



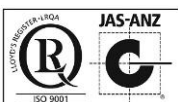
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**CERTIFICATE OF ANALYSIS FOR**

**Gold Ore (Andy Well Gold Mine, Western Australia)**

**CERTIFIED REFERENCE MATERIAL**

**OREAS 229b**



Document: COA-1288-OREAS229b-R2

(Template: BUP-70-10-01 Rev:2.0)

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**Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 229b.**

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
<b>Pb Fire Assay</b>						
Au, Gold (ppm)	11.95	0.288	11.86	12.04	11.92*	11.98*
<b>Aqua Regia Digestion (sample weights 10-50g)</b>						
Au, Gold (ppm)	11.86	0.334	11.75	11.98	11.83*	11.89*
<b>Cyanide Leach</b>						
Au, Gold (ppm)	11.76	0.376	11.54	11.98	11.73*	11.79*
<b>Aqua Regia Digestion (sample weights 0.15-50g)</b>						
Ag, Silver (ppm)	1.60	0.076	1.57	1.63	1.54	1.66
Al, Aluminium (wt.%)	3.09	0.169	3.02	3.17	3.02	3.17
As, Arsenic (ppm)	42.5	2.62	41.5	43.5	40.8	44.1
Ba, Barium (ppm)	37.3	5.9	34.3	40.3	36.5	38.1
Bi, Bismuth (ppm)	0.42	0.025	0.40	0.43	0.40	0.44
Ca, Calcium (wt.%)	2.96	0.117	2.91	3.01	2.90	3.02
Cd, Cadmium (ppm)	0.16	0.02	0.15	0.17	0.15	0.18
Ce, Cerium (ppm)	8.10	1.07	7.42	8.77	7.88	8.32
Co, Cobalt (ppm)	29.9	2.22	29.0	30.8	29.1	30.6
Cr, Chromium (ppm)	332	21	323	341	324	339
Cs, Cesium (ppm)	0.27	0.03	0.25	0.29	0.26	0.29
Cu, Copper (ppm)	131	5	129	133	128	134
Dy, Dysprosium (ppm)	1.92	0.37	1.41	2.43	1.83	2.02
Fe, Iron (wt.%)	4.53	0.377	4.37	4.69	4.45	4.61
Ga, Gallium (ppm)	9.54	1.16	8.78	10.29	9.12	9.96
Hf, Hafnium (ppm)	0.40	0.06	0.36	0.45	0.38	0.42
In, Indium (ppm)	0.023	0.003	0.021	0.025	0.021	0.025
K, Potassium (wt.%)	0.163	0.017	0.155	0.170	0.159	0.167
La, Lanthanum (ppm)	3.72	0.161	3.63	3.81	3.61	3.84
Li, Lithium (ppm)	20.6	2.02	19.4	21.7	19.7	21.4
Lu, Lutetium (ppm)	0.14	0.02	0.12	0.16	0.12	0.15
Mg, Magnesium (wt.%)	2.80	0.191	2.72	2.89	2.74	2.87
Mn, Manganese (wt.%)	0.061	0.004	0.060	0.063	0.060	0.062
Mo, Molybdenum (ppm)	4.16	0.253	4.00	4.33	4.02	4.31
Na, Sodium (wt.%)	0.070	0.012	0.064	0.075	0.068	0.071
Ni, Nickel (ppm)	118	6	116	121	116	121
P, Phosphorus (wt.%)	0.031	0.002	0.030	0.032	0.030	0.032
Pb, Lead (ppm)	22.7	1.69	22.1	23.4	21.9	23.5
Rb, Rubidium (ppm)	7.46	0.588	7.05	7.88	7.23	7.70
S, Sulphur (wt.%)	0.599	0.030	0.586	0.611	0.585	0.613
Sb, Antimony (ppm)	0.29	0.05	0.25	0.33	0.27	0.31
Sc, Scandium (ppm)	8.38	0.798	7.85	8.91	8.12	8.63
Sr, Strontium (ppm)	37.9	2.72	36.7	39.1	36.9	39.0

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu$ g/g  $\equiv$  0.0001 wt.%  $\equiv$  1000 ppb, parts per billion.

\*Gold Tolerance Limits for typical 30g fire assay, 25g aqua regia digestion and 30g cyanide leach methods are determined from 20 x 85mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973).

Note: intervals may appear asymmetric due to rounding.

Table 1 continued.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
<b>Aqua Regia Digestion (sample weights 0.15-50g) continued</b>						
Tb, Terbium (ppm)	0.26	0.04	0.22	0.30	0.25	0.26
Te, Tellurium (ppm)	0.21	0.03	0.19	0.22	0.18	0.23
Th, Thorium (ppm)	1.14	0.058	1.10	1.17	1.10	1.17
Ti, Titanium (wt.%)	0.240	0.039	0.221	0.258	0.230	0.249
Tl, Thallium (ppm)	0.075	0.011	0.068	0.082	IND	IND
U, Uranium (ppm)	0.23	0.04	0.21	0.26	0.22	0.24
V, Vanadium (ppm)	120	9	116	124	117	123
W, Tungsten (ppm)	5.08	0.92	4.45	5.71	4.83	5.33
Y, Yttrium (ppm)	9.79	0.966	9.20	10.39	9.58	10.01
Yb, Ytterbium (ppm)	0.96	0.16	0.81	1.10	0.93	0.98
Zn, Zinc (ppm)	65	3.6	64	67	63	67
Zr, Zirconium (ppm)	13.6	2.4	12.0	15.3	12.9	14.4

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu$ g/g  $\equiv$  0.0001 wt.%  $\equiv$  1000 ppb, parts per billion.

