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**CERTIFICATE OF ANALYSIS FOR**

**Copper Blank (Mt Isa Mine, Queensland, Australia)**

**CERTIFIED REFERENCE MATERIAL**

**OREAS 160**



Project: COA-754-OREAS160

Printed: 22-August-2018

**Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 160.**

Constituent	Certified Value	95% Confidence Interval		Tolerance Interval 1- $\alpha$ =0.99, $\rho$ =0.95	
		Low	High	Low	High
<b>Peroxide Fusion</b>					
Copper, Cu (wt.%)	<0.02	IND	IND	IND	IND
Iron, Fe (wt.%)	1.13	1.08	1.17	1.07	1.18
Sulphur, S (wt.%)	0.04	0.03	0.05	IND	IND
Calcium oxide, CaO (wt.%)	0.15	0.12	0.18	IND	IND
Magnesium oxide, MgO (wt.%)	0.62	0.59	0.65	0.59	0.64
Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%)	5.01	4.96	5.05	4.90	5.12
Silicon dioxide, SiO <sub>2</sub> (wt.%)	88.7	84.9	92.5	86.0	91.5
Silver, Ag (ppm)	<2	IND	IND	IND	IND
Lead, Pb (ppm)	7	2	13	IND	IND
Zinc, Zn (ppm)	<30	IND	IND	IND	IND
Cobalt, Co (ppm)	<8	IND	IND	IND	IND
<b>Acid Digest</b>					
Copper, Cu (wt.%)	0.0013	0.0012	0.0014	0.0011	0.0015
Iron, Fe (wt.%)	1.15	1.13	1.18	1.12	1.18
Sulphur, S (wt.%)	0.029	0.027	0.031	0.026	0.032
Calcium oxide, CaO (wt.%)	0.146	0.142	0.149	0.138	0.154
Magnesium oxide, MgO (wt.%)	0.64	0.61	0.66	0.62	0.65
Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%)	5.04	4.84	5.24	4.96	5.12
Silver, Ag (ppm)	<0.2	IND	IND	IND	IND
Lead, Pb (ppm)	6.6	6.0	7.2	5.1	8.1
Zinc, Zn (ppm)	7	5	9	IND	IND
Cobalt, Co (ppm)	2.8	2.5	3.1	2.5	3.2

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 2. Indicative Values for OREAS 160.**

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
<b>Borate Fusion XRF</b>								
Al <sub>2</sub> O <sub>3</sub>	wt.%	5.01	Fe <sub>2</sub> O <sub>3</sub>	wt.%	1.64	SnO <sub>2</sub>	ppm	< 13
As	ppm	40.0	K <sub>2</sub> O	wt.%	2.16	SO <sub>3</sub>	wt.%	0.075
BaO	ppm	363	MgO	wt.%	0.648	SrO	ppm	23.7
CaO	wt.%	0.131	MnO	wt.%	0.015	TiO <sub>2</sub>	wt.%	0.156
Cl	ppm	65	NiO	ppm	19.1	V <sub>2</sub> O <sub>5</sub>	ppm	17.9
CoO	ppm	< 13	P <sub>2</sub> O <sub>5</sub>	wt.%	0.037	ZnO	ppm	< 12
Cr <sub>2</sub> O <sub>3</sub>	ppm	132	PbO	ppm	10.8	ZrO <sub>2</sub>	ppm	311
CuO	ppm	18.8	SiO <sub>2</sub>	wt.%	89.70			
<b>Thermogravimetry</b>								
LOI <sup>1000</sup>	wt.%	0.425						
<b>Laser Ablation ICP-MS</b>								
Ag	ppm	0.200	Hf	ppb	6650	Sn	ppm	1.30
As	ppm	1.00	Ho	ppb	410	Sr	ppm	20.0

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

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. Indicative Values for OREAS 160 continued.**

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
<b>Laser Ablation ICP-MS</b>								
Ba	ppm	324	In	ppm	< 0.05	Ta	ppb	405
Be	ppm	0.90	La	ppm	18.2	Tb	ppb	315
Bi	ppm	0.080	Lu	ppb	180	Te	ppb	300
Cd	ppm	1.00	Mo	ppm	9.80	Th	ppm	6.00
Ce	ppm	33.7	Nb	ppm	3.32	Tl	ppm	1.60
Co	ppm	2.60	Nd	ppm	14.0	Tm	ppb	175
Cr	ppm	89	Ni	ppm	11.0	U	ppm	1.55
Cs	ppm	1.03	Pb	wt. %	0.001	V	ppm	7.25
Cu	ppm	12.0	Pr	ppm	3.89	W	ppm	2.45
Dy	ppm	1.77	Rb	ppm	63	Y	ppm	10.5
Er	ppm	1.12	Re	ppb	20.0	Yb	ppb	1120
Eu	ppb	570	Sb	ppm	0.80	Zn	ppm	10.0
Ga	ppm	5.05	Sc	ppm	1.75	Zr	ppm	230
Gd	ppm	2.11	Se	ppm	< 5			
Ge	ppb	650	Sm	ppm	2.55			

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.

## 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.

OREAS reference materials enable users to successfully achieve process control of these tasks because the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself.

## SOURCE MATERIAL

OREAS 160 is a copper blank certified reference material (CRM) prepared and certified by Ore Research & Exploration Pty Ltd. The material was sourced from Xstrata's Mt Isa copper deposits located near the township of Mt Isa in north-west Queensland. The deposits are hosted by brecciated siliceous rock masses within the Urquhart Shale comprising complex and dissociated veins with chalcopyrite, pyrite and pyrrhotite with grades of 3-4% copper. OREAS 160 is sourced from barren copper material and is one of a suite of seven CRMs characterised for Cu, Fe, S, CaO, MgO, Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, Ag, Pb, Zn and Co by both sodium peroxide fusion ICP and 4-acid ICP methods.

