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CERTIFICATE OF ANALYSIS FOR

Copper Sulphide Ore (Tritton Cu Project, NSW)

CERTIFIED REFERENCE MATERIAL

OREAS 113

Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 113.

Constituent	Certified Value	95% Confidence Interval		Tolerance Interval 1-α=0.99, ρ=0.95	
		Low	High	Low	High
Peroxide Fusion					
Silver, Ag (ppm)	~25	IND	IND	IND	IND
Arsenic, As (ppm)	238	207	269	214	262
Cadmium, Cd (ppm)	~16	IND	IND	IND	IND
Cobalt, Co (ppm)	754	708	801	728	780
Copper, Cu (wt.%)	13.3	12.7	13.8	13.0	13.5
Iron, Fe (wt.%)	28.0	26.1	29.8	27.5	28.5
Lead, Pb (ppm)	248	232	265	236	261
Antimony, Sb (ppm)	7.6	6.1	9.0	5.8	9.4
Zinc, Zn (ppm)	4158	3997	4320	4004	4313
Acid Digest					
Silver, Ag (ppm)	22.6	21.3	23.8	21.6	23.5
Arsenic, As (ppm)	234	223	245	225	242
Cadmium, Cd (ppm)	15.5	14.8	16.3	14.6	16.4
Cobalt, Co (ppm)	766	746	787	755	778
Copper, Cu (wt.%)	13.5	13.3	13.8	13.3	13.8
Iron, Fe (wt.%)	28.2	27.5	28.8	27.7	28.7
Lead, Pb (ppm)	230	213	247	219	241
Antimony, Sb (ppm)	8	5	11	7	9
Zinc, Zn (ppm)	4178	4010	4346	4108	4248

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 113.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Oxidising Fusion XRF								
Al_2O_3	wt.%	*3.02*	Fe_2O_3	wt.%	*39.74*	SnO_2	ppm	*25.4*
As	ppm	*265*	K_2O	wt.%	*0.047*	SO_3	wt.%	*72.62*
BaO	ppm	*22.3*	MgO	wt.%	*1.69*	SrO	ppm	*35.5*
CaO	wt.%	*0.540*	MnO	wt.%	*0.025*	TiO_2	wt.%	*0.117*
Cl	ppm	*< 10*	NiO	ppm	*25.5*	V_2O_5	ppm	*107*
CoO	ppm	*966*	P_2O_5	wt.%	*0.054*	ZnO	ppm	*5253*
Cr_2O_3	ppm	*29.2*	PbO	ppm	*253*	ZrO_2	ppm	*40.5*
CuO	ppm	*169369*	SiO_2	wt.%	*21.85*			
Thermogravimetry								
LOI^{1000}	wt.%	*17.05*						
Laser Ablation ICP-MS								
Ag	ppm	*22.2*	Hf	ppb	*915*	Sn	ppm	*7.00*
As	ppm	*245*	Ho	ppb	*280*	Sr	ppm	*17.6*
Ba	ppm	*10.0*	In	ppm	*2.78*	Ta	ppb	*235*
Be	ppm	*0.20*	La	ppm	*9.30*	Tb	ppb	*240*
Bi	ppm	*6.90*	Lu	ppb	*95.0*	Te	ppb	*3500*
Cd	ppm	*16.0*	Mo	ppm	*35.8*	Th	ppm	*3.22*

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 113 continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Laser Ablation ICP-MS								
Ce	ppm	*19.0*	Nb	ppm	*2.56*	Tl	ppm	*0.40*
Co	ppm	*770*	Nd	ppm	*8.32*	Tm	ppb	*115*
Cr	ppm	*19.5*	Ni	ppm	*13.0*	U	ppm	*3.66*
Cs	ppm	*0.25*	Pb	wt.%	*0.023*	V	ppm	*64*
Cu	ppm	*133000*	Pr	ppm	*2.19*	W	ppm	*1.70*
Dy	ppm	*1.39*	Rb	ppm	*2.23*	Y	ppm	*7.96*
Er	ppm	*0.75*	Re	ppb	*170*	Yb	ppb	*805*
Eu	ppb	*325*	Sb	ppm	*6.95*	Zn	ppm	*4315*
Ga	ppm	*8.25*	Sc	ppm	*1.75*	Zr	ppm	*32.5*
Gd	ppm	*1.65*	Se	ppm	*< 5*			
Ge	ppb	*175*	Sm	ppm	*1.78*			
Infrared Combustion								
C	wt.%	*0.245*	S	wt.%	*29.25*			