Note: intervals may appear asymmetric due to rounding.

## INTRODUCTION

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

## SOURCE MATERIALS

Certified Reference Material (CRM) OREAS 229b 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-Wydegee 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 metabasalt and meta-porphyrific 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.

## COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 229b was prepared in the following manner:

- Drying to constant mass at 105°C;
- Crushing and milling of the barren greenstone to 98% 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 60g units sealed in laminated foil pouches and 500g units in plastic jars.

## ANALYTICAL PROGRAM

Thirty-four commercial analytical laboratories participated in the program to certify the analytes reported in Table 1. The following methods were employed:

- Gold by 25-50g fire assay followed by AAS (22 laboratories), ICP-OES (6 laboratories) and Gravimetric (4 laboratories) finish;
- Gold by 10-50g aqua regia digestion followed by ICP-OES and/or ICP-MS finish (13 laboratories), AAS finish (12 laboratories);
- Gold by cyanide leach – A variety of cyanide leach methods were undertaken by the participating laboratories including the use of LeachWELL tablets, alkaline added sodium cyanide solution as well as sodium cyanide liquor with LeachWELL powder. The sample weights included: 30g (6 laboratories by AAS finish and 1 laboratory by ICP-MS finish), 50g (1 laboratory by AAS finish) and 200g (5 laboratories by AAS finish and 1 laboratory by ICP-MS finish);
- Gold by instrumental neutron activation analysis (INAA) on 20 x 85mg subsamples to confirm homogeneity (ANSTO, Lucas Heights);
- Full ICP-OES and ICP-MS elemental suites by aqua regia digestion using 0.15 to 50g sample weights (up to 27 laboratories depending on the element).

Gold was also determined by Chrysol Corporation's new Photon Assay technique at Minanalytical Services, Perth. This value is included in Table 2 as an indicative value since it is reported by one laboratory only. Table 2 also includes major and trace element characterisation by BV Perth Geoanalytical laboratory using the following methodologies:

- Major oxides by lithium borate fusion with X-ray fluorescence;
- LOI at 1000°C by thermogravimetric analyser;
- Infrared combustion furnace for C and S;
- Trace element characterisation by laser ablation with ICP-MS finish.

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.

For the round robin program twenty 2.5kg test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire prepared batch. The six samples received by each laboratory were obtained by taking two 120g scoop splits from each of three separate 2.5kg 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 49 certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 below shows 90 indicative values. 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<sup>3</sup>) are presented in the detailed certification data for this CRM (**OREAS 229b DataPack-1.0.181003\_115728.xlsx**).

Results are also presented in scatter plots for gold by fire assay, aqua regia digestion and cyanide leach (Figures 1 to 3, respectively) together with  $\pm 3SD$  (magenta) and  $\pm 5\%$  (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.

**Table 2. Indicative Values for OREAS 229b.**

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
<b>Pb Fire Assay</b>								
Pd	ppb	10.1	Pt	ppb	10.0			
<b>X-ray Photon Assay</b>								
Au	ppm	11.68						
<b>Aqua Regia Digestion (sample weights 0.15-50g)</b>								
B	ppm	16.9	Ir	ppm	< 0.002	Ru	ppm	< 0.002
Be	ppm	0.19	Nb	ppm	0.089	Se	ppm	0.61
Er	ppm	0.97	Nd	ppm	4.52	Sm	ppm	1.25
Eu	ppm	0.35	Pd	ppb	7.81	Sn	ppm	0.36
Gd	ppm	1.41	Pr	ppm	0.93	Ta	ppm	< 0.05
Ge	ppm	0.063	Pt	ppb	6.17	Tm	ppm	0.12
Hg	ppm	0.10	Re	ppm	0.003			
Ho	ppm	0.33	Rh	ppm	< 0.002			
<b>Borate Fusion XRF</b>								
Al <sub>2</sub> O <sub>3</sub>	wt.%	11.31	MgO	wt.%	7.22	SiO <sub>2</sub>	wt.%	56.65
CaO	wt.%	7.17	MnO	wt.%	0.130	SO <sub>3</sub>	wt.%	1.47
Fe <sub>2</sub> O <sub>3</sub>	wt.%	8.65	Na <sub>2</sub> O	wt.%	2.16	TiO <sub>2</sub>	wt.%	0.700
K <sub>2</sub> O	wt.%	0.633	P <sub>2</sub> O <sub>5</sub>	wt.%	0.075			

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu$ g/g  $\equiv$  0.0001 wt.%  $\equiv$  1000 ppb, parts per billion.