## COMMINUTION AND HOMOGENISATION PROCEDURES

The material was prepared in the following manner:

- Drying at 65°C to constant mass;
- Crushing and screening;
- Multi-stage milling to 100% minus 50 microns;
- Preliminary blending;
- Check assaying;
- Adjustment of grades as necessary;
- Final homogenisation;
- Packaging into 10g units in laminated foil pouches.

## ANALYTICAL PROGRAM

Ten commercial laboratories participated in the analytical program to characterise Cu, Fe, S, CaO, MgO, Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, Ag, Pb, Zn and Co by both sodium peroxide fusion ICP and 4-acid ICP methods. To maintain anonymity laboratories were randomly designated the letter codes A through J. In some instances laboratories determined one or more analytes using an alternative method to sodium peroxide fusion. These instances include: Lab J where a pyrosulfate fusion for Fe was used, Lab H used infrared combustion furnace to determine sulphur and used lithium borate fusion to determine all analytes except Cu and Zn. Another exception includes Lab J where an acid digest (non-specified) with AAS finish was used instead of a 4-acid digest to determine Ag. All results together with uncorrected means, medians, one sigma standard deviations, relative standard deviations and percent deviation of lab means from the corrected mean of means (PDM<sup>3</sup>) are presented in Tables A2 to A22 (Appendix). The parameter PDM<sup>3</sup> is a measure of laboratory accuracy while the relative standard deviation is an effective measure of analytical precision where homogeneity of the test material has been confirmed.

The approximate major and trace element composition of OREAS 160 is provided in Table 2. The non-certified values contained in this table are the means of duplicate assays from one laboratory.

The analytical methods employed by each laboratory are explained, together with other abbreviations used, in Table A1 (Appendix).

Each participating laboratory received 5 samples of 50g each. Each set of subsamples submitted to each laboratory was taken at regular intervals during packaging of the standard in order to maximise their representation. Laboratories were instructed to assay samples as received.

## STATISTICAL EVALUATION

### Certified Value and Confidence Intervals

The certified value is the mean of means of accepted replicate values of accepted participating laboratories computed according to the formulae

$$\bar{x}_i = \frac{1}{n_i} \sum_{j=1}^{n_i} x_{ij} \qquad \bar{\bar{x}} = \frac{1}{p} \sum_{i=1}^p \bar{x}_i$$

where,

$x_{ij}$  is the  $j$ th result reported by laboratory  $i$ ;  
 $p$  is the number of participating laboratories;  
 $n_i$  is the number of results reported by laboratory  $i$ ;  
 $\bar{x}_i$  is the mean for laboratory  $i$ ;  
 $\bar{x}$  is the mean of means.

The confidence intervals are obtained by calculation of the variance ( $\hat{V}$ ) of the consensus value ( $\bar{x}$ ) (mean of means) and reference to Student's- $t$  distribution with degrees of freedom ( $p-1$ ).

$$\hat{V}(\bar{x}) = \frac{1}{p(p-1)} \sum_{i=1}^p (\bar{x}_i - \bar{x})^2$$

$$\text{Confidence Interval} = \bar{x} \pm t_{1-x/2}(p-1)(\hat{V}(\bar{x}))^{1/2}$$

where,

$t_{1-x/2}(p-1)$  is the  $1-x/2$  fractile of the  $t$ -distribution with  $(p-1)$  degrees of freedom.

The distribution of the values is assumed to be symmetrical about the mean in the calculation of the confidence interval. The test for rejection of individual outliers from each laboratory data set is based on  $z$  scores (rejected if  $|z_i| > 2.5$ ) computed from the robust estimators of location and scale,  $T$  and  $S$ , respectively, according to the formulae

$$S = 1.483 \frac{\text{median}_{j=1, \dots, n} |x_j - \text{median}_{i=1, \dots, n}(x_i)|}{}$$

$$z_i = \frac{x_i - T}{S}$$

where,

$T$  is the median value in a data set;

$S$  is the median of all absolute deviations from the sample median multiplied by 1.483, a correction factor to make the estimator consistent with the usual parameter of a normal distribution.

The  $z$ -score test is used in combination with a second method of individual outlier detection that determines the percent deviation of the individual value from the median. Outliers in general are selected on the basis of  $z$ -scores  $> 2.5$  and with percent deviations  $> 1.5\%$ . In certain instances statistician's prerogative has been employed in discriminating outliers.

Each laboratory data set is tested for outlying status based on  $z$ -score discrimination and rejected if  $|z_i| > 2.5$ . After individual and lab data set 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.

Individual outliers and, more rarely, laboratory means deemed to be outlying are shown left justified and in bold in the tabulated results (see Appendix) and have been omitted in the determination of certified values.

The magnitude of the confidence interval is inversely proportional to the number of participating laboratories and interlaboratory agreement. It 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. A 95% confidence interval indicates a 95% probability that the interval includes the true value of the analyte under consideration.

### Indicative (uncertified) values

The indicative (uncertified) values (Table 2) are provided for the major and trace elements determined by oxidising fusion XRF (Al<sub>2</sub>O<sub>3</sub> to ZrO<sub>2</sub>), LOI at 1000°C 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.

### Statement of Homogeneity

The standard deviation of each laboratory data set includes error due to both the imprecision of the analytical method employed and to possible inhomogeneity of the material analysed. The standard deviation of the pooled individual analyses of all participating laboratories includes error due to the imprecision of each analytical method, to possible inhomogeneity of the material analysed and, in particular, to deficiencies in accuracy of each analytical method.

In determining tolerance intervals that component of error attributable to measurement inaccuracy was eliminated by transformation of the individual results of each data set to a common mean (the uncorrected grand mean) according to the formula

$$x'_{ij} = x_{ij} - \bar{x}_i + \frac{\sum_{i=1}^p \sum_{j=1}^{n_i} x_{ij}}{\sum_{i=1}^p n_i}$$

where,

$x_{ij}$  is the  $j$ th raw result reported by laboratory  $i$ ;

$x'_{ij}$  is the  $j$ th transformed result reported by laboratory  $i$ ;

$n_i$  is the number of results reported by laboratory  $i$ ;

$p$  is the number of participating laboratories;

$\bar{x}_i$  is the raw mean for laboratory  $i$ .