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 113 is a very 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 113 is one of a suite of five CRMs and was prepared from 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 113 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 OF ANALYTICAL DATA FOR OREAS 113

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,

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

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

according to the formula

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

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

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 113.

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)	~25	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Arsenic, As (ppm)	238	33	171	304	138	337	14.0%	27.9%	41.9%	226	250
Cadmium, Cd (ppm)	~16	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Cobalt, Co (ppm)	754	28	698	811	669	840	3.77%	7.54%	11.3%	717	792
Copper, Cu (wt.%)	13.3	0.5	12.3	14.3	11.8	14.8	3.74%	7.48%	11.2%	12.6	13.9
Iron, Fe (wt.%)	28.0	2.1	23.8	32.2	21.7	34.3	7.55%	15.1%	22.6%	26.6	29.4
Lead, Pb (ppm)	248	14	221	276	207	290	5.54%	11.1%	16.6%	236	261
Antimony, Sb (ppm)	7.6	1.0	5.6	9.5	4.7	10.5	12.8%	25.6%	38.4%	7.2	8.0
Zinc, Zn (ppm)	4158	196	3766	4551	3569	4748	4.72%	9.45%	14.2%	3951	4366
Acid Digest											
Silver, Ag (ppm)	22.6	1.7	19.2	25.9	17.6	27.6	7.37%	14.7%	22.1%	21.4	23.7
Arsenic, As (ppm)	234	13	208	260	195	272	5.48%	11.0%	16.5%	222	246
Cadmium, Cd (ppm)	15.5	2.0	11.5	19.5	9.5	21.5	12.8%	25.7%	38.5%	14.7	16.3
Cobalt, Co (ppm)	766	27	713	820	686	847	3.49%	6.99%	10.5%	728	805
Copper, Cu (wt.%)	13.5	0.4	12.8	14.3	12.4	14.6	2.74%	5.48%	8.23%	12.9	14.2
Iron, Fe (wt.%)	28.2	1.0	26.1	30.3	25.1	31.3	3.70%	7.41%	11.1%	26.8	29.6
Lead, Pb (ppm)	230	28	175	285	147	313	12.0%	24.0%	36.0%	219	242
Antimony, Sb (ppm)	8	2	4	12	2	14	26.8%	53.7%	80.5%	7	8
Zinc, Zn (ppm)	4178	248	3683	4673	3435	4921	5.92%	11.8%	17.8%	3969	4387

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 113 has been prepared and certified by:

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OREAS 113 available in 10g units sealed under a nitrogen environment in laminated foil pouches.

INTENDED USE

OREAS 113 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 113 is a reference material made from very 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 111b 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 113

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 113 (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	20.0	21.0	29.0	NR	NR	NR	NR	29.0	NR
2	<10	20.0	22.0	27.0	NR	NR	NR	NR	24.0	NR
3	< 10	20.0	22.0	30.0	NR	NR	NR	NR	21.0	NR
4	< 10	20.0	22.0	31.0	NR	NR	NR	NR	28.0	NR
5	< 10	20.0	22.0	28.0	NR	NR	NR	NR	38.0	NR
Mean		20.0	21.8	29.0					28.0	
Median		20.0	22.0	29.0					28.0	
Std.Dev.		0.0	0.4	1.6					6.4	
Rel.Std.Dev.		0.00%	2.05%	5.45%					23.0%	
PDM[3]		-19.0%	-11.7%	17.4%					13.4%	