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
<b>Thermogravimetry</b>								
LOI <sup>1000</sup>	wt.%	4.83						
<b>Infrared Combustion</b>								
C	wt.%	0.525	S	wt.%	0.610			
<b>Laser Ablation ICP-MS</b>								
Ag	ppm	1.60	Hf	ppm	1.97	Sm	ppm	1.65
As	ppm	42.1	Ho	ppm	0.57	Sn	ppm	0.60
Ba	ppm	201	In	ppm	< 0.05	Sr	ppm	91
Be	ppm	0.60	La	ppm	5.17	Ta	ppm	0.15
Bi	ppm	0.43	Lu	ppm	0.25	Tb	ppm	0.40
Cd	ppm	0.10	Mn	wt.%	0.099	Te	ppm	0.15
Ce	ppm	10.8	Mo	ppm	4.20	Th	ppm	1.45
Co	ppm	36.8	Nb	ppm	2.66	Ti	wt.%	0.404
Cr	ppm	452	Nd	ppm	6.54	Tl	ppm	< 0.2
Cs	ppm	0.43	Ni	ppm	152	Tm	ppm	0.26
Cu	ppm	129	Pb	ppm	23.0	U	ppm	0.38
Dy	ppm	2.66	Pr	ppm	1.51	V	ppm	199
Er	ppm	1.68	Rb	ppm	17.9	W	ppm	8.40
Eu	ppm	0.60	Re	ppm	< 0.01	Y	ppm	14.1
Ga	ppm	13.6	Sb	ppm	0.65	Yb	ppm	1.57
Gd	ppm	2.21	Sc	ppm	27.6	Zn	ppm	73
Ge	ppm	1.25	Se	ppm	< 5	Zr	ppm	72

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu$ g/g  $\equiv$  0.0001 wt.%  $\equiv$  1000 ppb, parts per billion.

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.

## 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 (see Table 3) 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 229b.

**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 2) are provided for the major and trace elements determined by borate fusion XRF ( $\text{Al}_2\text{O}_3$  to  $\text{TiO}_2$ ), laser ablation with ICP-MS (Ag to Zr), LOI at  $1000^\circ\text{C}$  and C + S by infrared combustion furnace and are the means of duplicate assays from Bureau Veritas, Perth. Additional indicative values by other analytical methods are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where inter-laboratory consensus is poor.

**Standard Deviation** values (1SDs) are reported in Table 1 and provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this CRM in a QA/QC program. The SD's take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The SD values thus include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability. OREAS prepared reference materials have a level of homogeneity such that the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself.

The SD for each analyte's certified value is calculated from the same filtered data set used to determine the certified value, i.e. after removal of any individual, lab dataset (batch) and 3SD outliers (single iteration). These outliers can only be removed after the absolute homogeneity of the CRM has been independently established, i.e. the outliers must be confidently deemed to be analytical rather than arising from inhomogeneity of the CRM. **The standard deviation is then calculated for each analyte from the pooled accepted analyses generated from the certification program.**

In the application of SD's in monitoring performance it is important to note that not all laboratories function at the same level of proficiency and that different methods in use at a particular laboratory have differing levels of precision. Each laboratory has its own inherent SD (for a specific concentration level and analyte-method pair) based on the analytical process and this SD is not directly related to the round robin program.

The majority of data generated in the round robin program was produced by a selection of world class laboratories. The SD's thus generated are more constrained than those that would be produced across a randomly selected group of laboratories. To produce more generally achievable SD's the 'pooled' SD's provided in this report include inter-lab bias. This 'one size fits all' approach may require revision at the discretion of the QC manager concerned following careful scrutiny of QC control charts.

### **Homogeneity Evaluation**

The homogeneity of gold 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 85 milligrams was employed and the 1RSD of 0.074% calculated for a 30g fire assay or aqua regia sample (1.38% at 85mg weights) confirms the high level of gold homogeneity in OREAS 229b.

*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.*

Table 3 below shows the INAA data determined on 20 x 85mg subsamples of OREAS 229b. An equivalent scaled version of the results is also provided to demonstrate an appreciation of what this data means if 30g fire assay determinations were undertaken without the normal measurement error associated with this methodology.

**Table 3. Neutron Activation Analysis of Au (in ppm) on 20 x 85mg subsamples showing the equivalent results scaled to a 30g sample mass typical of fire assay determination.**

Replicate No	Au 85mg actual	Au 30g equivalent*
1	12.22	12.16
2	12.22	12.16
3	11.95	12.14
4	12.29	12.16
5	12.36	12.16
6	12.17	12.15
7	12.19	12.16
8	12.29	12.16
9	12.24	12.16
10	12.07	12.15
11	12.43	12.17
12	11.93	12.14
13	11.97	12.14
14	12.20	12.16
15	12.11	12.15
16	12.39	12.17
17	11.92	12.14
18	12.19	12.16
19	11.82	12.14
20	12.11	12.15
Mean	12.15	12.15
Median	12.19	12.16
Std Dev.	0.168	0.009
<b>Rel.Std.Dev.</b>	<b>1.38%</b>	<b>0.074%</b>

\*Results calculated for a 30g equivalent sample mass using the formula:  $x^{30g Eq} = \frac{(x^{INAA} - \bar{X}) \times RSD@30g}{RSD@85mg} + \bar{X}$   
 where  $x^{30g Eq}$  = equivalent result calculated for a 30g sample mass  
 $(x^{INAA})$  = raw INAA result at 85mg  
 $\bar{X}$  = mean of 85mg INAA results

The homogeneity of OREAS 229b has also been evaluated in a **nested ANOVA** of the round robin program. Each of the thirty-four round robin laboratories received six samples per CRM and these samples were made up of paired samples from three different, non-adjacent sampling intervals. The purpose of the ANOVA evaluation is to test that no statistically significant difference exists in the variance between-units to that of the



variance within-units. This allows an assessment of homogeneity across the entire prepared batch of OREAS 229b. The test was performed using the following parameters:

- Gold fire assay – 192 samples (32 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 150 samples (25 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 datasets were filtered for both individual and laboratory data set (batch) outliers prior to the calculation of  $p$ -values. 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.

