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CERTIFICATE OF ANALYSIS FOR

Copper Sulphide Ore (Tritton Cu Project, NSW)

CERTIFIED REFERENCE MATERIAL

OREAS 112

Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 112.

Constituent	Certified Value	95% Confidence Interval		Tolerance Interval 1-α=0.99, ρ=0.95	
		Low	High	Low	High
Peroxide Fusion					
Silver, Ag (ppm)	17	7	26	IND	IND
Arsenic, As (ppm)	240	216	264	211	269
Cadmium, Cd (ppm)	15	12	18	IND	IND
Cobalt, Co (ppm)	547	531	562	519	575
Copper, Cu (wt.%)	5.13	4.95	5.30	5.03	5.22
Iron, Fe (wt.%)	33.3	31.8	34.8	32.5	34.1
Lead, Pb (ppm)	349	323	375	330	369
Antimony, Sb (ppm)	17	13	22	IND	IND
Zinc, Zn (ppm)	4302	4151	4452	4198	4406
Acid Digest					
Silver, Ag (ppm)	13.2	12.3	14.0	12.6	13.8
Arsenic, As (ppm)	222	214	231	219	226
Cadmium, Cd (ppm)	14.6	13.6	15.6	13.7	15.5
Cobalt, Co (ppm)	551	529	574	535	568
Copper, Cu (wt.%)	5.10	4.95	5.25	4.95	5.25
Iron, Fe (wt.%)	34.1	33.4	34.8	33.3	34.8
Lead, Pb (ppm)	360	346	374	346	375
Antimony, Sb (ppm)	16	10	21	15	16
Zinc, Zn (ppm)	4351	4201	4502	4238	4465

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding

Table 2. Indicative Values for OREAS 112.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Oxidising Fusion XRF								
Al_2O_3	wt.%	*1.29*	Fe_2O_3	wt.%	*47.49*	SnO_2	ppm	*25.4*
As	ppm	*230*	K_2O	wt.%	*0.020*	SO_3	wt.%	*90.31*
BaO	ppm	*22.3*	MgO	wt.%	*0.569*	SrO	ppm	*23.7*
CaO	wt.%	*0.243*	MnO	wt.%	*0.014*	TiO_2	wt.%	*0.042*
Cl	ppm	*< 10*	NiO	ppm	*51*	V_2O_5	ppm	*80*
CoO	ppm	*687*	P_2O_5	wt.%	*0.050*	ZnO	ppm	*5334*
Cr_2O_3	ppm	*29.2*	PbO	ppm	*355*	ZrO_2	ppm	*13.5*
CuO	ppm	*62515*	SiO_2	wt.%	*18.62*			
Thermogravimetry								
LOI^{1000}	wt.%	*26.06*						
Laser Ablation ICP-MS								
Ag	ppm	*12.8*	Hf	ppb	*285*	Sn	ppm	*7.40*
As	ppm	*231*	Ho	ppb	*120*	Sr	ppm	*8.80*
Ba	ppm	*5.25*	In	ppm	*1.43*	Ta	ppb	*85.0*
Be	ppm	*< 0.2*	La	ppm	*3.50*	Tb	ppb	*100*
Bi	ppm	*5.88*	Lu	ppb	*50.0*	Te	ppb	*2400*
Cd	ppm	*14.0*	Mo	ppm	*30.6*	Th	ppm	*1.15*