Table A3. Fusion results for As in OREAS 113 (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	219	240	225	290	NR	NR	300	NR	142	NR
2	210	250	224	270	NR	NR	200	NR	148	NR
3	212	230	223	290	NR	NR	300	NR	142	NR
4	**251**	235	222	250	NR	NR	200	NR	137	NR
5	198	250	218	280	NR	NR	200	NR	135	NR
Mean	218	241	222	276			240		**141**	
Median	212	240	223	280			200		142	
Std.Dev.	20	9	3	17			55		5	
Rel.Std.Dev.	9.15%	3.71%	1.21%	6.06%			22.8%		3.60%	
PDM[3]	-8.34%	1.33%	-6.49%	16.0%			0.91%		-40.8%	

Table A4. Fusion results for Cd in OREAS 113 (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	16.0	20.0	16.0	**19.0**	NR	NR	NR	NR	<50	NR
2	16.0	10.0	17.0	17.7	NR	NR	NR	NR	<50	NR
3	17.0	20.0	16.0	18.4	NR	NR	NR	NR	<50	NR
4	16.0	10.0	16.0	17.9	NR	NR	NR	NR	<50	NR
5	16.0	20.0	17.0	17.7	NR	NR	NR	NR	<50	NR
Mean	16.2	16.0	16.4	**18.1**						
Median	16.0	20.0	16.0	17.9						
Std.Dev.	0.4	5.5	0.5	0.6						
Rel.Std.Dev.	2.76%	34.23%	3.34%	3.08%						
PDM[3]	0.00%	-1.23%	1.23%	12.0%						

Table A5. Fusion results for Co in OREAS 113 (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	722	780	NR	795	NR	NR	740	NR	NR	NR
2	724	780	NR	775	NR	NR	750	NR	NR	NR
3	722	780	NR	792	NR	NR	730	NR	NR	NR
4	731	800	NR	749	NR	NR	720	NR	NR	NR
5	718	780	NR	759	NR	NR	740	NR	NR	NR
Mean	723	784		774			736			
Median	722	780		775			740			
Std.Dev.	5	9		20			11			
Rel.Std.Dev.	0.66%	1.14%		2.60%			1.55%			
PDM[3]	-4.10%	3.93%		2.60%			-2.43%			

Table A6. Fusion results for Cu in OREAS 113 (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	13.0	12.9	14.0	>10	12.5	13.0	13.4	NR	11.3	NR
2	13.3	13.5	14.2	>10	12.6	13.4	13.5	NR	11.2	NR
3	13.2	13.0	14.2	>10	12.6	13.3	13.2	NR	11.3	NR
4	13.3	13.4	14.3	>10	**12.1**	13.1	13.2	NR	11.3	NR
5	13.4	13.4	14.2	>10	12.5	13.0	13.2	NR	11.4	NR
Mean	13.2	13.2	14.2		12.5	13.1	13.3		**11.3**	
Median	13.3	13.4	14.2		12.5	13.1	13.2		11.3	
Std.Dev.	0.2	0.3	0.1		0.2	0.2	0.2		0.1	
Rel.Std.Dev.	1.15%	2.04%	0.74%		1.61%	1.39%	1.21%		0.65%	
PDM[3]	-0.24%	-0.24%	6.83%		-6.02%	-1.06%	0.07%		-14.9%	

Table A7. Fusion results for Fe in OREAS 113 (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	27.2	28.6	28.9	29.9	24.7	26.5	26.6	NR	31.6	NR
2	27.2	**29.3**	29.8	29.9	25.2	27.2	26.6	NR	32.0	NR
3	27.1	28.6	29.4	30.8	25.1	26.4	26.3	NR	31.9	NR
4	27.1	28.7	29.3	27.7	24.5	26.0	26.6	NR	32.1	NR
5	27.1	29.0	28.7	27.9	24.8	25.8	26.4	NR	**33.0**	NR
Mean	27.1	28.8	29.2	29.2	24.9	26.4	26.5		32.1	
Median	27.1	28.7	29.3	29.9	24.8	26.4	26.6		32.0	
Std.Dev.	0.1	0.3	0.4	1.4	0.3	0.5	0.1		0.5	
Rel.Std.Dev.	0.20%	1.06%	1.47%	4.67%	1.14%	2.05%	0.53%		1.61%	
PDM[3]	-3.05%	3.02%	4.33%	4.45%	-11.2%	-5.77%	-5.34%		14.8%	