The homogeneity of each constituent was determined from tables of factors for two-sided tolerance limits for normal distributions (ISO 3207) in which

$$\text{Lower limit is } \bar{x} - k'_2(n, p, 1 - \alpha) s_g''$$

$$\text{Upper limit is } \bar{x} + k'_2(n, p, 1 - \alpha) s_g''$$

where,

$n$  is the number of results;

$1 - \alpha$  is the confidence level;

$p$  is the proportion of results expected within the tolerance limits;

$k'_2$  is the factor for two-sided tolerance limits ( $m, \alpha$  unknown);

$s_g''$  is the corrected grand standard deviation

The meaning of these tolerance limits may be illustrated for Cu by 4-acid digest, where 99% of the time at least 95% of subsamples will have concentrations lying between 0.156 and 0.168 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 (ISO Guide 35).

The corrected grand standard deviation,  $s_g''$ , used to compute the tolerance intervals is the weighted means of standard deviations of all data sets for a particular constituent according to the formula:

$$s_g'' = \frac{\sum_{i=1}^p (s_i (1 - \frac{s_i}{s_g'}))}{\sum_{i=1}^p (1 - \frac{s_i}{s_g'})}$$

where,

$1 - (\frac{s_i}{s_g'})$  is the weighting factor for laboratory  $i$ ;

$s_g'$  is the grand standard deviation computed from the transformed (i.e. means-adjusted) results

according to the formula

$$s_g' = \left[ \frac{\sum_{i=1}^p \sum_{j=i}^{n_i} (x'_{ij} - \bar{x}'_i)^2}{\sum_{i=1}^p n_i - 1} \right]^{1/2}$$

where  $\bar{x}'_i$  is the transformed mean for laboratory  $i$

The weighting factors were applied to compensate for the considerable variation in analytical precision amongst participating laboratories. Hence, weighting factors for each data set have been constructed so as to be inversely proportional to the standard deviation of that data set. It should be noted that estimates of tolerance by this method are considered conservative as a significant proportion of the observed variance, even in those laboratories exhibiting the best analytical precision, can presumably be attributed to measurement error.

### Performance Gates

Performance gates 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 and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. Sources of measurement error include inter-lab bias, analytical precision (repeatability) and inter-batch bias (reproducibility).

Two methods have been employed to calculate performance gates. The first method uses the same filtered data set used to determine the certified value, i.e. after removal of all individual, lab dataset (batch) and 3SD outliers. 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 individual analyses generated from the certification program. Table 3 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 3. Performance Gates for OREAS 160.**

Constituent	Certified Value	1SD	2SD window		3SD window		Relative Standard Deviations			5% window	
			Low	High	Low	High	1RSD	2RSD	3RSD	Low	High
<b>Peroxide Fusion</b>											
Copper, Cu (wt.%)	<0.02	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Iron, Fe (wt.%)	1.13	0.06	1.01	1.24	0.95	1.30	5.18%	10.4%	15.5%	1.07	1.18
Sulphur, S (wt.%)	0.04	0.02	0.01	0.07	-0.01	0.09	43.4%	86.8%	130%	0.04	0.04
Calcium oxide, CaO (wt.%)	0.15	0.04	0.07	0.23	0.03	0.27	27.3%	54.6%	82%	0.14	0.16
Magnesium oxide, MgO (wt.%)	0.62	0.04	0.54	0.70	0.50	0.74	6.41%	12.8%	19.2%	0.59	0.65
Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%)	5.01	0.08	4.85	5.16	4.77	5.24	1.57%	3.13%	4.70%	4.76	5.26
Silicon dioxide, SiO <sub>2</sub> (wt.%)	88.7	4.8	79.1	98.4	74.3	103.2	5.42%	10.8%	16.3%	84.3	93.2
Silver, Ag (ppm)	<2	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Lead, Pb (ppm)	7	2	3	11	2	13	26.6%	53.3%	79.9%	7	8
Zinc, Zn (ppm)	<30	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Cobalt, Co (ppm)	<8	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
<b>Acid Digest</b>											
Copper, Cu (wt.%)	0.0013	0.0002	0.0009	0.0017	0.0007	0.0019	16.0%	32.1%	48.1%	0.0012	0.0014
Iron, Fe (wt.%)	1.15	0.04	1.07	1.24	1.02	1.28	3.73%	7.47%	11.2%	1.10	1.21
Sulphur, S (wt.%)	0.029	0.002	0.025	0.033	0.023	0.035	6.45%	12.9%	19.3%	0.028	0.031
Calcium oxide, CaO (wt.%)	0.146	0.005	0.136	0.156	0.130	0.161	3.53%	7.06%	10.6%	0.139	0.153
Magnesium oxide, MgO (wt.%)	0.64	0.04	0.56	0.71	0.53	0.75	5.77%	11.5%	17.3%	0.60	0.67
Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%)	5.04	0.27	4.51	5.58	4.24	5.85	5.33%	10.7%	16.0%	4.79	5.29
Silver, Ag (ppm)	<0.2	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Lead, Pb (ppm)	6.6	0.7	5.1	8.0	4.4	8.8	11.0%	22.0%	33.0%	6.3	6.9
Zinc, Zn (ppm)	7	2	3	11	1	14	28.0%	56.0%	84.0%	7	8
Cobalt, Co (ppm)	2.8	0.5	1.8	3.9	1.3	4.4	18.2%	36.3%	54.5%	2.7	3.0

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

Note: intervals may appear asymmetric due to rounding



## PARTICIPATING LABORATORIES

1. Acme Analytical Laboratories Ltd, Vancouver, BC, Canada
2. Activation Laboratories, Ancaster, ONtario, Canada
3. Activation Laboratories, Perth, WA, Australia
4. ALS Chemex, Brisbane, QLD, Australia
5. ALS Chemex, Vancouver, BC, Canada
6. Amdel Laboratories, Perth, WA, Australia
7. Bureau Veritas (Ultra Trace) Geoanalytical, Perth, WA, Australia
8. Genalysis Laboratory Services Pty Ltd, Perth, WA, Australia
9. SGS Mineral Services Australia, Perth, WA, Australia
10. SGS Mineral Services, Lakefield, ON, Canada

## PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

Reference material OREAS 160 has been prepared and certified by:



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OREAS 160 has been packaged into 10g units in laminated foil pouches.