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 229b 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 229b is fit-for-purpose as a certified reference material (see 'Intended Use' below).

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. One approach used at commercial laboratories is to set the acceptance criteria at twice the detection level (DL)  $\pm 10\%$ .

*i.e. Certified Value  $\pm 10\% \pm 2DL$  (adapted from Govett, 1983)*

**Table 4. Pooled-Lab Performance Gates for OREAS 229b.**

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
<b>Pb Fire Assay</b>											
Au, ppm	11.95	0.288	11.37	12.53	11.09	12.82	2.41%	4.83%	7.24%	11.35	12.55
<b>Aqua Regia Digestion (sample weights 10-50g)</b>											
Au, ppm	11.86	0.334	11.20	12.53	10.86	12.87	2.82%	5.64%	8.46%	11.27	12.46
<b>Cyanide Leach</b>											
Au, ppm	11.76	0.376	11.01	12.51	10.63	12.89	3.20%	6.40%	9.60%	11.17	12.35
<b>Aqua Regia Digestion (sample weights 0.15-50g)</b>											
Ag, ppm	1.60	0.076	1.45	1.75	1.37	1.83	4.73%	9.47%	14.20%	1.52	1.68
Al, wt. %	3.09	0.169	2.76	3.43	2.59	3.60	5.45%	10.90%	16.35%	2.94	3.25
As, ppm	42.5	2.62	37.2	47.7	34.6	50.3	6.16%	12.33%	18.49%	40.3	44.6
Ba, ppm	37.3	5.9	25.5	49.2	19.5	55.1	15.90%	31.79%	47.69%	35.5	39.2
Bi, ppm	0.42	0.025	0.37	0.47	0.34	0.49	6.00%	12.00%	18.01%	0.40	0.44
Ca, wt. %	2.96	0.117	2.73	3.19	2.61	3.31	3.96%	7.92%	11.87%	2.81	3.11
Cd, ppm	0.16	0.02	0.12	0.20	0.10	0.23	12.69%	25.38%	38.07%	0.16	0.17
Ce, ppm	8.10	1.07	5.96	10.23	4.89	11.30	13.18%	26.36%	39.54%	7.69	8.50
Co, ppm	29.9	2.22	25.4	34.3	23.2	36.5	7.43%	14.86%	22.28%	28.4	31.4
Cr, ppm	332	21	291	373	270	393	6.20%	12.39%	18.59%	315	348
Cs, ppm	0.27	0.03	0.21	0.34	0.17	0.37	11.95%	23.90%	35.85%	0.26	0.29
Cu, ppm	131	5	121	142	115	147	4.07%	8.14%	12.21%	125	138
Dy, ppm	1.92	0.37	1.18	2.66	0.81	3.04	19.32%	38.64%	57.95%	1.83	2.02
Fe, wt. %	4.53	0.377	3.78	5.28	3.40	5.66	8.31%	16.62%	24.93%	4.30	4.76
Ga, ppm	9.54	1.16	7.22	11.86	6.06	13.02	12.16%	24.32%	36.48%	9.06	10.02
Hf, ppm	0.40	0.06	0.27	0.53	0.21	0.60	15.94%	31.88%	47.82%	0.38	0.42
In, ppm	0.023	0.003	0.016	0.030	0.013	0.033	14.38%	28.77%	43.15%	0.022	0.024
K, wt. %	0.163	0.017	0.129	0.196	0.112	0.213	10.36%	20.72%	31.08%	0.154	0.171
La, ppm	3.72	0.161	3.40	4.04	3.24	4.20	4.32%	8.64%	12.96%	3.54	3.91
Li, ppm	20.6	2.02	16.5	24.6	14.5	26.6	9.83%	19.67%	29.50%	19.5	21.6
Lu, ppm	0.14	0.02	0.10	0.18	0.07	0.20	15.28%	30.56%	45.84%	0.13	0.14
Mg, wt. %	2.80	0.191	2.42	3.19	2.23	3.38	6.81%	13.62%	20.43%	2.66	2.95
Mn, wt. %	0.061	0.004	0.053	0.069	0.049	0.073	6.63%	13.25%	19.88%	0.058	0.064
Mo, ppm	4.16	0.253	3.66	4.67	3.40	4.92	6.09%	12.17%	18.26%	3.95	4.37
Na, wt. %	0.070	0.012	0.045	0.094	0.033	0.106	17.56%	35.11%	52.67%	0.066	0.073
Ni, ppm	118	6	106	130	100	137	5.21%	10.42%	15.63%	112	124
P, wt. %	0.031	0.002	0.027	0.035	0.025	0.037	6.44%	12.88%	19.32%	0.030	0.033
Pb, ppm	22.7	1.69	19.3	26.1	17.7	27.8	7.44%	14.87%	22.31%	21.6	23.9
Rb, ppm	7.46	0.588	6.28	8.64	5.70	9.22	7.88%	15.77%	23.65%	7.09	7.83
S, wt. %	0.599	0.030	0.538	0.659	0.508	0.689	5.04%	10.08%	15.11%	0.569	0.629
Sb, ppm	0.29	0.05	0.18	0.39	0.13	0.45	18.29%	36.59%	54.88%	0.27	0.30
Sc, ppm	8.38	0.798	6.78	9.97	5.98	10.77	9.52%	19.05%	28.57%	7.96	8.80

