OREAS
Certified Reference Materials

ORE RESEARCH & EXPLORATION P/L ABN 28 006 859 856
37A Hosie Street · Bayswater North · VIC 3153 · AUSTRALIA
61 3 9729 0333 Fax 61 3 9729 8338
info@ore.com.au www.ore.com.au

CERTIFICATE OF ANALYSIS FOR

MATRIX-MATCHED CERTIFIED REFERENCE MATERIAL

OX_CU_L6

SEPON GOLD MINE, LANE XANG MINERALS LTD, SAVANNAKHET PROVINCE, LAO P.D.R.

Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OX_CU_L6

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fire Assay						
Au, Gold (ppb)	79.6	3.6	77.1	82.2	*74.7	*84.6
4-Acid Digestion						
Ag, Silver (ppm)	6.21	0.301	5.97	6.45	6.04	6.38
Cu, Copper (ppm)	8472	99	8377	8567	8416	8528
S, Sulphur (wt.%)	0.694	0.010	0.682	0.706	0.685	0.702
Infrared Combustion						
C, Carbon (wt.%)	2.92	0.037	2.87	2.97	2.90	2.95

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

SOURCE MATERIALS

OX_CU_L6 is a matrix-matched certified reference material (MMCRM) prepared by Ore Research & Exploration Pty Ltd from material sourced from the Sepon Gold Mine. The Sepon property is located in the Savannakhet Province, Lao P.D.R. and is owned by Minerals and Metals Group through its associated company Lane Xang Minerals Limited.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material (100kg) constituting OX_CU_L6 was prepared in the following manner:

- drying to constant mass at 105°C;
- multi stage milling to 100% <35 microns;
- homogenisation;
- packaging in 100g units sealed under nitrogen into labelled laminated foil pouches.

ANALYTICAL PROGRAM

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

- Au via 25-40g fire assay with AAS (5 labs) or ICP-OES (5 labs) finish;
- Instrumental neutron activation analysis for Au on 20 x 1.0g subsamples to confirm homogeneity (1 lab);
- Ag, Cu, and S via 4-acid digestion with ICP-OES and/or ICP-MS finish (10 labs);
- C via infrared furnace combustion (10 labs).

For the round robin program 1kg test units were taken at 10 predetermined sampling intervals immediately following homogenisation and are considered representative of the entire prepared batch of OX_CU_L6. To incorporate batch to batch variation at individual laboratories, samples were submitted to each laboratory one week and then a week later, a second round of samples were submitted to the laboratories. For each round of samples the four samples received by each laboratory were obtained by taking two 100g scoop splits from each of two 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. This exercise validates that the variance of the material is uniformly distributed (for further detail see 'Tolerance Limits' section below).

Table 1 presents the certified values together with their associated 1SD's, 95% confidence and tolerance limits. Table 2 provides performance gate intervals for the certified values based on their 1SD's and Table 3 shows the gold instrumental neutron activation analysis (INAA) results for twenty 1.0 gram subsamples determined by Actlabs located in Ancaster, Canada. Tabulated results of all elements (including Au INAA analyses) together with analytical method codes, uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of lab means from the corrected mean of means (PDM^3) are presented in the detailed certification data for this CRM (**OX_CU_L6 Datapack.xlsx**).

Results for gold and copper are also presented in scatter plots (Figures 1 and 2) together with ±3SD (magenta) and ±5% (yellow) control lines and certified value (green line). Accepted individual results are coloured blue and individual and dataset outliers are identified in red and violet, respectively.

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. It should not be used as a control limit 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. They take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability. The SD for each analyte's certified value is calculated from the same filtered data set used to determine the certified value, i.e. after removal of all individual, lab dataset (batch) and 3SD outliers (single iteration). These outliers can only be removed after the absolute homogeneity of the CRM has been independently established, i.e. the outliers must be confidently deemed to be analytical rather than arising from inhomogeneity of the CRM. The standard deviation is then calculated for each analyte from the pooled accepted analyses generated from the certification program.