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 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 112 continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Laser Ablation ICP-MS								
Ce	ppm	*6.84*	Nb	ppm	*0.95*	Tl	ppm	*2.80*
Co	ppm	*555*	Nd	ppm	*3.36*	Tm	ppb	*40.0*
Cr	ppm	*19.0*	Ni	ppm	*33.0*	U	ppm	*3.81*
Cs	ppm	*0.26*	Pb	wt.%	*0.033*	V	ppm	*47.7*
Cu	ppm	*48250*	Pr	ppm	*0.77*	W	ppm	*3.03*
Dy	ppm	*0.54*	Rb	ppm	*0.93*	Y	ppm	*3.37*
Er	ppm	*0.35*	Re	ppb	*80.0*	Yb	ppb	*280*
Eu	ppb	*145*	Sb	ppm	*17.3*	Zn	ppm	*4340*
Ga	ppm	*3.10*	Sc	ppm	*1.05*	Zr	ppm	*12.3*
Gd	ppm	*0.59*	Se	ppm	*< 5*			
Ge	ppb	*200*	Sm	ppm	*0.73*			
Infrared Combustion								
C	wt.%	*0.105*	S	wt.%	*34.50*			

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 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 112 is a high grade Cu ore certified reference material (CRM) prepared from material sourced from the Tritton Copper Project near Nyngan, New South Wales. The deposit consists of sulphide ore bodies (massive pyrite and chalcopyrite breccias) underlying oxide ores. The mineralisation is interpreted as stratiform "Besshi style" volcanic-hosted massive sulphide, within Ordovician turbidite metasediments and mafic volcanics. OREAS 112 is one of a suite of five CRMs and was prepared from massive pyrite material blended with chalcopyrite breccia ore. All five CRMs have been characterised for Ag, As, Cd, Co, Cu, Fe, Pb, Sb and Zn by 4-acid ICP and sodium peroxide fusion 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 35 microns;
- Final homogenisation;
- Packaging into 10g units sealed under nitrogen in laminated foil pouches.

ANALYITICAL PROGRAM

Ten commercial laboratories participated in the analytical program to characterise Ag, As, Cd, Co, Cu, Fe, Pb, Sb and Zn. Their 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[3]) are presented in Tables A2 and A19 (Appendix). The parameter PDM[3] 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 112 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 30g 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. All ten laboratories reported 4-acid data for the requested elements while eight included sodium peroxide fusion results. 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

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

where,

x_{ij} *is the jth 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;*

$\ddot{x}$ *is the mean of means.*

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

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

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

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

$$S = 1.483 \underset{j=1.....n}{\text{median}} / x_j - \underset{i=1.....n}{\text{median}} (x_i) /$$

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

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_2O_3 to ZrO_2), 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 jth raw result reported by laboratory i*;

x'_{ij} *is the jth 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

$$\text{Lower limit is } \ddot{x} - k'_2(n, p, 1-\alpha)s''_g$$
$$\text{Upper limit is } \ddot{x} + k'_2(n, p, 1-\alpha)s''_g$$

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,

$$1-(\frac{s_i}{2s'_g}) \text{ is the weighting factor for laboratory } i;$$

s'_g *is the grand standard deviation computed from the transformed (i.e. means -adjusted) results*

according to the formula

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

where $\bar{x}'_i$ *is the transformed mean for laboratorty 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 112.