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu$ g/g  $\equiv$  0.0001 wt. %  $\equiv$  1000 ppb, parts per billion.

Note: intervals may appear asymmetric due to rounding.

**Table 4 continued.**

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
<b>Aqua Regia Digestion (sample weights 0.15-50g) continued</b>											
Sr, ppm	37.9	2.72	32.5	43.4	29.8	46.1	7.16%	14.32%	21.48%	36.0	39.8
Tb, ppm	0.26	0.04	0.17	0.34	0.13	0.38	16.14%	32.28%	48.42%	0.24	0.27
Te, ppm	0.21	0.03	0.15	0.26	0.12	0.29	13.57%	27.13%	40.70%	0.20	0.22
Th, ppm	1.14	0.058	1.02	1.25	0.96	1.31	5.14%	10.28%	15.42%	1.08	1.19
Ti, wt. %	0.240	0.039	0.162	0.317	0.123	0.356	16.25%	32.49%	48.74%	0.228	0.252
Tl, ppm	0.075	0.011	0.053	0.097	0.042	0.108	14.75%	29.49%	44.24%	0.071	0.079
U, ppm	0.23	0.04	0.15	0.31	0.12	0.35	16.86%	33.73%	50.59%	0.22	0.24
V, ppm	120	9	102	138	93	148	7.64%	15.28%	22.91%	114	126
W, ppm	5.08	0.92	3.25	6.92	2.33	7.84	18.07%	36.14%	54.21%	4.83	5.34
Y, ppm	9.79	0.966	7.86	11.73	6.89	12.69	9.87%	19.74%	29.60%	9.30	10.28
Yb, ppm	0.96	0.16	0.63	1.28	0.47	1.44	16.94%	33.88%	50.82%	0.91	1.01
Zn, ppm	65	3.6	58	72	54	76	5.51%	11.01%	16.52%	62	68
Zr, ppm	13.6	2.4	8.8	18.4	6.4	20.8	17.61%	35.23%	52.84%	12.9	14.3

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu$ g/g  $\equiv$  0.0001 wt. %  $\equiv$  1000 ppb, parts per billion.

Note: intervals may appear asymmetric due to rounding.

## PARTICIPATING LABORATORIES

1. ALS, Brisbane, QLD, Australia
2. ALS, Lima, Peru
3. ALS, Loughrea, Galway, Ireland
4. ALS, Perth, WA, Australia
5. ALS, Vancouver, BC, Canada
6. American Assay Laboratories, Sparks, Nevada, USA
7. ANSTO, Lucas Heights, NSW, Australia
8. ARGETEST Mineral Processing, Ankara, Central Anatolia, Turkey
9. Bureau Veritas, Abidjan, Cote D'ivoire
10. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
11. Bureau Veritas Geoanalytical, Perth, WA, Australia
12. Gekko Assay Labs, Ballarat, VIC, Australia
13. Information and Research Center, Kara-Balta, Chuy Region, Kyrgyzstan

14. Inspectorate (BV), Lima, Peru
15. Inspectorate America Corporation (BV), Sparks, Nevada, USA
16. Intertek Genalysis, Perth, WA, Australia
17. Intertek Tarkwa, Tarkwa, Ghana
18. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
19. Kinross Brasil Mineração, Paracatu, Minas Gerais, Brazil
20. MinAnalytical Services, Perth, WA, Australia
21. Nagrom, Perth, WA, Australia
22. Newcrest Laboratory Services, Orange, NSW, Australia
23. Newcrest Laboratory Services, Telfer, WA, Australia
24. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
25. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
26. PT SGS Indo Assay Laboratories, Jakarta, Indonesia
27. SGS, Randfontein, Gauteng, South Africa
28. SGS Australia Mineral Services, Kalgoorlie, WA, Australia
29. SGS Australia Mineral Services, Perth, WA, Australia
30. SGS del Peru, Lima, Peru
31. SGS Lakefield Research Ltd, Lakefield, Ontario, Canada
32. SGS Mineral Services, Townsville, QLD, Australia
33. SGS Tarkwa, Tarkwa, Western Region, Ghana
34. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
35. Zarazma Mineral Studies Company, Tehran, Iran

***Please Note: Above numbered alphabetical list of participating laboratories does not reflect the Lab ID numbering on the scatter plots below.***