Table 2. Performance Gates for OX_CU_L6

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	79.6	3.6	72.3	86.9	68.7	90.6	4.58%	9.16%	13.74%	75.7	83.6
4-Acid Digestion											
Ag, ppm	6.21	0.301	5.61	6.81	5.31	7.11	4.84%	9.69%	14.53%	5.90	6.52
Cu, ppm	8472	99	8275	8669	8176	8768	1.16%	2.33%	3.49%	8048	8895
S, wt.%	0.694	0.010	0.674	0.713	0.665	0.723	1.40%	2.79%	4.19%	0.659	0.729
Infrared Combustion											
C, wt.%	2.92	0.037	2.85	3.00	2.81	3.03	1.27%	2.54%	3.81%	2.78	3.07

Note: intervals may appear asymmetric due to rounding

Performance Gates (Table 2) 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.

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 where 99% of the time (1-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 8416 and 8528ppm. 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 (see Table 3 below) 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 latter parameter is substantially reduced to a point where most of the variability in replicate assays is 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 1.96% calculated for a 30g fire assay sample (10.7% at 1g weights) confirms the high level of gold homogeneity in OX_CU_L6.

Please note that these RSD 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 OX_CU_L6 has also been evaluated in a **nested ANOVA** of the round robin program. Each of the ten round robin laboratories received four samples on two separate occasions and each batch of four samples were made up of paired subsamples from two different, non-adjacent 1kg test units (see 'Analytical Program' section above). 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 OX_CU_L6. The test was performed using the following parameters:

- Gold fire assay – 80 samples (10 laboratories each providing analyses on 2 pairs of samples on two occasions);
- 4-acid digestion for Ag, Cu and S – 80 samples (10 laboratories each providing analyses on 2 pairs of samples on two occasions);
- C by infrared combustion furnace – 80 samples (10 laboratories each providing analyses on 2 pairs of samples on two occasions);
- 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 0.79 for Au, 0.83 for Ag, 0.99 for Cu, 0.83 for S and 0.99 for C. All 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 OX_CU_L6 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 OX_CU_L6 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

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

Replicate No	INAA 1g
1	79
2	80
3	97
4	86
5	84
6	70
7	84
8	72
9	102
10	90
11	102
12	94
13	86
14	95
15	81
16	86
17	76
18	76
19	85
20	92
Mean	85.9
Median	85.5
Std Dev.	9.2
Rel.Std.Dev.	10.69%
PDM[3]	7.79%