## INTENDED USE

OREAS 160 is a reference material intended for the following:

- i) For the monitoring of laboratory performance in the analysis of Cu, Fe, S, cao, mgo, Al<sub>2</sub>O<sub>3</sub>, sio<sub>2</sub>, Ag, Pb, Zn and Co in geological samples;
- ii) For the calibration of instruments used in the determination of the concentration of Cu, Fe, S, cao, mgo, Al<sub>2</sub>O<sub>3</sub>, sio<sub>2</sub>, Ag, Pb, Zn and Co;
- iii) For the verification of analytical methods for Cu, Fe, S, cao, mgo, Al<sub>2</sub>O<sub>3</sub>, sio<sub>2</sub>, Ag, Pb, Zn and Co.

## STABILITY AND STORAGE INSTRUCTIONS

OREAS 160 is a reference material made from barren copper material from the Mt Isa Copper Operations. In its unopened state in the nitrogen-purged laminated foil pouches and under normal conditions of storage it has a shelf life beyond five years.

## 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.

## INSTRUCTIONS FOR THE CORRECT USE

The certified values for OREAS 160 refer to the concentration level of Cu, Fe, S, CaO, MgO, Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, Ag, Pb, Zn and Co in its packaged state. The CRM should not be dried prior to weighing and analysis.

## 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.

## 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	22 <sup>nd</sup> Aug, 2018	Added major and trace element characterisation.
1	7 <sup>th</sup> Aug, 2012	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

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

## REFERENCES

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

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

ISO Guide 31 (2015), Reference materials – Contents of certificates and labels.

ISO Guide 35 (2017), Certification of reference materials - General and statistical principals.

# **APPENDIX**

## **Analytical Data for OREAS 160**

Table A1. Explanation of abbreviations used in Tables A2 – A11.

Abbreviation	Explanation
Std.Dev.	one standard deviation
Rel.Std.Dev.	one relative standard deviation (%)
PDM <sup>3</sup>	percent deviation of lab mean from corrected mean of means
NR	not reported
AD	acid digest (unspecified)
4A	four acid digest (HF-HNO <sub>3</sub> -HClO <sub>4</sub> -HCl)
PF	sodium peroxide fusion
PSF	pyrosulfate fusion
XRF	X-ray fluorescence
AAS	atomic absorption spectrometry
OES	inductively coupled plasma optical emission spectrometry
MS	inductively coupled plasma mass spectrometry
ICP	unspecified/combination of ICP-OES and ICP-MS

Table A2. Fusion results for Cu in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A PF*ICP	Lab B -	Lab C PF*OES	Lab D PF*OES	Lab E PF*MS	Lab F PF*OES	Lab G -	Lab H PF*OES	Lab I PF*ICP	Lab J PF*OES
1	<0.005	NR	0.002	0.002	0.003	<0.005	NR	<0.01	0.015	<0.002
2	0.010	NR	0.002	0.002	0.001	<0.005	NR	<0.01	0.012	<0.002
3	<0.005	NR	<0.002	0.002	0.001	<0.005	NR	<0.01	0.012	<0.002
4	<0.005	NR	0.002	0.003	0.002	<0.005	NR	<0.01	0.011	<0.002
5	<0.005	NR	<0.002	0.003	<0.001	<0.005	NR	<0.01	0.013	<0.002
Mean	0.010		0.002	0.002	0.002				0.013	
Median	0.010		0.002	0.002	0.001				0.012	
Std.Dev.			0.000	0.001	0.001				0.002	
Rel.Std.Dev.			0.00%	22.8%	60.2%				12.0%	
PDM <sup>3</sup>	74.2%		-65.2%	-58.2%	-70.4%				120%	

Table A3. Fusion results for Fe in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A PF*ICP	Lab B PF*OES	Lab C PF*OES	Lab D PF*OES	Lab E PF*OES	Lab F PF*OES	Lab G PF*OES	Lab H BF*OES	Lab I PF*ICP	Lab J PSF*XRF
1	1.13	1.17	1.23	0.83	1.08	<b>0.93</b>	1.13	1.04	1.17	1.11
2	1.16	1.16	1.20	0.85	1.07	1.13	1.07	1.10	1.16	1.11
3	1.15	1.21	<b>1.25</b>	0.85	<b>1.20</b>	1.09	1.08	1.08	1.09	1.08
4	1.16	1.21	1.19	0.81	1.01	1.13	1.08	1.06	1.22	1.12
5	1.13	1.20	1.19	<b>1.19</b>	1.04	1.19	1.01	1.06	1.16	1.10
Mean	1.15	1.19	1.21	<b>0.91</b>	1.08	1.09	1.07	1.07	1.16	1.10
Median	1.15	1.20	1.20	0.85	1.07	1.13	1.08	1.06	1.16	1.11
Std.Dev.	0.02	0.02	0.03	0.16	0.07	0.10	0.04	0.02	0.05	0.02
Rel.Std.Dev.	1.32%	1.97%	2.21%	17.6%	6.7%	8.99%	4.07%	2.09%	4.00%	1.37%
PDM <sup>3</sup>	1.82%	5.73%	7.68%	-19.5%	-4.04%	-2.80%	-4.62%	-5.06%	3.06%	-1.91%