Figure 1. Au by Fire Assay in OREAS 229b

SPC.1288.2018-RR.OREAS 229b.3.Fire Assay.Au.Lab.180928.110107.SN

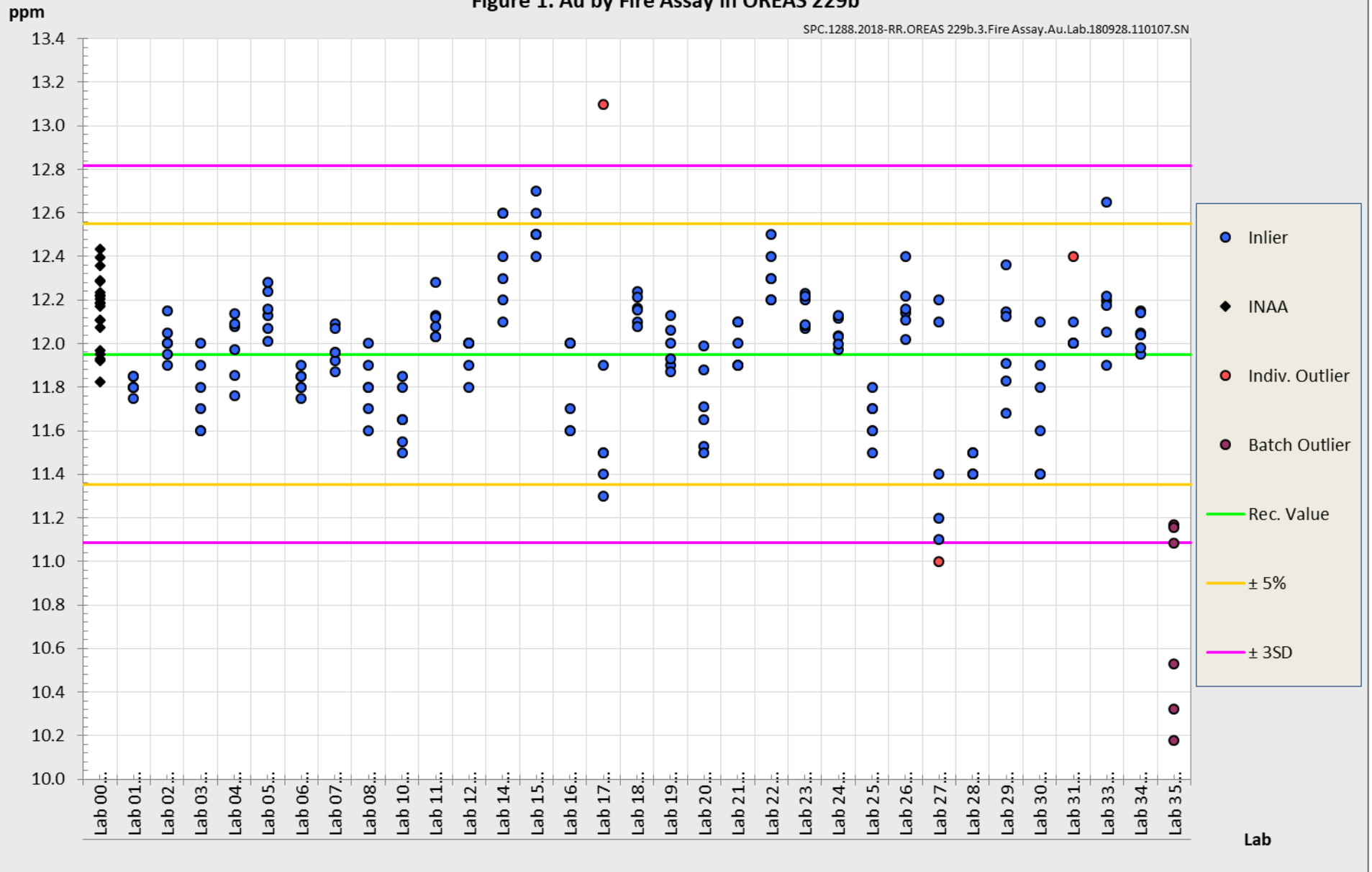


Figure 2. Au by AR Digest 10-50g in OREAS 229b