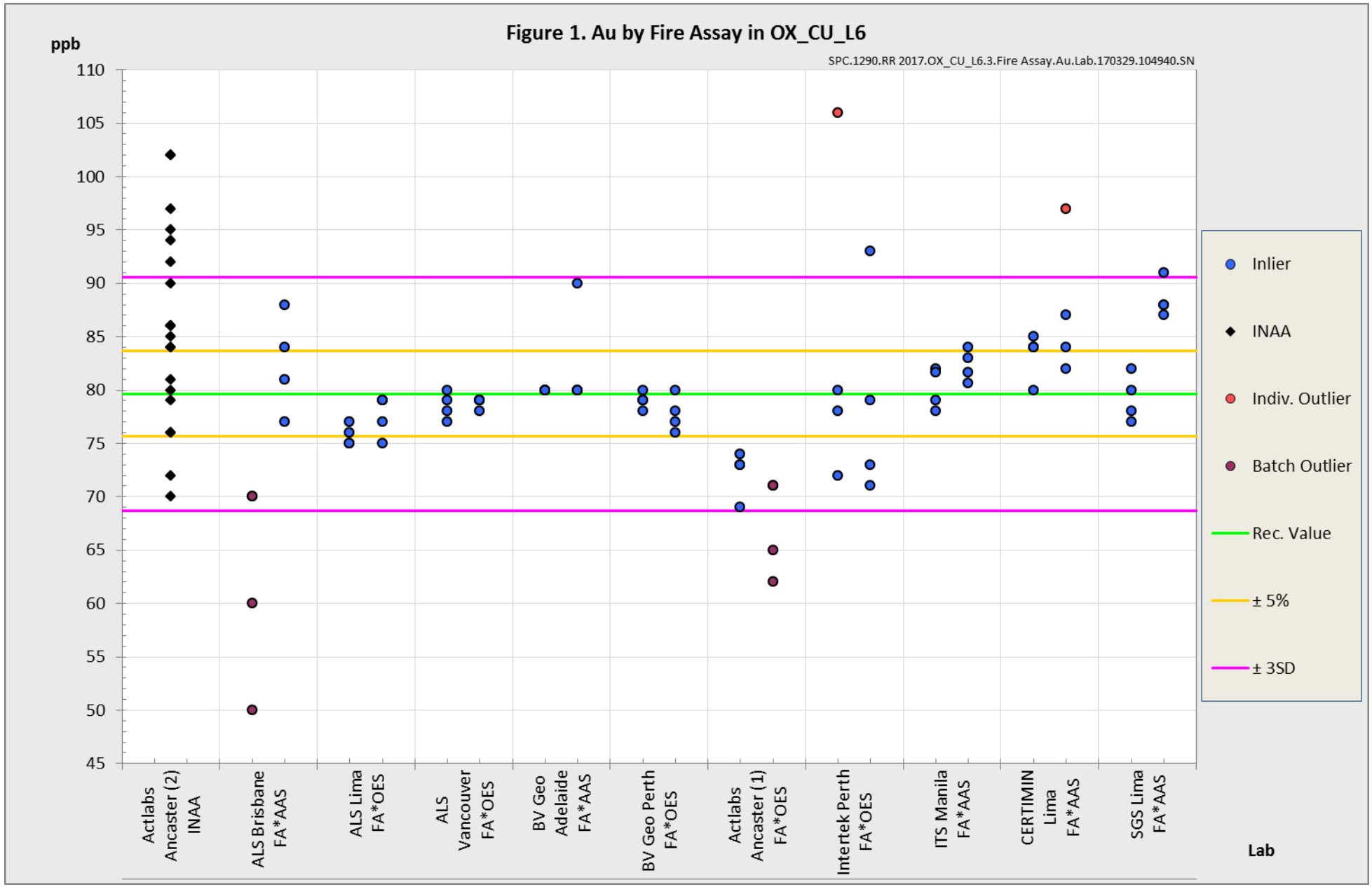
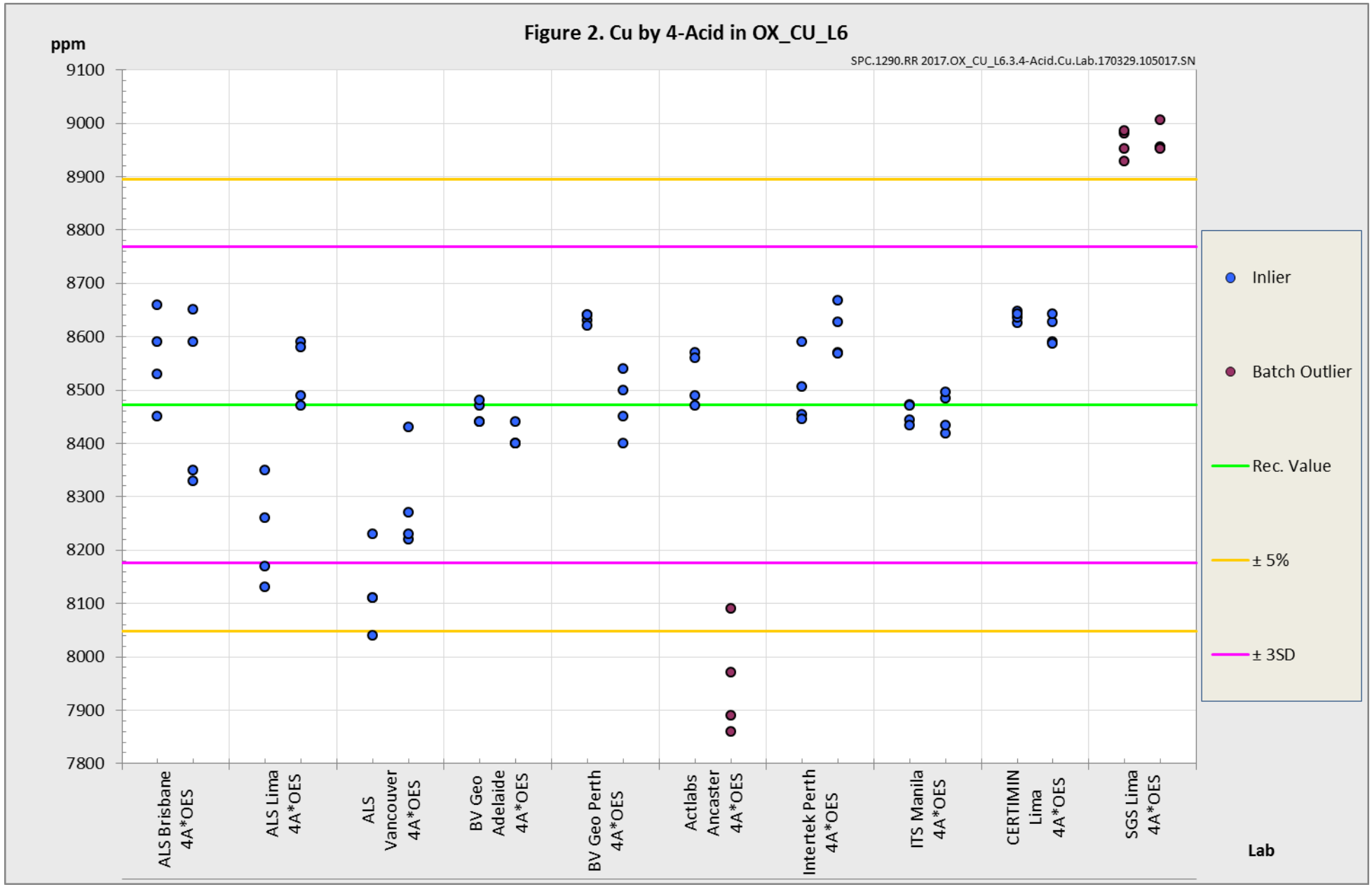