Constituent	Certified Value	1SD	2SD window		3SD window		Relative Standard Deviations			5% window	
			Low	High	Low	High	1RSD	2RSD	3RSD	Low	High
Peroxide Fusion											
Silver, Ag (ppm)	17	5	6	27	0	33	32.6%	65.1%	97.7%	16	17
Arsenic, As (ppm)	240	30	181	299	151	329	12.4%	24.7%	37.1%	228	252
Cadmium, Cd (ppm)	15	3	9	20	6	23	18.6%	37.2%	55.7%	14	15
Cobalt, Co (ppm)	547	12	522	572	510	584	2.26%	4.51%	6.77%	520	574
Copper, Cu (wt.%)	5.13	0.23	4.66	5.60	4.42	5.83	4.58%	9.16%	13.7%	4.87	5.38
Iron, Fe (wt.%)	33.3	1.8	29.7	36.9	28.0	38.6	5.34%	10.7%	16.0%	31.6	35.0
Lead, Pb (ppm)	349	28	294	405	267	432	7.90%	15.8%	23.7%	332	367
Antimony, Sb (ppm)	17	2	14	21	12	22	9.39%	18.8%	28.2%	17	18
Zinc, Zn (ppm)	4302	195	3912	4691	3718	4886	4.53%	9.05%	13.6%	4087	4517
Acid Digest											
Silver, Ag (ppm)	13.2	1.2	10.8	15.5	9.6	16.7	8.97%	17.9%	26.9%	12.5	13.8
Arsenic, As (ppm)	222	10	203	242	193	252	4.40%	8.80%	13.2%	211	233
Cadmium, Cd (ppm)	14.6	2.2	10.3	18.9	8.1	21.0	14.8%	29.5%	44.3%	13.9	15.3
Cobalt, Co (ppm)	551	33	485	618	451	652	6.06%	12.1%	18.2%	524	579
Copper, Cu (wt.%)	5.10	0.24	4.61	5.58	4.37	5.82	4.75%	9.49%	14.2%	4.84	5.35
Iron, Fe (wt.%)	34.1	0.9	32.2	36.0	31.3	36.9	2.75%	5.50%	8.25%	32.4	35.8
Lead, Pb (ppm)	360	29	302	418	273	447	8.06%	16.1%	24.2%	342	378
Antimony, Sb (ppm)	16	4	7	24	3	28	27.1%	54.1%	81.2%	15	16
Zinc, Zn (ppm)	4351	223	3905	4798	3682	5021	5.13%	10.3%	15.4%	4134	4569

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 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. ALS Chemex, Brisbane, QLD, Australia
4. ALS Chemex, Vancouver, BC, Canada
5. Amdel Laboratories, Perth, WA, Australia
6. Bureau Veritas (Ultra Trace) Geoanalytical, Perth, WA, Australia
7. Genalysis Laboratory Services Pty Ltd, Perth, WA, Australia
8. Intertek Testing Services, Jakarta, Indonesia
9. OMAC Laboratories Ltd, Loughrea, County Galway, Ireland
10. SGS Australia, Perth, WA, Australia

PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

Reference material OREAS 112 has been prepared and certified by:

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OREAS 112 available in 10g units sealed under a nitrogen environment in laminated foil pouches.

INTENDED USE

OREAS 112 is a reference material intended for the following:

i) For the monitoring of laboratory performance in the analysis of Ag, As, Cd, Co, Cu, Fe, Pb, Sb and Zn in geological samples;
ii) For the calibration of instruments used in the determination of the concentration of Ag, As, Cd, Co, Cu, Fe, Pb, Sb and Zn;
iii) For the verification of analytical methods for Ag, As, Cd, Co, Cu, Fe, Pb, Sb and Zn.

STABILITY AND STORAGE INSTRUCTIONS

OREAS 112 is a reference material made from high grade copper sulphide ore from the Tritton Copper Mine. 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.

INSTRUCTIONS FOR THE CORRECT USE

The certified values for OREAS 112 refer to the concentration level of Ag, As, Cd, Co, Cu, Fe, Pb, Sb and Zn in its packaged state. The CRM 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.

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
1	3rd Sep, 2018	Added major and trace element characterisation
0	7th 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

3rd Sep, 2018

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 112

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[3]	percent deviation of lab mean from corrected mean of means
NR	not reported
4A	four acid digest (HF-HNO_3-$HClO_4$-HCl)
MAR	modified aqua regia digest
PF	sodium peroxide fusion
AAS	atomic absorption spectrometry
OES	inductively coupled plasma optical emission spectrometry
MS	inductively coupled plasma mass spectrometry