Table A8. Fusion results for Pb in OREAS 113 (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	233	250	281	259	NR	NR	200	NR	NR	NR
2	236	260	276	251	NR	NR	200	NR	NR	NR
3	235	250	254	**264**	NR	NR	200	NR	NR	NR
4	237	240	247	251	NR	NR	100	NR	NR	NR
5	236	230	243	248	NR	NR	200	NR	NR	NR
Mean	235	246	260	255			**180**			
Median	236	250	254	251			200			
Std.Dev.	2	11	17	7			45			
Rel.Std.Dev.	0.64%	4.63%	6.63%	2.61%			24.8%			
PDM[3]	-5.26%	-0.99%	4.72%	2.47%			-27.6%			

Table A9. Fusion results for Sb in OREAS 113 (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	7.0	8.0	6.9	8.3	NR	NR	NR	NR	60.0	NR
2	7.0	8.0	7.0	10.3	NR	NR	NR	NR	83.0	NR
3	7.0	8.0	6.7	8.7	NR	NR	NR	NR	**114.0**	NR
4	7.0	8.0	6.8	**26.2**	NR	NR	NR	NR	70.0	NR
5	7.0	6.0	6.9	8.2	NR	NR	NR	NR	60.0	NR
Mean	7.0	7.6	6.9	12.3					**77.4**	
Median	7.0	8.0	6.9	8.7					70.0	
Std.Dev.	0.0	0.9	0.1	7.8					22.5	
Rel.Std.Dev.	0.00%	11.8%	1.66%	63.2%					29.1%	
PDM[3]	-7.70%	0.21%	-9.54%	62.7%					921%	

Table A10. Fusion results for Zn in OREAS 113 (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	4100	4060	4340	4130	3900	4500	4000	NR	4710	NR
2	4200	4000	4375	4060	4000	4600	4000	NR	4522	NR
3	4200	4120	4363	4250	4300	4500	4000	NR	4675	NR
4	4100	4140	4284	3800	**11100**	4400	4100	NR	4593	NR
5	4200	4100	4319	3780	3900	4300	4100	NR	4731	NR
Mean	4160	4084	4336	4004	5440	4460	4040		**4646**	
Median	4200	4100	4340	4060	4000	4500	4000		4675	
Std.Dev.	55	55	36	207	3168	114	55		87	
Rel.Std.Dev.	1.32%	1.36%	0.84%	5.17%	58.2%	2.56%	1.36%		1.87%	
PDM[3]	0.04%	-1.79%	4.27%	-3.71%	30.8%	7.25%	-2.85%		11.7%	

Table A11. 4-acid results for Ag in OREAS 113 (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	23.0	24.0	34.0	21.0	24.0	24.1	21.5	21.0	22.7
2	20.0	24.0	24.0	33.0	22.0	25.0	23.8	21.6	21.1	22.8
3	20.0	24.5	24.0	31.0	20.0	26.0	24.4	21.1	21.6	23.0
4	20.0	24.0	23.0	35.0	23.0	25.0	23.4	22.0	20.6	22.7
5	20.0	23.0	24.0	29.0	21.0	25.0	23.7	21.2	20.8	22.8
Mean	20.0	23.7	23.8	**32.4**	21.4	25.0	23.9	21.5	21.0	22.8
Median	20.0	24.0	24.0	33.0	21.0	25.0	23.8	21.5	21.0	22.8
Std.Dev.	0.0	0.7	0.4	2.4	1.1	0.7	0.4	0.4	0.4	0.1
Rel.Std.Dev.	0.00%	2.83%	1.88%	7.43%	5.33%	2.83%	1.61%	1.66%	1.87%	0.52%
PDM[3]	-11.36%	5.04%	5.48%	43.60%	-5.16%	10.80%	5.84%	-4.80%	-6.82%	0.98%

