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OREAS
Certified Reference Materials

CERTIFICATE OF ANALYSIS FOR

LOW LEVEL GOLD OXIDE
CERTIFIED REFERENCE MATERIAL
OREAS H5

Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS H5.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Fire Assay						
Gold, Au (ppb)	47	6	43	52	37	58
Aqua Regia Digestion						
Ag, Silver (ppm)	1.92	0.18	1.68	2.16	IND	IND
As, Arsenic (ppm)	8.4	1.6	7.1	9.8	IND	IND
Au, Gold (ppb)	57	9	50	63	52	61
Bi, Bismuth (ppm)	5.44	0.480	4.81	6.07	IND	IND
Cd, Cadmium (ppm)	1.28	0.23	1.03	1.53	IND	IND
Co, Cobalt (ppm)	3.68	0.63	3.05	4.31	IND	IND
Cr, Chromium (ppm)	31.1	2.36	29.0	33.1	29.1	33.0
Cu, Copper (ppm)	99	5.5	94	104	94	104
Fe, Iron (wt.%)	0.813	0.079	0.730	0.896	0.770	0.856
Mn, Manganese (wt.%)	0.007	0.001	0.006	0.008	0.007	0.008
Mo, Molybdenum (ppm)	7.22	1.15	5.97	8.48	IND	IND
Ni, Nickel (ppm)	11.9	1.5	10.6	13.2	IND	IND
P, Phosphorus (wt.%)	0.010	0.001	0.008	0.012	0.009	0.011
Pb, Lead (ppm)	36.1	5.1	32.0	40.3	33.2	39.1
V, Vanadium (ppm)	35.0	1.70	33.2	36.8	33.3	36.7
Zn, Zinc (ppm)	6.58	0.79	5.94	7.22	IND	IND

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 H5 was prepared from lateritic 'waste' samples sourced from the Hedges Gold Mine located within the Saddleback Greenstone Belt, 130 kms southeast of Perth, Western Australia. This lateritic gold deposit was developed over and proximal to primary gold–copper mineralisation in felsic to intermediate volcanics and felsic intrusions of the Saddleback Greenstone Belt.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS H5 was prepared in the following manner:

- drying to constant mass at 105°C;
- crushing and milling of the material to 100% minus 30 microns;
- homogenisation;
- packaging in 60g units sealed in laminated foil pouches and 1kg units in plastic jars.

ANALYTICAL PROGRAM

Thirteen commercial analytical laboratories participated in the program to characterise gold by fire assay with AAS (9 labs) or ICP-OES (1 lab) finish. Eleven laboratories determined gold via aqua regia digestion with AAS (10 labs) or graphite furnace AAS (1 lab) finish. Gold has been certified separately for the fire assay and aqua regia digestion methods. Other elements certified via aqua regia digestion include Ag, As, Bi, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, P, Pb, V and Zn with a range of finishes including ICP-OES, AAS, graphite furnace AAS, hydride generation AAS and cold vapour AAS.

For the round robin program each of the participating laboratories was sent 10 samples selected at random. Ten 100g samples were submitted to each laboratory for analysis. Table 1 (above) presents the certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 shows indicative values. Indicative values are provided where; i) the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification; ii) inter-laboratory consensus is poor; or iii) a significant proportion of results are outlying or reported as less than detection limits.

Table 3 provides performance gate intervals for the certified values based on their associated standard deviations. Tabulated results of all elements 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 (**OREAS H5 DataPack.xlsx**).