Table A2. Fusion results for Ag in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*OES	Lab B PF*MS	Lab C PF*MS	Lab D PF*MS	Lab E -	Lab F -	Lab G -	Lab H -	Lab I PF*OES	Lab J -
1	<10	10.0	13.0	20.0	NR	NR	NR	NR	23.0	NR
2	<10	10.0	13.0	19.0	NR	NR	NR	NR	22.0	NR
3	< 10	10.0	13.0	23.0	NR	NR	NR	NR	<20	NR
4	< 10	10.0	13.0	20.0	NR	NR	NR	NR	26.0	NR
5	< 10	10.0	14.0	18.0	NR	NR	NR	NR	21.0	NR
Mean		10.0	13.2	20.0					23.0	
Median		10.0	13.0	20.0					22.5	
Std.Dev.		0.0	0.4	1.9					2.2	
Rel.Std.Dev.		0.00%	3.39%	9.35%					9.39%	
PDM[3]		-39.6%	-20.2%	20.8%					39.0%	

Table A3. Fusion results for As in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*OES	Lab B PF*MS	Lab C PF*MS	Lab D PF*MS	Lab E -	Lab F -	Lab G PF*OES	Lab H -	Lab I PF*OES	Lab J -
1	218	250	208	250	NR	NR	200	NR	160	NR
2	224	260	219	250	NR	NR	300	NR	111	NR
3	207	230	221	240	NR	NR	200	NR	149	NR
4	210	250	222	260	NR	NR	300	NR	174	NR
5	234	260	229	260	NR	NR	300	NR	131	NR
Mean	219	250	220	252			260		**145**	
Median	218	250	221	250			300		149	
Std.Dev.	11	12	8	8			55		25	
Rel.Std.Dev.	4.99%	4.90%	3.46%	3.32%			21.1%		17.01%	
PDM[3]	-8.95%	4.13%	-8.45%	4.97%			8.30%		-39.6%	

Table A4. Fusion results for Cd in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*OES	Lab B PF*MS	Lab C PF*MS	Lab D PF*MS	Lab E -	Lab F -	Lab G -	Lab H -	Lab I PF*OES	Lab J -
1	15.0	10.0	14.0	15.9	NR	NR	NR	NR	**76.0**	NR
2	14.0	10.0	15.0	17.3	NR	NR	NR	NR	<50	NR
3	15.0	20.0	16.0	16.3	NR	NR	NR	NR	<50	NR
4	15.0	10.0	16.0	16.4	NR	NR	NR	NR	<50	NR
5	15.0	10.0	15.0	17.1	NR	NR	NR	NR	<50	NR
Mean	14.8	12.0	15.2	16.6					**76.0**	
Median	15.0	10.0	15.0	16.4					76.0	
Std.Dev.	0.4	4.5	0.8	0.6						
Rel.Std.Dev.	3.02%	37.27%	5.50%	3.51%						
PDM[3]	1.02%	-18.09%	3.75%	13.31%					418.77%	

Table A5. Fusion results for Co in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*OES	Lab B PF*OES	Lab C NR	Lab D PF*MS	Lab E -	Lab F -	Lab G PF*OES	Lab H -	Lab I PF*OES	Lab J -
1	554	580	NR	534	NR	NR	540	NR	NR	NR
2	544	600	NR	575	NR	NR	540	NR	NR	NR
3	541	560	NR	538	NR	NR	540	NR	NR	NR
4	543	620	NR	553	NR	NR	550	NR	NR	NR
5	531	580	NR	570	NR	NR	550	NR	NR	NR
Mean	543	**588**		554			544			
Median	543	580		553			540			
Std.Dev.	8	23		18			5			
Rel.Std.Dev.	1.51%	3.88%		3.32%			1.01%			
PDM[3]	-0.78%	7.52%		1.30%			-0.52%			