Table A12. 4-acid results for As in OREAS 113 (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	180	235	251	NR	<200	230	224	231	219	223
2	180	245	242	NR	<200	250	237	229	217	226
3	190	245	247	NR	<200	270	232	227	222	220
4	150	235	256	NR	<200	240	218	231	223	221
5	210	245	245	NR	<200	250	225	**221**	222	225
Mean	**182**	241	248			248	227	228	221	223
Median	180	245	247			250	225	229	222	223
Std.Dev.	22	5	5			15	7	4	3	2
Rel.Std.Dev.	11.9%	2.27%	2.20%			5.98%	3.26%	1.82%	1.14%	1.06%
PDM[3]	-22.2%	3.02%	6.09%			6.01%	-2.88%	-2.63%	-5.70%	-4.63%

Table A13. 4-acid results for Cd in OREAS 113 (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	16.0	17.0	15.8	20.0	20.0	15.5	16.0	14.7	13.9
2	20.0	16.0	17.0	15.6	20.0	20.0	15.5	16.0	15.1	13.9
3	10.0	16.0	17.0	15.0	10.0	20.0	15.5	14.0	14.9	13.5
4	20.0	16.0	17.0	16.5	20.0	20.0	14.8	16.0	15.0	14.3
5	20.0	16.5	17.0	14.5	10.0	20.0	15.1	15.0	15.1	14.1
Mean	**18.0**	16.1	17.0	15.5	16.0	**20.0**	15.3	15.4	15.0	13.9
Median	20.0	16.0	17.0	15.6	20.0	20.0	15.5	16.0	15.0	13.9
Std.Dev.	4.5	0.2	0.0	0.8	5.5	0.0	0.3	0.9	0.2	0.3
Rel.Std.Dev.	24.8%	1.39%	0.00%	4.95%	34.2%	0.00%	2.09%	5.81%	1.20%	2.25%
PDM[3]	16.0%	3.73%	9.53%	-0.26%	3.09%	28.9%	-1.55%	-0.78%	-3.57%	-10.2%

Table A14. 4-acid results for Co in OREAS 113 (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	790	755	815	593	740	720	700	765	762	758
2	800	765	802	584	730	740	700	756	757	759
3	790	750	806	562	730	800	711	737	759	761
4	830	760	805	625	740	760	678	764	754	759
5	800	750	806	552	740	780	682	734	762	761
Mean	802	756	807	**583**	736	760	**694**	751	759	760
Median	800	755	806	584	740	760	700	756	759	759
Std.Dev.	16	7	5	29	5	32	14	15	3	1
Rel.Std.Dev.	2.05%	0.86%	0.60%	4.90%	0.74%	4.16%	1.99%	1.97%	0.45%	0.19%
PDM[3]	4.66%	-1.34%	5.29%	-23.9%	-3.95%	-0.82%	-9.41%	-1.97%	-0.98%	-0.88%

Table A15. 4-acid results for Cu in OREAS 113 (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	13.3	12.9	14.2	13.6	13.4	13.8	13.1	12.5	13.3	13.4
2	13.4	12.9	14.2	13.7	**12.7**	13.8	13.2	12.4	13.4	13.6
3	13.2	13.1	14.2	13.8	13.5	13.9	13.4	12.2	13.4	13.0
4	13.9	13.2	14.3	14.1	13.3	13.5	13.4	12.6	13.5	13.1
5	13.8	13.4	14.1	14.0	13.7	13.9	13.5	12.3	13.5	13.2
Mean	13.5	13.1	14.2	13.8	13.3	13.8	13.3	**12.4**	13.4	13.2
Median	13.4	13.1	14.2	13.8	13.4	13.8	13.4	12.4	13.4	13.2
Std.Dev.	0.3	0.2	0.1	0.2	0.4	0.2	0.2	0.2	0.1	0.2
Rel.Std.Dev.	2.30%	1.62%	0.37%	1.50%	2.70%	1.34%	1.35%	1.28%	0.44%	1.68%
PDM[3]	-0.12%	-3.22%	4.86%	2.25%	-1.56%	1.58%	-1.89%	-8.39%	-0.91%	-2.11%

