analysis of Variance (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 certified values together with their associated 1SD's, 95% confidence and tolerance limits. Table 2 provides indicative major and trace element data and Table 3 shows the gold neutron activation analysis (NAA) results for twenty 85mg subsamples determined by the Australian Nuclear Science & Technology Organisation (ANSTO) located in Lucas Heights, NSW, Australia. 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 NAA 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 216 Datapack.xlsx**).

Table 3. Neutron Activation Analysis of Au on 20 x 85mg subsamples.

Replicate No	NAA 0.09g
1	6.84
2	6.81
3	6.69
4	6.60
5	6.82
6	6.82
7	6.93
8	6.81
9	6.83
10	6.81
11	6.78
12	6.73
13	6.89
14	6.74
15	6.79
16	6.73
17	6.79
18	6.85
19	6.84
20	6.78
Mean	6.79
Median	6.81
Std Dev.	0.072
Rel.Std.Dev.	1.06%
PDM[3]	2.08%

STATISTICAL ANALYSIS

Certified Values, Confidence Limits, Standard Deviations and Tolerance Limits (Table 1) have been determined for gold by two methods: fire assay and aqua regia digestion. These statistics were calculated following the 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 is omitted from determination of the certified value for gold and is used solely for the calculation of Tolerance Limits and homogeneity evaluation of OREAS 216.

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 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.

Table 4 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 4. Performance Gates for OREAS 216.

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	6.66	0.155	6.34	6.97	6.19	7.12	2.34%	4.67%	7.01%	6.32	6.99
Aqua Regia Digestion											
Au, ppm	6.53	0.204	6.13	6.94	5.92	7.15	3.13%	6.25%	9.38%	6.21	6.86

Tolerance Limits (ISO Guide 3207) were determined by NAA 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 85 milligrams was employed and the 1RSD (across the twenty subsamples) of 1.06%, or 0.06% at a conventional 30g fire assay charge weight, confirms the exceptional level of gold homogeneity in OREAS 216. The homogeneity is of a level such that ***no sampling error exists*** for a conventional fire assay or aqua regia determination.

The meaning of tolerance limits may be illustrated for gold by fire assay, where 99% of the time (1-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 6.64 and 6.67ppm. 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).

The homogeneity of OREAS 216 has also been evaluated in a **nested ANOVA** of the round robin program. Each of the thirty-three 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 216. The test was performed using the following parameters:

- Gold Fire Assay – 192 samples (32 laboratories each providing analyses on 3 pairs of samples);
- Aqua Regia Digestion – 114 samples (19 laboratories each providing analyses on 3 pairs of samples);
- Significance Level α = P (type I error) = 0.05;
- 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 0.54 for Au by fire assay

and 0.51 for Au by aqua regia digestion. Both p-values are insignificant and 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 216 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 216 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. ALS, Brisbane, QLD, Australia
3. ALS, Johannesburg, South Africa
4. ALS, Lima, Peru
5. ALS, Loughrea, Galway, Ireland
6. ALS, Perth, WA, Australia
7. ALS, Reno, Nevada, USA
8. ALS, Vancouver, BC, Canada
9. American Assay Laboratories, Sparks, Nevada, USA
10. ANSTO, Lucas Heights, NSW, Australia
11. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
12. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
13. Bureau Veritas Geoanalytical, Perth, WA, Australia
14. Bureau Veritas Minerals, Santiago, Chile
15. Inspectorate America Corporation (BV), Sparks, Nevada, USA
16. Inspectorate de Mexico (BV), S.A. de C.V., Hermosillo, Sonora, Mexico
17. Intertek Genalysis, Adelaide, SA, Australia
18. Intertek Genalysis, Perth, WA, Australia
19. Intertek Testing Services, Cupang, Muntinlupa, Philippines
20. Intertek Testing Services, Hidden Valley, Wau, PNG
21. Intertek Testing Services, Shunyi, Beijing, China
22. McClelland Laboratories Inc., Sparks, Nevada, USA
23. Ok Tedi Mine Lab, Mt Fubilan, Western Province, PNG
24. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
25. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
26. SGS Australia Mineral Services, Perth (Newburn), WA, Australia
27. SGS Canada Inc., Vancouver, BC, Canada
28. SGS del Peru, Lima, Peru
29. SGS Geosol Laboratorios Ltda, Vespasiano, Minas Gerais, Brazil
30. SGS Lakefield Research Ltd, Lakefield, Ontario, Canada
31. SGS Mineral Services, Townsville, QLD, Australia
32. SGS South Africa Pty Ltd, Booysens, Gauteng, South Africa
33. Skyline, Sparks, Nevada, USA
34. TSL Laboratories Inc., Saskatoon, Saskatchewan, Canada

PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

Reference material OREAS 216 has been prepared, certified and is supplied by:

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Email: info@ore.com.au

It is available in unit sizes of 60 and 100g (single-use laminated foil pouches) and 1kg (plastic jars).

INTENDED USE

OREAS 216 is intended for the following uses:

- for the monitoring of laboratory performance in the analysis of gold by fire assay and aqua regia digestion in geological samples;
- for the verification of gold fire assay and aqua regia digestion methods;
- for the calibration of instruments used in the determination of gold.

STABILITY AND STORAGE INSTRUCTIONS

OREAS 216 has been prepared from primary gold ore diluted with barren greenstone. It is low in reactive sulphide (~0.76 wt.%) 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 CORRECT USE

The certified values for OREAS 216 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.

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.

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 9001:2008 by Lloyd's Register Quality Assurance Ltd for its quality management system including development, manufacturing, certification and supply of CRMs.

CERTIFYING OFFICER

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

REFERENCES

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