Table A6. Fusion results for Cu in OREAS 112 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A PF*OES	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 -	Lab I PF*OES	Lab J -
1	5.42	**4.93**	5.46	5.18	4.96	4.88	4.89	NR	5.15	NR
2	5.51	5.04	5.27	5.19	4.99	4.85	5.08	NR	4.92	NR
3	5.20	5.16	5.58	**4.87**	4.95	5.08	5.01	NR	4.91	NR
4	5.42	5.20	5.32	5.18	**5.13**	4.95	5.27	NR	4.70	NR
5	**4.86**	5.15	5.64	**4.79**	4.96	4.95	5.19	NR	4.65	NR
Mean	5.28	5.10	5.45	5.04	5.00	4.94	5.09		4.87	
Median	5.42	5.15	5.46	5.18	4.96	4.95	5.08		4.91	
Std.Dev.	0.26	0.11	0.16	0.20	0.08	0.09	0.15		0.20	
Rel.Std.Dev.	4.96%	2.16%	2.88%	3.88%	1.51%	1.80%	2.93%		4.09%	
PDM[3]	3.01%	-0.62%	6.33%	-1.68%	-2.53%	-3.63%	-0.78%		-5.09%	

Table A7. Fusion results for Fe in OREAS 112 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A PF*OES	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 -	Lab I PF*OES	Lab J -
1	32.9	35.0	35.9	34.8	30.7	30.7	33.3	NR	32.6	NR
2	32.4	34.0	36.0	35.4	30.6	31.1	33.4	NR	31.8	NR
3	32.5	35.4	36.0	33.8	30.7	31.3	33.4	NR	33.4	NR
4	32.3	35.8	35.5	34.5	31.0	32.1	33.3	NR	34.2	NR
5	32.8	35.1	36.5	33.4	30.3	31.7	33.0	NR	33.2	NR
Mean	32.6	35.1	36.0	34.4	30.7	31.4	33.3		33.0	
Median	32.5	35.1	36.0	34.5	30.7	31.3	33.3		33.2	
Std.Dev.	0.3	0.7	0.3	0.8	0.3	0.5	0.2		0.9	
Rel.Std.Dev.	0.79%	1.91%	0.91%	2.31%	0.90%	1.72%	0.49%		2.74%	
PDM[3]	-2.15%	5.30%	8.07%	3.26%	-7.91%	-5.75%	-0.05%		-0.77%	

Table A8. Fusion results for Pb in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*OES	Lab B PF*MS	Lab C PF*MS	Lab D PF*MS	Lab E -	Lab F -	Lab G PF*OES	Lab H -	Lab I PF*OES	Lab J -
1	350	340	358	**355**	NR	NR	300	NR	NR	NR
2	349	330	353	382	NR	NR	400	NR	NR	NR
3	345	350	**443**	369	NR	NR	300	NR	NR	NR
4	347	330	369	376	NR	NR	300	NR	NR	NR
5	355	350	371	372	NR	NR	300	NR	NR	NR
Mean	349	340	379	371			320			
Median	349	340	369	372			300			
Std.Dev.	4	10	37	10			45			
Rel.Std.Dev.	1.08%	2.94%	9.68%	2.72%			14.0%			
PDM[3]	-0.04%	-2.67%	8.43%	6.14%			-8.40%			

Table A9. Fusion results for Sb in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*OES	Lab B PF*MS	Lab C PF*MS	Lab D PF*MS	Lab E -	Lab F -	Lab G -	Lab H -	Lab I PF*OES	Lab J -
1	9.0	18.0	**15.3**	20.6	NR	NR	NR	NR	234	NR
2	10.0	16.0	16.6	**29.6**	NR	NR	NR	NR	244	NR
3	9.0	16.0	16.3	19.7	NR	NR	NR	NR	198	NR
4	9.0	16.0	16.3	18.7	NR	NR	NR	NR	177	NR
5	10.0	16.0	16.1	18.8	NR	NR	NR	NR	211	NR
Mean	**9.4**	16.4	16.1	21.5					**213**	
Median	9.0	16.0	16.3	19.7					211	
Std.Dev.	0.5	0.9	0.5	4.6					27	
Rel.Std.Dev.	5.83%	5.45%	3.05%	21.4%					12.7%	
PDM[3]	-46.0%	-5.70%	-7.31%	23.5%					1124%	