Table A16. 4-acid results for Fe in OREAS 113 (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	28.1	29.0	29.6	28.7	28.6	27.8	26.7	27.1	29.1	27.4
2	28.2	28.6	29.4	28.2	**26.9**	28.6	26.5	27.0	28.4	27.6
3	27.8	28.0	29.3	27.2	28.7	30.9	26.6	27.4	28.6	27.5
4	28.6	29.2	29.5	30.1	28.5	29.4	**25.1**	26.9	28.3	27.4
5	28.1	28.1	29.4	25.8	28.5	29.9	**25.2**	27.2	28.3	27.7
Mean	28.2	28.6	29.4	28.0	28.3	29.3	26.0	27.1	28.5	27.5
Median	28.1	28.6	29.4	28.2	28.5	29.4	26.5	27.1	28.4	27.5
Std.Dev.	0.3	0.5	0.1	1.6	0.8	1.2	0.8	0.2	0.3	0.1
Rel.Std.Dev.	1.02%	1.86%	0.44%	5.76%	2.75%	4.06%	3.07%	0.71%	1.11%	0.53%
PDM[3]	-0.10%	1.39%	4.43%	-0.67%	0.27%	4.01%	-7.70%	-3.79%	1.26%	-2.37%

Table A17. 4-acid results for Pb in OREAS 113 (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	240	237	240	234	300	250	226	195	340	192
2	240	228	234	232	200	250	224	198	330	196
3	250	237	245	222	200	280	227	206	340	198
4	250	236	**258**	248	200	270	215	**215**	340	195
5	250	230	243	216	300	270	219	194	330	198
Mean	246	234	244	230	240	264	222	202	**336**	196
Median	250	236	243	232	200	270	224	198	340	196
Std.Dev.	5	4	9	12	55	13	5	9	5	3
Rel.Std.Dev.	2.23%	1.83%	3.63%	5.33%	22.82%	5.08%	2.28%	4.39%	1.63%	1.28%
PDM[3]	6.92%	1.53%	6.05%	0.14%	4.31%	14.7%	-3.43%	-12.4%	46.0%	-14.9%

Table A18. 4-acid results for Sb in OREAS 113 (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	6.8	6.1	NR	<100	<50	<5	11.0	<50	<5
2	10.0	7.0	5.8	NR	<100	<50	<5	10.0	<50	5.0
3	10.0	7.0	6.3	NR	<100	<50	<5	10.0	<50	<5
4	10.0	6.8	6.0	NR	<100	<50	<5	11.0	<50	<5
5	10.0	7.0	6.5	NR	<100	<50	<5	11.0	<50	<5
Mean	10.0	6.9	6.1					10.6		5.0
Median	10.0	7.0	6.1					11.0		5.0
Std.Dev.	0.0	0.1	0.3					0.5		
Rel.Std.Dev.	0.00%	1.58%	4.40%					5.17%		
PDM[3]	29.3%	-10.5%	-20.6%					37.1%		-35.3%

Table A19. 4-acid results for Zn in OREAS 113 (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	4510	**4030**	4390	3980	4300	4250	3940	3880	4270	4100
2	4570	4100	4384	4080	4000	4410	3930	3890	4180	4096
3	4460	4110	**4267**	3790	4300	4740	3970	3850	4200	4107
4	4580	4110	4389	4250	4200	4520	3800	3950	4130	4129
5	4510	4100	4387	3710	4300	4620	3880	3840	4130	4089
Mean	4526	4090	4363	3962	4220	4508	3904	3882	4182	4104
Median	4510	4100	4387	3980	4300	4520	3930	3880	4180	4100
Std.Dev.	49	34	54	218	130	189	67	43	58	15
Rel.Std.Dev.	1.09%	0.83%	1.24%	5.50%	3.09%	4.19%	1.70%	1.11%	1.39%	0.37%
PDM[3]	8.33%	-2.11%	4.44%	-5.17%	1.00%	7.90%	-6.56%	-7.09%	0.09%	-1.77%