SPC.1288.2018-RR.OREAS 229b.3.AR Digest 10-50g.Au.Lab.180928.110135.SN

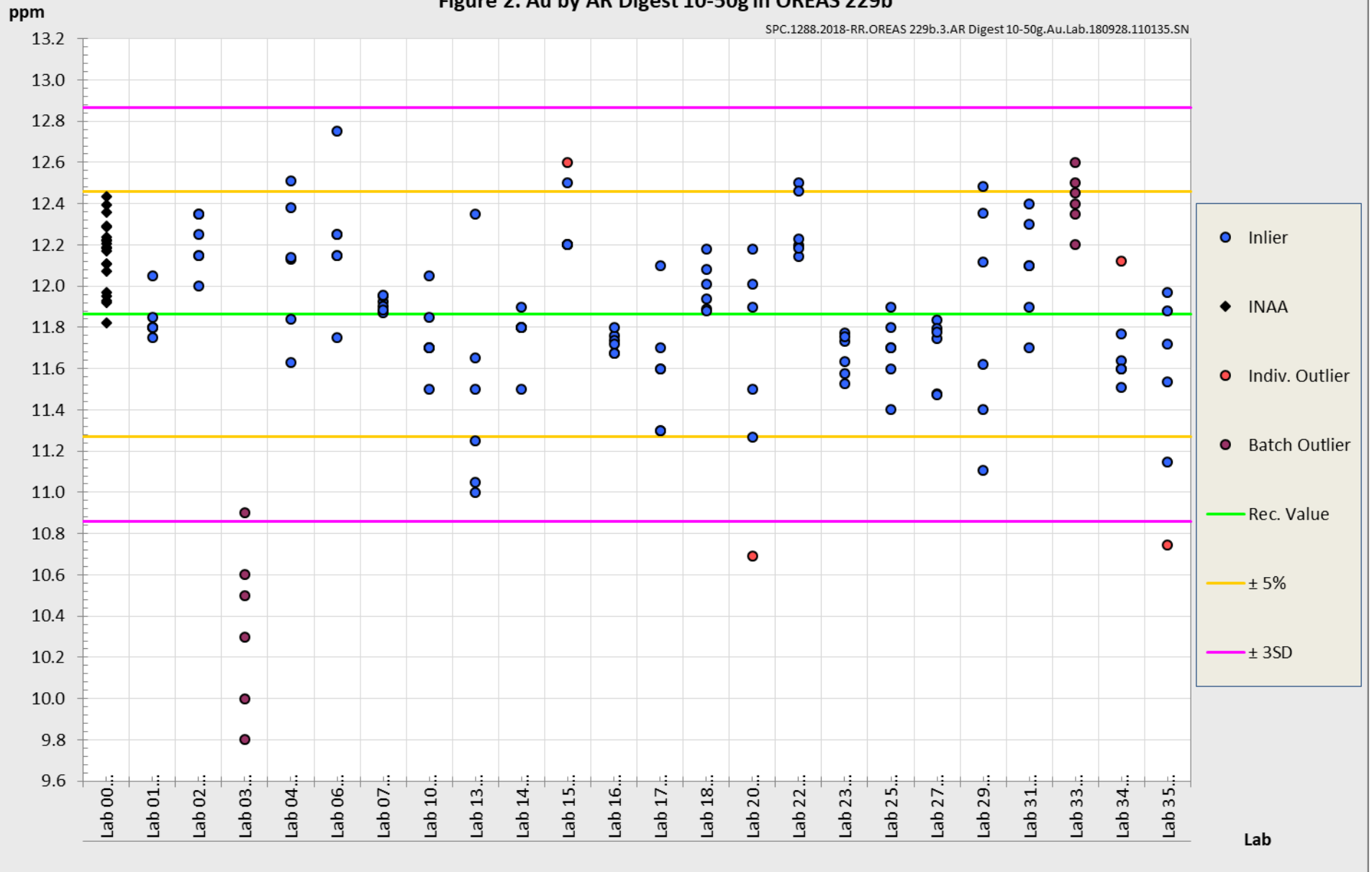
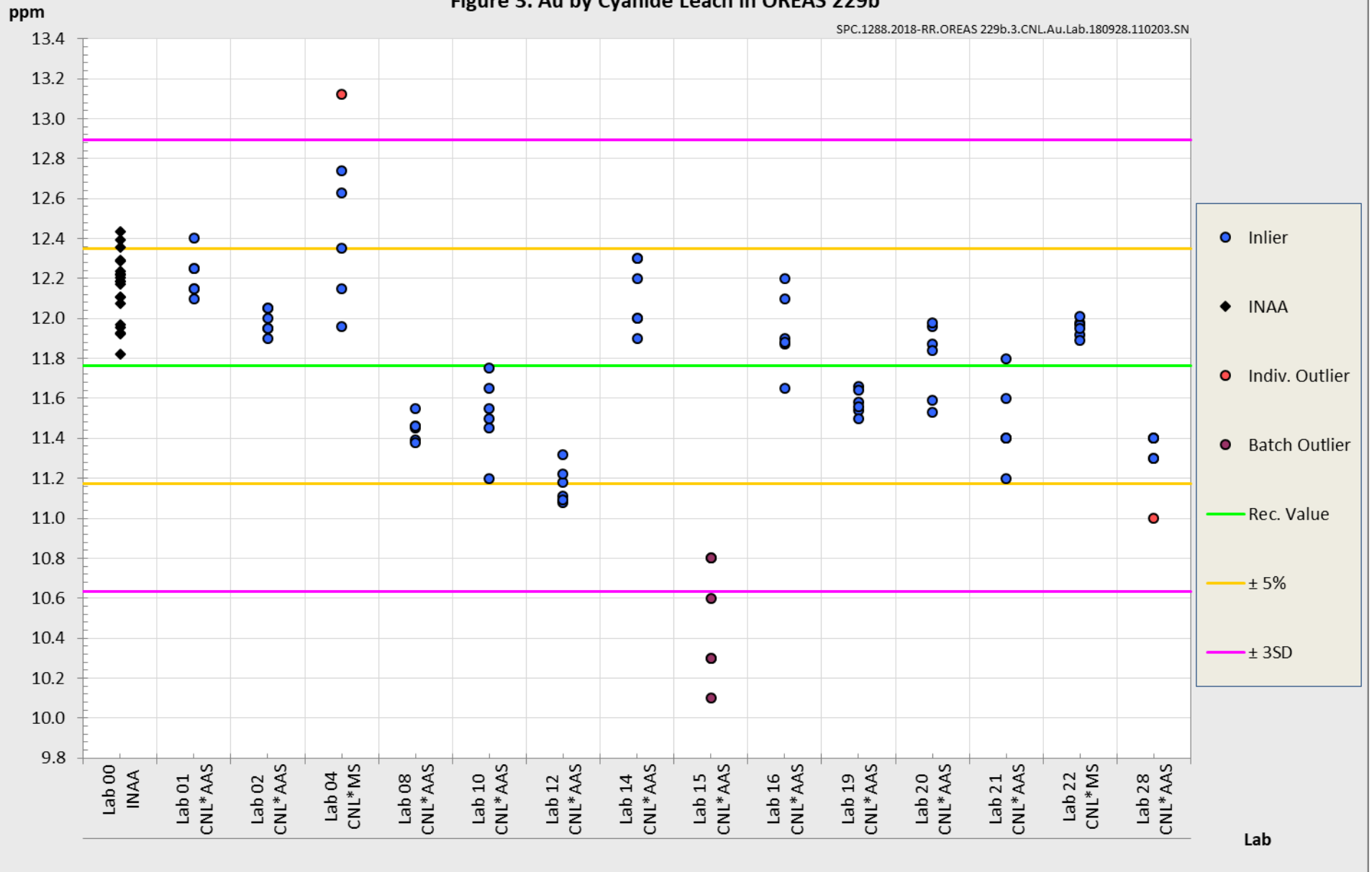