Table A10. Fusion results for Zn in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A PF*OES	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 -	Lab I PF*OES	Lab J -
1	4300	4380	4571	4150	4100	4300	4300	NR	3992	NR
2	4300	4260	4622	4170	4200	4300	4400	NR	4015	NR
3	4300	4240	4735	4010	4100	4500	4300	NR	3967	NR
4	4300	4380	4579	4190	4200	4500	4400	NR	4197	NR
5	4300	4380	4522	**3960**	4100	4800	4300	NR	4275	NR
Mean	4300	4328	4606	4096	4140	4480	4340		4089	
Median	4300	4380	4579	4150	4100	4500	4300		4015	
Std.Dev.	0	72	80	104	55	205	55		138	
Rel.Std.Dev.	0.00%	1.65%	1.75%	2.53%	1.32%	4.57%	1.26%		3.37%	
PDM[3]	-0.04%	0.61%	7.07%	-4.78%	-3.76%	4.15%	0.89%		-4.94%	

Table A11. 4-acid results for Ag in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*MS	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*OES	Lab E 4A*OES	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I MAR*OES	Lab J 4A*OES
1	10.0	13.5	14.0	18.0	13.0	13.0	14.2	11.9	**13.1**	13.0
2	10.0	13.5	14.0	16.0	14.0	12.0	14.3	12.1	11.7	13.2
3	10.0	13.0	14.0	17.0	12.0	15.0	14.6	12.0	11.6	13.3
4	10.0	14.0	14.0	18.0	14.0	14.0	14.5	12.3	12.0	12.9
5	10.0	14.5	15.0	18.0	10.0	14.0	14.5	12.2	10.9	13.6
Mean	**10.0**	13.7	14.2	**17.4**	12.6	13.6	14.4	12.1	11.8	13.2
Median	10.0	13.5	14.0	18.0	13.0	14.0	14.5	12.1	11.7	13.2
Std.Dev.	0.0	0.6	0.4	0.9	1.7	1.1	0.2	0.2	0.8	0.3
Rel.Std.Dev.	0.00%	4.16%	3.15%	5.14%	13.3%	8.38%	1.14%	1.31%	6.70%	2.00%
PDM[3]	-24.1%	4.02%	7.82%	32.1%	-4.33%	3.26%	9.49%	-8.13%	-10.1%	0.29%

Table A12. 4-acid results for As in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*MS	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*OES	Lab E 4A*OES	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I MAR*OES	Lab J 4A*OES
1	170	240	**233**	NR	<200	210	224	212	224	223
2	170	230	248	NR	<200	200	228	219	217	224
3	150	230	250	NR	<200	220	224	210	223	228
4	170	235	251	NR	<200	220	223	213	212	230
5	170	240	245	NR	<200	230	232	215	204	229
Mean	**166**	235	**245**			216	226	214	216	227
Median	170	235	248			220	224	213	217	228
Std.Dev.	9	5	7			11	4	3	8	3
Rel.Std.Dev.	5.39%	2.13%	2.98%			5.28%	1.67%	1.60%	3.83%	1.28%
PDM[3]	-25.3%	5.71%	10.4%			-2.84%	1.75%	-3.83%	-2.84%	2.04%