Figure 1. Au by Fire Assay in OX_CU_L6
ppb
SPC.1290.RR 2017.OX_CU_L6.3.Fire Assay.Au.Lab.170329.104940.SN
110
105
100
95
90
85
80
75
70
65
60
55
50
45
Actlabs Ancaster (2) INAA
ALS Brisbane FA*AAS
ALS Lima FA*OES
ALS Vancouver FA*OES
BV Geo Adelaide FA*AAS
BV Geo Perth FA*OES
Actlabs Ancaster (1) FA*OES
Intertek Perth FA*OES
ITS Manila FA*AAS
CERTIMIN Lima FA*AAS
SGS Lima FA*AAS
Lab
Inlier
INAA
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD

Figure 2. Cu by 4-Acid in OX_CU_L6



PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. ALS, Brisbane, QLD, Australia
3. ALS, Lima, Peru
4. ALS, Vancouver, BC, Canada
5. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
6. Bureau Veritas Geoanalytical, Perth, WA, Australia
7. CERTIMIN, Lima, Peru
8. Intertek Genalysis, Perth, WA, Australia
9. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
10. SGS del Peru, Lima, Peru

PREPARER AND SUPPLIER

Reference material OX_CU_L6 has been prepared and certified by:

ORE Research & Exploration Pty Ltd
37A Hosie Street
Bayswater North VIC 3153
AUSTRALIA

Tel: +613-9729 0333
Fax: +613-9729 8338
Web: www.ore.com.au
Email: info@ore.com.au

It has been packaged in 100g units sealed under nitrogen into laminated foil pouches and packed into cartons.

INTENDED USE

OX_CU_L6 is intended for the following uses:

- for the monitoring of laboratory performance in the analysis of Ag, Au, C, Cu and S in geological samples;
- for the verification of analytical methods for Ag, Au, C, Cu and S;
- for the calibration of instruments used in the determination of the concentration of Ag, Au, C, Cu and S.

STABILITY AND STORAGE INSTRUCTIONS

OX_CU_L6 was prepared from samples sourced from the Sepon Gold Mine. To ensure a long shelf life it has been sealed in robust laminated foil pouches. In its unopened state under normal conditions of storage it has a shelf life beyond five years.

INSTRUCTIONS FOR CORRECT USE

The certified values for OX_CU_L6 refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis.

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 and non-certified (indicative) values presented in this report are calculated from the means of accepted data following robust statistical treatment as detailed in this report.

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.

CERTIFYING OFFICER

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

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.

REFERENCES

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

ISO Guide 30 (1992), Terms and definitions used in connection with reference materials.

ISO Guide 31 (2000), Reference materials – Contents of certificates and labels.

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

ISO Guide 35 (2006), Certification of reference materials - General and statistical principals.