Table A4. Fusion results for S in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A PF*ICP	Lab B -	Lab C PF*OES	Lab D -	Lab E PF*OES	Lab F PF*OES	Lab G PF*OES	Lab H IRC	Lab I PF*ICP	Lab J PF*OES
1	0.07	NR	0.04	NR	0.06	0.04	0.07	<0.02	<0.01	0.04
2	0.05	NR	0.02	NR	0.05	0.06	0.05	<0.02	<0.01	0.03
3	0.04	NR	0.04	NR	<b>0.18</b>	0.03	0.05	0.03	<0.01	0.03
4	0.01	NR	0.01	NR	<0.05	0.03	0.07	0.02	<0.01	0.03
5	<0.01	NR	0.01	NR	<0.05	0.04	0.06	0.03	<0.01	0.03
Mean	0.04		0.02		0.10	0.04	0.06	0.03		0.03
Median	0.05		0.02		0.06	0.04	0.06	0.03		0.03
Std.Dev.	0.03		0.02		0.07	0.01	0.01	0.01		0.00
Rel.Std.Dev.	58.8%		63.2%		74.8%	30.6%	13.6%	21.7%		14.0%
PDM <sup>3</sup>	6.18%		-40.0%		142%	-0.07%	50.0%	-33.4%		-20.1%

Table A5. Fusion results for CaO in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A PF*ICP	Lab B -	Lab C PF*OES	Lab D PF*OES	Lab E PF*OES	Lab F PF*OES	Lab G PF*OES	Lab H BF*OES	Lab I PF*ICP	Lab J -
1	0.18	NR	0.10	0.20	0.11	0.09	0.15	0.14	0.42	NR
2	0.15	NR	0.10	0.20	0.15	0.23	0.12	0.14	0.41	NR
3	0.15	NR	0.10	0.20	0.18	0.12	0.13	0.13	0.41	NR
4	0.14	NR	0.10	0.30	0.11	0.20	0.14	0.14	0.41	NR
5	0.15	NR	0.10	NR	0.13	0.25	0.11	0.13	0.38	NR
Mean	0.15		0.10	0.23	0.14	0.18	0.13	0.14	<b>0.41</b>	
Median	0.15		0.10	0.20	0.13	0.20	0.13	0.14	0.41	
Std.Dev.	0.02		0.00	0.05	0.03	0.07	0.02	0.01	0.02	
Rel.Std.Dev.	9.85%		0.00%	22.2%	21.8%	39.2%	11.9%	4.03%	3.74%	
PDM <sup>3</sup>	4.28%		-32.3%	52.4%	-7.90%	20.5%	-12.2%	-7.90%	175%	

Table A6. Fusion results for MgO in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A PF*ICP	Lab B PF*OES	Lab C PF*OES	Lab D PF*OES	Lab E PF*OES	Lab F PF*OES	Lab G PF*OES	Lab H BF*OES	Lab I PF*ICP	Lab J PF*OES
1	0.630	0.630	0.650	<b>3.39</b>	0.610	0.540	0.623	0.630	0.540	0.690
2	0.630	0.630	0.630	<b>3.24</b>	0.620	0.620	0.579	0.630	0.560	0.690
3	0.620	0.647	0.650	<b>3.94</b>	0.600	0.560	0.616	0.610	0.550	0.680
4	0.630	0.630	0.630	<b>3.60</b>	0.590	0.580	0.590	0.620	0.530	0.670
5	0.610	0.630	0.650	0.650	0.600	0.610	0.547	0.610	<b>0.500</b>	0.680
Mean	0.624	0.633	0.642	2.964	0.604	0.582	0.591	0.620	0.536	0.682
Median	0.630	0.630	0.650	3.390	0.600	0.580	0.590	0.620	0.540	0.680
Std.Dev.	0.009	0.007	0.011	1.320	0.011	0.033	0.031	0.010	0.023	0.008
Rel.Std.Dev.	1.43%	1.17%	1.71%	44.5%	1.89%	5.75%	5.18%	1.61%	4.30%	1.23%
PDM <sup>3</sup>	1.08%	2.60%	4.00%	380%	-2.16%	-5.72%	-4.29%	0.43%	-13.2%	10.5%

Table A7. Fusion results for Al<sub>2</sub>O<sub>3</sub> in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A PF*ICP	Lab B PF*OES	Lab C PF*OES	Lab D PF*OES	Lab E PF*OES	Lab F PF*OES	Lab G PF*OES	Lab H BF*OES	Lab I PF*ICP	Lab J PF*OES
1	5.02	5.01	<b>5.27</b>	5.40	4.93	<b>4.34</b>	4.45	5.07	4.91	5.30
2	<b>5.62</b>	5.01	4.99	5.20	5.14	5.04	4.32	5.07	4.94	5.30
3	5.09	5.08	4.97	5.50	4.83	4.90	4.46	5.01	4.93	5.30
4	5.04	5.01	5.03	5.40	<b>4.70</b>	5.01	4.31	5.04	4.94	5.20
5	5.07	5.04	5.18	5.50	4.84	4.99	4.48	5.00	<b>5.07</b>	5.30
Mean	5.17	5.03	5.09	<b>5.40</b>	4.89	4.86	<b>4.40</b>	5.04	4.96	<b>5.28</b>
Median	5.07	5.01	5.03	5.40	4.84	4.99	4.45	5.04	4.94	5.30
Std.Dev.	0.25	0.03	0.13	0.12	0.16	0.29	0.08	0.03	0.06	0.04
Rel.Std.Dev.	4.92%	0.67%	2.57%	2.27%	3.33%	6.04%	1.90%	0.65%	1.29%	0.85%
PDM <sup>3</sup>	3.23%	0.47%	1.63%	7.87%	-2.36%	-3.00%	-12.0%	0.64%	-0.96%	5.47%