Table A13. 4-acid results for Cd in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*MS	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*OES	Lab E 4A*OES	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I MAR*OES	Lab J 4A*OES
1	10.0	15.5	16.0	14.7	10.0	10.0	14.5	14.0	14.7	13.3
2	10.0	15.5	16.0	14.6	10.0	10.0	14.5	13.0	14.6	12.7
3	10.0	15.0	17.0	15.7	10.0	20.0	14.5	13.0	14.0	12.3
4	10.0	15.0	15.0	14.7	10.0	20.0	14.9	13.0	14.1	11.9
5	10.0	15.5	15.0	15.5	10.0	20.0	14.7	14.0	12.7	12.2
Mean	**10.0**	15.3	15.8	15.0	**10.0**	16.0	14.6	13.4	14.0	12.5
Median	10.0	15.5	16.0	14.7	10.0	20.0	14.5	13.0	14.1	12.3
Std.Dev.	0.0	0.3	0.8	0.5	0.0	5.5	0.2	0.5	0.8	0.6
Rel.Std.Dev.	0.00%	1.79%	5.30%	3.44%	0.00%	34.2%	1.22%	4.09%	5.74%	4.46%
PDM[3]	-31.4%	4.93%	8.36%	3.14%	-31.4%	9.73%	0.26%	-8.10%	-4.00%	-14.3%

Table A14. 4-acid results for Co in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*MS	Lab B 4A*OES	Lab C 4A*MS	Lab D 4A*OES	Lab E 4A*OES	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I MAR*OES	Lab J 4A*OES
1	620	560	587	503	530	510	524	540	561	534
2	590	560	616	491	520	480	528	558	561	547
3	620	565	618	515	530	550	525	547	557	550
4	590	570	598	505	550	550	538	543	563	540
5	570	570	602	497	530	550	536	556	**517**	555
Mean	598	565	604	502	532	528	530	549	552	545
Median	590	565	602	503	530	550	528	547	561	547
Std.Dev.	22	5	13	9	11	32	6	8	20	8
Rel.Std.Dev.	3.63%	0.88%	2.14%	1.79%	2.06%	6.05%	1.21%	1.44%	3.55%	1.54%
PDM[3]	8.45%	2.47%	9.58%	-8.92%	-3.52%	-4.24%	-3.84%	-0.47%	0.07%	-1.15%

Table A15. 4-acid results for Cu in OREAS 112 (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*AAS	Lab E 4A*OES	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I MAR*OES	Lab J 4A*OES
1	5.27	4.92	5.36	4.93	5.22	4.99	5.20	4.74	**5.33**	4.78
2	5.35	5.02	5.37	4.89	5.10	4.75	4.95	4.66	5.15	5.03
3	**5.07**	5.00	**5.65**	4.92	5.17	5.58	4.97	4.65	5.16	4.93
4	5.25	5.18	5.42	4.90	5.38	5.39	5.20	4.61	5.18	4.89
5	5.29	5.17	5.60	5.06	5.03	5.40	5.10	4.74	**4.70**	5.03
Mean	5.25	5.06	5.48	4.94	5.18	5.22	5.08	4.68	5.10	4.93
Median	5.27	5.02	5.42	4.92	5.17	5.39	5.10	4.66	5.16	4.93
Std.Dev.	0.11	0.11	0.14	0.07	0.13	0.34	0.12	0.06	0.24	0.11
Rel.Std.Dev.	2.01%	2.24%	2.50%	1.40%	2.57%	6.53%	2.37%	1.24%	4.67%	2.15%
PDM[3]	2.89%	-0.80%	7.50%	-3.11%	1.60%	2.42%	-0.29%	-8.21%	0.10%	-3.27%