Figure 3. Au by Cyanide Leach in OREAS 229b

SPC.1288.2018-RR.OREAS 229b.3.CNL.Au.Lab.180928.110203.SN



## PREPARER AND SUPPLIER

Certified reference material OREAS 229b is prepared, certified and supplied by:



ORE Research & Exploration Pty Ltd  
37A Hosie Street  
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AUSTRALIA

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Fax: +613-9729 8338  
Web: [www.ore.com.au](http://www.ore.com.au)  
Email: [info@ore.com.au](mailto:info@ore.com.au)

It is packaged in 60g laminated foil pouch units, and 500g wide-mouth plastic jars.

## METROLOGICAL 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 undertaken by ORE Pty Ltd) 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.

Guide ISO/TR 16476:2016, section 5.3.1 describes metrological traceability in reference materials as it pertains to the transformation of the measurand. In this section it states, *"Although the determination of the property value itself can be made traceable to appropriate units through, for example, calibration of the measurement equipment used, steps like the transformation of the sample from one physical (chemical) state to another cannot. Such transformations may only be compared with a reference (when available), or among themselves. For some transformations, reference methods have been defined and may be used in certification projects to evaluate the uncertainty associated with such a transformation. In other cases, **only a comparison among different laboratories using the same method is possible. In this case, certification takes place on the basis of agreement among independent measurement results** (see ISO Guide 35:2006, Clause 10)."*

## COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving pre-treatment (digestion/fusion) of the sample. This served to reduce the sample to a simple and well understood form permitting calibration using simple solutions of the CRM. Due to these methods being well understood and highly effective, commutability is not an issue for this CRM. All OREAS CRMs are sourced from natural ore minerals meaning they will display similar behaviour as routine 'field' samples in the relevant measurement process. Care should be taken to ensure 'matrix matching' as close as practically achievable. The matrix and mineralisation style of the CRM is described in the 'Source Material' section and users should select appropriate CRMs matching these attributes to their field samples.



## INTENDED USE

OREAS 229b is intended to cover all activities needed to produce a measurement result. This includes extraction, possible separation steps and the actual measurement process (the signal producing step). OREAS 229b may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 229b 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 229b has been prepared from primary gold ore diluted with barren greenstone. It is low in reactive sulphide (~0.6 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 229b refer to the concentration levels in its packaged state. There is no need for drying prior to weighing and analysis.

## HANDLING INSTRUCTIONS

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

## LEGAL NOTICE

Ore Research & Exploration Pty Ltd has prepared and statistically evaluated the property values of this reference material to the best of its ability. The Purchaser by receipt hereof releases and indemnifies Ore Research & Exploration Pty Ltd from and against all liability and costs arising from the use of this material and information.

## DOCUMENT HISTORY

Revision No	Date	Changes applied
2	6 <sup>th</sup> February, 2019	Amended Gold by fire assay finishes under the Analytical Program.
1	6 <sup>th</sup> December, 2018	Corrected formula (page 8). Added note regarding laboratory number codes (page 12).
0	3 <sup>rd</sup> October, 2018	First publication.

## QMS ACCREDITED

ORE Pty Ltd is accredited to ISO 9001:2015 by Lloyd's Register Quality Assurance Ltd for its quality management system including development, manufacturing, certification and supply of CRMs.



## CERTIFYING OFFICER

A handwritten signature in blue ink, appearing to read 'Craig Hamlyn'.

6<sup>th</sup> February, 2019

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

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