Table A8. Fusion results for SiO<sub>2</sub> in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A PF*ICP	Lab B PF*OES	Lab C PF*OES	Lab D PF*OES	Lab E PF*OES	Lab F PF*OES	Lab G PF*OES	Lab H BF*OES	Lab I PF*ICP	Lab J PF*OES
1	40.8	91.4	89.6	96.2	84.8	<b>81.0</b>	89.5	89.2	83.1	81.0
2	41.3	91.9	90.5	98.4	84.6	92.7	83.0	89.0	84.5	83.0
3	42.4	93.8	88.6	98.3	88.7	90.3	81.2	89.2	84.3	81.0
4	61.7	92.3	89.6	98.4	84.2	92.0	88.8	89.0	85.0	80.0
5	64.4	93.3	89.4	<b>80.6</b>	84.5	93.3	86.6	89.3	86.0	84.0
Mean	<b>50.1</b>	92.5	89.5	94.4	85.4	89.9	85.8	89.1	84.6	81.8
Median	42.4	92.3	89.6	98.3	84.6	92.0	86.6	89.2	84.5	81.0
Std.Dev.	11.9	1.0	0.7	7.8	1.9	5.1	3.6	0.2	1.1	1.6
Rel.Std.Dev.	23.7%	1.07%	0.76%	8.22%	2.20%	5.65%	4.21%	0.19%	1.25%	2.01%
PDM <sup>3</sup>	-43.5%	4.28%	0.90%	6.36%	-3.81%	1.26%	-3.30%	0.46%	-4.71%	-7.82%

Table A9. Fusion results for Ag in OREAS 160 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*ICP	Lab B -	Lab C PF*MS	Lab D -	Lab E -	Lab F -	Lab G PF*OES	Lab H -	Lab I -	Lab J -
1	<10	NR	<5	NR	NR	NR	<1	NR	NR	NR
2	<10	NR	<5	NR	NR	NR	1.6	NR	NR	NR
3	<10	NR	<5	NR	NR	NR	1.7	NR	NR	NR
4	<10	NR	<5	NR	NR	NR	<1	NR	NR	NR
5	<10	NR	<5	NR	NR	NR	1.4	NR	NR	NR
Mean							<b>1.6</b>			
Median							1.6			
Std.Dev.							0.2			
Rel.Std.Dev.							9.75%			
PDM <sup>3</sup>										



Table A10. Fusion results for Pb in OREAS 160 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*ICP	Lab B PF*OES	Lab C PF*MS	Lab D -	Lab E -	Lab F -	Lab G PF*OES	Lab H -	Lab I PF*ICP	Lab J PF*OES
1	<100	NR	10.0	NR	NR	<100	5.0	NR	<100	<5
2	<100	NR	10.0	NR	NR	<100	7.0	NR	<100	<5
3	<100	NR	10.0	NR	NR	<100	6.0	NR	<100	<5
4	<100	25.0	<10	NR	NR	<100	7.0	NR	<100	6.0
5	<100	NR	10.0	NR	NR	<100	7.0	NR	<100	<5
Mean		<b>25.0</b>	10.0				6.4			6.0
Median		25.0	10.0				7.0			6.0
Std.Dev.			0.0				0.9			
Rel.Std.Dev.			0.00%				14.0%			
PDM <sup>3</sup>		235%	33.9%				-14.3%			-19.6%

Table A11. Fusion results for Zn in OREAS 160 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*ICP	Lab B -	Lab C PF*OES	Lab D -	Lab E -	Lab F PF*OES	Lab G -	Lab H PF*OES	Lab I PF*ICP	Lab J PF*OES
1	<100	NR	20	NR	NR	<100	NR	<100	<100	<30
2	<100	NR	<20	NR	NR	<100	NR	<100	<100	<30
3	<100	NR	20	NR	NR	<100	NR	<100	<100	<30
4	<100	NR	<20	NR	NR	<100	NR	<100	<100	<30
5	<100	NR	20	NR	NR	<100	NR	<100	<100	<30
Mean			<b>20</b>							
Median			20							
Std.Dev.			0							
Rel.Std.Dev.			0.00%							
PDM <sup>3</sup>										

Table A12. Fusion results for Co in OREAS 160 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*ICP	Lab B PF*MS	Lab C PF*OES	Lab D -	Lab E -	Lab F PF*OES	Lab G PF*OES	Lab H PF*OES	Lab I PF*ICP	Lab J PF*OES
1	<20	3.0	<20	NR	NR	<20	4.0	2.5	30.0	<8
2	<20	3.0	<20	NR	NR	<20	7.0	2.5	20.0	<8
3	<20	3.0	<20	NR	NR	<20	6.0	2.3	30.0	<8
4	<20	3.0	<20	NR	NR	<20	7.0	2.6	30.0	<8
5	<20	3.0	<20	NR	NR	<20	7.0	2.5	20.0	<8
Mean		3.0					6.2	2.5	<b>26.0</b>	
Median		3.0					7.0	2.5	30.0	
Std.Dev.		0.0					1.3	0.1	5.5	
Rel.Std.Dev.		0.00%					21.0%	4.42%	21.1%	
PDM <sup>3</sup>		-22.9%					59.2%	-36.3%	568%	

Table A13. 4-acid results for Cu in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A 4A*OES	Lab B 4A*OES	Lab C 4A*OES	Lab D 4A*OES	Lab E 4A*OES	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	0.0014	0.0012	0.0013	0.0016	0.0013	0.0012	0.0013	<0.001	0.0008	0.0012
2	0.0015	0.0012	0.0012	0.0014	0.0013	0.0013	0.0010	<0.001	0.0012	0.0012
3	0.0015	0.0014	0.0012	0.0015	0.0012	0.0014	0.0012	<0.001	0.0013	0.0014
4	0.0016	0.0017	0.0012	<b>0.0021</b>	0.0012	0.0013	0.0010	<0.001	0.0011	0.0013
5	0.0016	0.0017	0.0013	0.0015	0.0012	0.0014	0.0012	<0.001	0.0007	0.0016
Mean	0.0015	0.0014	0.0012	0.0016	0.0013	0.0013	0.0011		0.0010	0.0013
Median	0.0015	0.0014	0.0012	0.0015	0.0012	0.0013	0.0012		0.0011	0.0013
Std.Dev.	0.0001	0.0003	0.0001	0.0003	0.0000	0.0001	0.0001		0.0003	0.0002
Rel.Std.Dev.	5.50%	17.4%	4.42%	17.1%	3.36%	5.96%	12.9%		25.4%	12.5%
PDM <sup>3</sup>	16.2%	10.13%	-5.17%	23.9%	-4.25%	1.56%	-13.7%		-22.0%	2.48%