Table A16. 4-acid results for Fe in OREAS 112 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A 4A*MS	Lab B 4A*OES	Lab C 4A*OES	Lab D 4A*OES	Lab E 4A*OES	Lab F 4A*AAS	Lab G 4A*OES	Lab H 4A*OES	Lab I MAR*OES	Lab J 4A*OES
1	34.4	34.5	36.6	35.2	34.1	32.1	33.0	**34.7**	35.1	33.3
2	33.8	34.5	36.4	35.4	34.0	**30.2**	33.1	32.6	35.5	33.2
3	33.5	34.9	36.5	**38.1**	33.7	34.9	32.9	33.1	35.5	33.3
4	33.6	34.9	36.1	35.0	34.6	33.5	34.2	33.2	35.1	33.8
5	32.7	34.8	36.3	36.3	34.0	34.0	33.6	33.6	**32.9**	34.0
Mean	33.6	34.7	**36.4**	36.0	34.1	32.9	33.4	33.4	34.8	33.5
Median	33.6	34.8	36.4	35.4	34.0	33.5	33.1	33.2	35.1	33.3
Std.Dev.	0.6	0.2	0.2	1.3	0.3	1.8	0.5	0.8	1.1	0.3
Rel.Std.Dev.	1.82%	0.59%	0.52%	3.54%	0.90%	5.58%	1.62%	2.36%	3.11%	1.03%
PDM[3]	-1.43%	1.86%	6.77%	5.61%	-0.01%	-3.36%	-2.13%	-1.90%	2.15%	-1.74%

Table A17. 4-acid results for Pb in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*MS	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*OES	Lab E 4A*OES	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I MAR*OES	Lab J 4A*OES
1	380	335	361	367	400	350	343	309	410	330
2	360	341	355	346	300	330	349	316	400	331
3	380	337	357	397	300	440	343	289	390	330
4	360	348	367	361	400	390	356	295	390	**340**
5	340	352	351	384	400	380	347	296	360	330
Mean	364	343	358	371	360	378	348	**301**	390	332
Median	360	341	357	367	400	380	347	296	390	330
Std.Dev.	17	7	6	20	55	42	5	11	19	5
Rel.Std.Dev.	4.60%	2.11%	1.70%	5.37%	15.2%	11.1%	1.54%	3.69%	4.80%	1.37%
PDM[3]	1.06%	-4.88%	-0.55%	3.00%	-0.05%	4.94%	-3.50%	-16.4%	8.28%	-7.73%

Table A18. 4-acid results for Sb in OREAS 112 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A 4A*MS	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*OES	Lab E 4A*OES	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I MAR*OES	Lab J 4A*OES
1	20.0	18.2	15.1	NR	<100	<50	9.0	21.0	<50	13.6
2	20.0	17.8	15.1	NR	<100	<50	<5	22.0	<50	13.1
3	20.0	17.4	15.1	NR	<100	<50	5.0	20.0	<50	13.1
4	20.0	16.4	15.2	NR	<100	<50	8.0	19.0	<50	13.0
5	20.0	17.4	14.9	NR	<100	<50	<5	20.0	<50	12.2
Mean	20.0	17.4	15.1				7.3	20.4		13.0
Median	20.0	17.4	15.1				8.0	20.0		13.1
Std.Dev.	0.0	0.7	0.1				2.1	1.1		0.5
Rel.Std.Dev.	0.00%	3.84%	0.73%				28.4%	5.59%		3.80%
PDM[3]	28.7%	12.2%	-2.98%				-52.8%	31.2%		-16.3%

Table A19. 4-acid results for Zn in OREAS 112 (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*OES	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I MAR*OES	Lab J 4A*OES
1	4760	4270	4587	4090	4400	4380	4170	3960	4350	4197
2	4690	4280	4634	4230	4300	4130	4200	3960	4450	4220
3	4630	4340	**4761**	**4540**	4300	4770	4150	3960	4460	4250
4	4680	4320	4587	4280	4500	4620	4260	3890	4400	4221
5	4710	4370	4549	4340	4300	4610	4220	4070	**4110**	4288
Mean	4694	4316	4624	4296	4360	4502	4200	3968	4354	4235
Median	4690	4320	4587	4280	4300	4610	4200	3960	4400	4221
Std.Dev.	47	42	83	165	89	250	43	65	143	35
Rel.Std.Dev.	1.01%	0.96%	1.78%	3.83%	2.05%	5.56%	1.02%	1.63%	3.29%	0.83%
PDM[3]	7.87%	-0.81%	6.25%	-1.27%	0.20%	3.46%	-3.48%	-8.81%	0.06%	-2.67%