Table 2. Indicative Values for OREAS H5.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Borate Fusion XRF								
Al_2O_3	wt.%	*25.28*	Fe_2O_3	wt.%	*1.86*	Pb	ppm	*55*
As	ppm	*20.0*	K_2O	wt.%	*0.682*	SiO_2	wt.%	*59.94*
Ba	ppm	*165*	MgO	wt.%	*0.220*	Sn	ppm	*12.5*
CaO	wt.%	*0.020*	MnO	wt.%	*0.030*	SO_3	wt.%	*0.056*
Co	ppm	*< 10*	Na_2O	wt.%	*0.300*	TiO_2	wt.%	*1.60*
Cr	ppm	*100*	Ni	ppm	*20.0*	U	ppm	*< 10*
Cu	ppm	*105*	P_2O_5	wt.%	*0.058*	Zn	ppm	*20.0*
Thermogravimetry								
LOI^{1000}	wt.%	*9.47*						
Laser Ablation ICP-MS								
Ag	ppm	*1.40*	Ho	ppm	*0.98*	Sn	ppm	*10.2*
As	ppm	*13.5*	In	ppm	*0.075*	Sr	ppm	*20.5*
Ba	ppm	*158*	La	ppm	*56*	Ta	ppm	*2.99*
Be	ppm	*1.10*	Lu	ppm	*0.60*	Tb	ppm	*0.70*
Bi	ppm	*5.98*	Mn	wt.%	*0.015*	Te	ppm	*3.70*
Cd	ppm	*1.70*	Mo	ppm	*9.50*	Th	ppm	*30.9*
Ce	ppm	*78*	Nb	ppm	*35.1*	Ti	wt.%	*0.977*
Co	ppm	*4.90*	Nd	ppm	*30.8*	Tl	ppm	*< 0.2*
Cr	ppm	*103*	Ni	ppm	*30.0*	Tm	ppm	*0.47*
Cs	ppm	*2.27*	Pb	ppm	*52*	U	ppm	*8.26*
Cu	ppm	*117*	Pr	ppm	*9.78*	V	ppm	*85*
Dy	ppm	*4.65*	Rb	ppm	*68*	W	ppm	*8.40*
Er	ppm	*2.88*	Re	ppm	*< 0.01*	Y	ppm	*27.4*
Eu	ppm	*0.86*	Sb	ppm	*4.60*	Yb	ppm	*3.58*
Ga	ppm	*43.5*	Sc	ppm	*8.85*	Zn	ppm	*12.5*
Gd	ppm	*4.69*	Se	ppm	*< 5*	Zr	ppm	*2270*
Hf	ppm	*63*	Sm	ppm	*5.66*			
Aqua Regia Digestion								
Al	wt.%	*2.31*	Li	ppm	*2.00*	Ta	ppm	*< 10*
B	ppm	*23.0*	Mg	wt.%	*0.073*	Te	ppm	*2.37*
Ba	ppm	*52*	Na	wt.%	*0.135*	Th	ppm	*19.1*
Be	ppm	*< 1*	Nb	ppm	*0.75*	Ti	wt.%	*0.040*
Ca	wt.%	*0.014*	S	wt.%	*0.017*	Tl	ppm	*0.71*
Ga	ppm	*11.4*	Sb	ppm	*4.85*	W	ppm	*< 5*
Ge	ppm	*< 0.1*	Sc	ppm	*2.50*	Y	ppm	*5.00*
Hg	ppm	*0.14*	Se	ppm	*1.86*	Zr	ppm	*47.8*
K	wt.%	*0.059*	Sn	ppm	*< 10*			
La	ppm	*27.5*	Sr	ppm	*6.89*			
Instrumental Neutron Activation Analysis								
As	ppm	*14*	Ir	ppb	*< 5*	Sm	ppm	*5.3*
Au	ppb	*53*	K	wt.%	*0.50*	Sn	ppm	*< 100*
Ba	ppm	*173*	La	ppm	*52*	Ta	ppm	*2.8*
Br	ppm	*5.0*	Lu	ppm	*0.7*	Tb	ppm	*0.7*
Ce	ppm	*76*	Mo	ppm	*14*	Th	ppm	*29*

Table 2 continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Instrumental Neutron Activation Analysis Continued								
Co	ppm	*4.6*	Na	wt.%	*0.21*	U	ppm	*7.6*
Cr	ppm	*108*	Nd	ppm	*32*	W	ppm	*8.4*
Cs	ppm	*1.9*	Ni	ppm	*28*	Yb	ppm	*4.3*
Eu	ppm	*0.93*	Rb	ppm	*58*	Zn	ppm	*46*
Fe	wt.%	*1.24*	Sb	ppm	*5.1*	Zr	ppm	*2085*
Hf	ppm	*57*	Sc	ppm	*9.1*			
Hg	ppm	*< 1*	Se	ppm	*12*			

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.