Table A14. 4-acid results for Fe in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A 4A*OES	Lab B 4A*OES	Lab C 4A*OES	Lab D 4A*OES	Lab E 4A*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	1.14	1.16	1.24	1.19	1.20	1.11	1.10	1.10	1.18	1.10
2	1.09	1.16	1.24	1.17	1.17	1.16	1.11	1.15	1.19	1.10
3	1.13	1.17	1.23	1.17	1.12	1.15	1.11	1.11	1.18	1.10
4	1.18	1.18	1.19	1.24	1.16	1.15	1.11	1.13	1.17	1.10
5	1.16	1.17	1.17	1.24	1.09	1.15	1.12	1.13	1.20	1.10
Mean	1.14	1.17	1.21	1.20	1.15	1.14	1.11	1.12	1.18	1.10
Median	1.14	1.17	1.23	1.19	1.16	1.15	1.11	1.13	1.18	1.10
Std.Dev.	0.03	0.01	0.03	0.04	0.04	0.02	0.01	0.02	0.01	0.00
Rel.Std.Dev.	2.97%	0.72%	2.64%	2.96%	3.77%	1.70%	0.54%	1.73%	0.96%	0.00%
PDM <sup>3</sup>	-1.16%	1.27%	5.26%	4.22%	-0.46%	-0.81%	-3.80%	-2.55%	2.66%	-4.63%

Table A15. 4-acid results for S in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A 4A*OES	Lab B 4A*OES	Lab C 4A*OES	Lab D 4A*OES	Lab E 4A*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H -	Lab I 4A*OES	Lab J -
1	0.010	0.028	0.025	0.032	0.030	0.030	0.027	NR	0.030	NR
2	<0.01	0.039	0.030	0.030	0.030	0.030	0.027	NR	0.030	NR
3	<0.01	0.070	0.025	0.030	0.030	0.030	0.027	NR	0.030	NR
4	<0.01	0.086	0.025	0.031	0.030	0.030	0.027	NR	0.030	NR
5	<0.01	0.073	0.030	0.029	0.030	0.030	0.027	NR	0.030	NR
Mean	<b>0.010</b>	<b>0.059</b>	0.027	0.030	0.030	0.030	0.027		0.030	
Median	0.010	0.070	0.025	0.030	0.030	0.030	0.027		0.030	
Std.Dev.		0.025	0.003	0.001	0.000	0.000	0.000		0.000	
Rel.Std.Dev.		41.5%	10.1%	3.75%	0.00%	0.00%	0.76%		0.00%	
PDM <sup>3</sup>	-65.6%	104%	-7.07%	4.64%	3.26%	3.26%	-7.34%		3.26%	

Table A16. 4-acid results for CaO in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A 4A*OES	Lab B 4A*OES	Lab C 4A*OES	Lab D 4A*OES	Lab E 4A*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	0.140	0.138	0.150	0.145	<b>0.170</b>	0.140	0.144	0.126	0.154	0.140
2	0.140	0.133	0.150	0.142	0.150	0.150	0.145	0.126	0.154	0.140
3	0.140	0.135	0.150	0.142	0.140	0.150	0.146	0.126	0.154	0.140
4	0.150	0.133	0.150	0.147	0.140	0.150	0.145	0.126	0.154	0.140
5	0.150	0.133	0.140	0.149	0.140	0.150	0.146	0.126	0.154	0.140
Mean	0.144	<b>0.134</b>	0.148	0.145	0.148	0.148	0.145	<b>0.126</b>	0.154	0.140
Median	0.140	0.133	0.150	0.145	0.140	0.150	0.145	0.126	0.154	0.140
Std.Dev.	0.005	0.002	0.004	0.003	0.013	0.004	0.001	0.000	0.000	0.000
Rel.Std.Dev.	3.80%	1.71%	3.02%	2.13%	8.81%	3.02%	0.68%	0.00%	0.00%	0.00%
PDM <sup>3</sup>	-1.25%	-7.87%	1.49%	-0.57%	1.49%	1.49%	-0.44%	-13.6%	5.55%	-3.99%

Table A17. 4-acid results for MgO in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A 4A*OES	Lab B 4A*OES	Lab C 4A*OES	Lab D 4A*OES	Lab E 4A*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	0.690	0.656	0.650	0.648	0.630	0.550	0.656	0.597	0.647	0.650
2	0.680	0.673	0.630	<b>0.636</b>	0.610	0.600	0.658	0.597	0.663	0.620
3	0.680	0.670	0.650	0.648	0.580	0.580	0.661	0.597	0.663	0.640
4	0.690	0.661	0.630	0.653	0.600	0.580	0.664	0.597	0.663	0.610
5	0.680	0.669	0.630	0.651	0.550	0.580	0.664	0.597	0.663	0.600
Mean	0.684	0.666	0.638	0.647	0.594	0.578	0.661	0.597	0.660	0.624
Median	0.680	0.669	0.630	0.648	0.600	0.580	0.661	0.597	0.663	0.620
Std.Dev.	0.005	0.007	0.011	0.007	0.030	0.018	0.004	0.000	0.007	0.021
Rel.Std.Dev.	0.80%	1.06%	1.72%	1.02%	5.13%	3.09%	0.56%	0.00%	1.12%	3.32%
PDM <sup>3</sup>	7.69%	4.84%	0.45%	1.90%	-6.48%	-9.00%	4.03%	-6.02%	3.90%	-1.75%