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 (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.

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.

Performance Gates (Table 3) 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.

Table 3. Performance Gates for OREAS H5.

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	47	6	35	60	28	67	13.50%	26.99%	40.49%	45	50
Aqua Regia Digestion											
Ag, ppm	1.92	0.18	1.56	2.28	1.38	2.46	9.40%	18.80%	28.20%	1.82	2.01
As, ppm	8.4	1.6	5.3	11.6	3.7	13.1	18.60%	37.21%	55.81%	8.0	8.8
Au, ppb	57	9	39	74	30	83	15.64%	31.29%	46.93%	54	59
Bi, ppm	5.44	0.480	4.48	6.40	4.00	6.88	8.81%	17.62%	26.43%	5.17	5.71
Cd, ppm	1.28	0.23	0.82	1.74	0.59	1.97	17.91%	35.83%	53.74%	1.22	1.35
Co, ppm	3.68	0.63	2.43	4.94	1.80	5.56	17.02%	34.05%	51.07%	3.50	3.87
Cr, ppm	31.1	2.36	26.4	35.8	24.0	38.1	7.59%	15.17%	22.76%	29.5	32.6
Cu, ppm	99	5.5	88	110	83	115	5.51%	11.03%	16.54%	94	104
Fe, wt.%	0.813	0.079	0.654	0.972	0.575	1.052	9.78%	19.55%	29.33%	0.772	0.854
Mn, wt.%	0.007	0.001	0.005	0.009	0.004	0.010	14.01%	28.02%	42.03%	0.007	0.008
Mo, ppm	7.22	1.15	4.92	9.53	3.77	10.68	15.95%	31.89%	47.84%	6.86	7.59
Ni, ppm	11.9	1.5	8.9	14.9	7.4	16.3	12.48%	24.95%	37.43%	11.3	12.5
P, wt.%	0.010	0.001	0.007	0.012	0.006	0.014	12.42%	24.84%	37.26%	0.009	0.010
Pb, ppm	36.1	5.1	26.0	46.3	20.9	51.4	14.04%	28.07%	42.11%	34.3	38.0
V, ppm	35.0	1.70	31.6	38.4	29.9	40.1	4.85%	9.69%	14.54%	33.2	36.7
Zn, ppm	6.58	0.79	4.99	8.16	4.20	8.96	12.06%	24.12%	36.18%	6.25	6.91

Note: intervals may appear asymmetric due to rounding

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 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 37 and 58 ppb. 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).

Based on the statistical analysis of the results of the inter-laboratory certification program it can be concluded that OREAS H5 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PARTICIPATING LABORATORIES

1. Acme, Vancouver, BC, Canada
2. Actlabs, Ancaster, Ontario, Canada
3. ALS, Brisbane, QLD, Australia
4. Amdel (BV), Adelaide, SA, Australia
5. SGS Analabs, Perth, WA, Australia
6. Bondar-Clegg, Vancouver, BC, Canada
7. Intertek Testing Services, Jakarta, Indonesia
8. IPL, Vancouver, BC, Canada
9. Intertek Testing Services, Muntinlupa, Philippines
10. NOMOS, Rio de Janeiro, Brazil
11. Ostrea, Laguna Philippines
12. TSL, Saskatchewan, Canada
13. UMSL, Missouri, U.S.A

PREPARER AND SUPPLIER

Certified reference material OREAS H5 is prepared, certified and supplied by:

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

INTENDED USE

OREAS H5 is intended for the following uses:

- for the monitoring of laboratory performance in the analysis of Ag, As, Au, Bi, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, P, Pb, V and Zn in geological samples;
- for the verification of analytical methods for Ag, As, Au, Bi, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, P, Pb, V and Zn;
- for the calibration of instruments used in the determination of the concentration of Ag, As, Au, Bi, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, P, Pb, V and Zn.

STABILITY AND STORAGE INSTRUCTIONS

OREAS H5 has been prepared from samples sourced from the Hedges Gold Mine. In its unopened state under normal conditions of storage it has a shelf life beyond ten years.

INSTRUCTIONS FOR CORRECT USE

The certified values for OREAS H5 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 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.

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

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.