Table A18. 4-acid results for Al<sub>2</sub>O<sub>3</sub> in OREAS 160 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A 4A*OES	Lab B 4A*OES	Lab C 4A*OES	Lab D 4A*OES	Lab E 4A*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	5.65	4.86	5.01	5.13	5.04	<b>4.74</b>	5.19	4.65	5.10	4.50
2	5.34	4.88	5.12	4.95	4.95	5.16	5.17	4.50	5.10	4.40
3	5.46	4.91	5.06	4.96	4.70	5.14	5.25	4.57	5.12	4.60
4	5.64	4.90	4.87	5.26	4.89	5.10	5.20	4.65	5.14	4.30
5	5.54	4.87	4.82	5.29	4.55	5.10	5.19	4.70	5.10	4.30
Mean	5.53	4.88	4.98	5.12	4.83	5.05	5.20	4.61	5.11	<b>4.42</b>
Median	5.54	4.88	5.01	5.13	4.89	5.10	5.19	4.65	5.10	4.40
Std.Dev.	0.13	0.02	0.13	0.16	0.20	0.17	0.03	0.08	0.02	0.13
Rel.Std.Dev.	2.35%	0.43%	2.55%	3.14%	4.11%	3.45%	0.54%	1.75%	0.33%	2.95%
PDM <sup>3</sup>	9.59%	-3.16%	-1.32%	1.50%	-4.29%	0.11%	3.14%	-8.49%	1.40%	-12.3%

Table A19. 4-acid results for Ag in OREAS 160 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*OES	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*OES	Lab E 4A*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J AD*AAS
1	<0.3	NR	<0.5	NR	0.07	<0.01	0.12	<2	<0.3	<0.5
2	<0.3	NR	<0.5	NR	0.05	<0.01	0.16	<2	<0.3	<0.5
3	<0.3	NR	<0.5	NR	0.05	0.01	0.19	<2	<0.3	<0.5
4	<0.3	NR	<0.5	NR	0.04	<0.01	<0.1	<2	<0.3	<0.5
5	<0.3	NR	<0.5	NR	0.06	<0.01	<0.1	<2	<0.3	<0.5
Mean					0.05	0.01	0.16			
Median					0.05	0.01	0.16			
Std.Dev.					0.01		0.04			
Rel.Std.Dev.					21.1%		22.4%			
PDM <sup>3</sup>					-26.6%	-86.4%	113%			

Table A20. 4-acid results for Pb in OREAS 160 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*OES	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*OES	Lab E 4A*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	4.0	8.0	8.0	7.0	<b>7.5</b>	6.5	6.3	<200	<b>45.0</b>	6.0
2	3.0	7.0	9.0	7.0	5.5	6.9	6.3	<200	39.0	8.0
3	6.0	7.0	8.0	6.0	5.2	6.9	6.1	<200	36.0	8.0
4	6.0	7.0	8.0	6.0	5.5	6.6	6.9	<200	37.0	7.0
5	6.0	7.0	10.0	<b>13.0</b>	6.4	6.9	5.7	<200	32.0	7.0
Mean	<b>5.0</b>	7.2	<b>8.6</b>	7.8	6.0	6.8	6.3		<b>37.8</b>	7.2
Median	6.0	7.0	8.0	7.0	5.5	6.9	6.3		37.0	7.0
Std.Dev.	1.4	0.4	0.9	2.9	0.9	0.2	0.4		4.8	0.8
Rel.Std.Dev.	28.3%	6.21%	10.4%	37.8%	15.6%	2.88%	6.93%		12.6%	11.6%
PDM <sup>3</sup>	-24.2%	9.17%	30.4%	18.3%	-8.72%	2.50%	-5.08%		473%	9.17%

Table A21. 4-acid results for Zn in OREAS 160 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*OES	Lab B 4A*OES	Lab C 4A*OES	Lab D 4A*OES	Lab E 4A*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	8	10	3	9	7	6	<2	<100	7	<30
2	8	9	4	9	6	7	<2	<100	9	<30
3	8	10	5	10	6	7	<2	<100	6	<30
4	9	11	5	9	6	6	<2	<100	7	<30
5	8	12	4	8	6	6	<2	<100	6	<30
Mean	8	10	4	9	6	6			7	
Median	8	10	4	9	6	6			7	
Std.Dev.	0	1	1	1	0	1			1	
Rel.Std.Dev.	5.45%	11.0%	19.9%	7.86%	7.21%	8.56%			17.5%	
PDM <sup>3</sup>	11.7%	41.6%	-42.8%	22.6%	-15.6%	-12.8%			-4.67%	

Table A22. 4-acid results for Co in OREAS 160 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*OES	Lab B 4A*MS	Lab C 4A*OES	Lab D -	Lab E 4A*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	3.0	2.8	4.0	NR	2.8	2.7	2.5	<10	5.0	<4
2	3.0	2.7	4.0	NR	2.8	2.9	3.0	<10	7.0	<4
3	3.0	2.7	2.0	NR	2.6	2.9	2.5	<10	4.0	<4
4	3.0	2.9	4.0	NR	2.6	2.8	2.0	<10	4.0	4.0
5	3.0	2.8	2.0	NR	3.0	2.9	1.9	<10	4.0	<4
Mean	3.0	2.8	3.2		2.8	2.8	2.4		<b>4.8</b>	<b>4.0</b>
Median	3.0	2.8	4.0		2.8	2.9	2.5		4.0	4.0
Std.Dev.	0.0	0.1	1.1		0.2	0.1	0.4		1.3	
Rel.Std.Dev.	0.00%	3.01%	34.2%		6.06%	3.15%	18.6%		27.2%	
PDM <sup>3</sup>	6.13%	-1.65%	13.2%		-2.36%	0.47%	-15.8%		69.8%	41.5%