



CERTIFICATE OF ANALYSIS FOR

COPPER SULPHIDE ORE REFERENCE MATERIAL

OREAS 111b

Summary Statistics for OREAS 111b

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
SP Fusion ICP											
Ag (ppm)	<20	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
As (ppm)	212	24	165	260	141	284	11.2%	22.5%	33.7%	202	223
Cd (ppm)	14.8	2.8	9.3	20.3	6.5	23.1	18.67%	37.3%	56.0%	14.1	15.6
Co (ppm)	488	13	461	514	448	528	2.72%	5.45%	8.17%	463	512
Cu (wt.%)	2.44	0.12	2.20	2.67	2.08	2.79	4.82%	9.65%	14.5%	2.31	2.56
Fe (wt.%)	35.5	2.9	29.7	41.3	26.8	44.2	8.20%	16.4%	24.6%	33.7	37.3
Pb (ppm)	397	13	371	423	358	435	3.23%	6.46%	9.69%	377	417
Sb (ppm)	19	5	10	29	5	33	24.1%	48.2%	72.3%	18	20
Zn (ppm)	4370	193	3983	4756	3789	4950	4.43%	8.85%	13.3%	4151	4588
4-Acid ICP											
Ag (ppm)	10.1	0.8	8.4	11.7	7.6	12.5	8.06%	16.1%	24.2%	9.6	10.6
As (ppm)	220	12	196	244	184	255	5.38%	10.8%	16.1%	209	231
Cd (ppm)	14.3	2.2	10.0	18.7	7.9	20.8	15.1%	30.2%	45.2%	13.6	15.1
Co (ppm)	490	29	433	547	405	576	5.82%	11.6%	17.5%	466	515
Cu (wt.%)	2.47	0.13	2.21	2.72	2.09	2.84	5.11%	10.2%	15.3%	2.34	2.59
Fe (wt.%)	36.1	1.5	33.0	39.2	31.5	40.8	4.29%	8.57%	12.9%	34.3	37.9
Pb (ppm)	393	24	345	442	320	466	6.17%	12.3%	18.5%	374	413
Sb (ppm)	21	6	9	32	3	38	28.3%	56.6%	84.9%	20	22
Zn (ppm)	4334	214	3905	4762	3691	4977	4.95%	9.89%	14.8%	4117	4550

Note - intervals may appear asymmetric due to rounding; IND - indeterminate

Prepared by:

Ore Research & Exploration Pty Ltd

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INTRODUCTION

OREAS reference materials (RM) are intended to provide a low cost method of evaluating and improving the quality of precious and base metal analysis of geological samples. To the explorationist, they provide an important control in analytical data sets related to exploration from the grass roots level through to resource definition. To the analyst, they provide an effective means of calibrating analytical equipment, assessing new techniques and routinely monitoring in-house procedures.

OREAS 111b is a medium 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. OREAS 111b has a pigeon pair with OREAS 111 which is ~4% lower in Cu grade. OREAS 111b is one of a suite of five CRMs and was prepared from massive pyrite ore material. 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:

- a) *drying at 65^o C to constant mass;*
- b) *crushing and screening;*
- c) *multi-stage milling to 100% minus 35 microns;*
- d) *final homogenisation;*
- e) *packaging into 10g units sealed under nitrogen in laminated foil pouches.*

ANALYSIS OF OREAS 111b

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 (PDM³) are presented in Tables A2 and A19 (Appendix). The parameter PDM³ 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 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 111b

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

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

$$\bar{\bar{x}} = \frac{1}{p} \sum_{i=1}^p \bar{x}_i$$

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 ;
 $\bar{\bar{x}}$ is the mean of means.

The confidence intervals were obtained by calculation of the variance of the consensus value (mean of means) and reference to Student's- t distribution with degrees of freedom $(p-1)$.

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

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

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 was primarily 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:

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

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

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.

Table 1. Certified values and 95% confidence intervals for OREAS 111b

Constituent	Certified Value	95% Confidence Interval	
		Low	High
Sodium Peroxide Fusion ICP			
Silver, Ag (ppm)	<20	IND	IND
Arsenic, As (ppm)	212	188	237
Cadmium, Cd (ppm)	14.8	12.9	16.7
Cobalt, Co (ppm)	488	468	508
Copper, Cu (wt.%)	2.44	2.35	2.52
Iron, Fe (wt.%)	35.5	32.9	38.1
Lead, Pb (ppm)	397	378	416
Antimony, Sb (ppm)	19	11	27
Zinc, Zn (ppm)	4370	4222	4517
4-Acid Digest ICP			
Silver, Ag (ppm)	10.1	9.6	10.5
Arsenic, As (ppm)	220	211	229
Cadmium, Cd (ppm)	14.3	13.4	15.3
Cobalt, Co (ppm)	490	470	510
Copper, Cu (wt.%)	2.47	2.39	2.55
Iron, Fe (wt.%)	36.1	35.1	37.1
Lead, Pb (ppm)	393	377	410
Antimony, Sb (ppm)	21	15	26
Zinc, Zn (ppm)	4334	4194	4473

Note - intervals may appear asymmetric due to rounding; IND - indeterminate

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.

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, α 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 2.38 and 2.55 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:

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

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

Table 2. Certified values and tolerance intervals for OREAS 111b.

Constituent	Certified Value	Tolerance Interval 1- α =0.99, ρ =0.95	
		Low	High
Sodium Peroxide Fusion ICP			
Silver, Ag (ppm)	<20	IND	IND
Arsenic, As (ppm)	212	199	226
Cadmium, Cd (ppm)	14.8	IND	IND
Cobalt, Co (ppm)	488	IND	IND
Copper, Cu (wt.%)	2.44	2.32	2.55
Iron, Fe (wt.%)	35.5	35.0	36.0
Lead, Pb (ppm)	397	379	415
Antimony, Sb (ppm)	19	16	22
Zinc, Zn (ppm)	4370	4214	4525
4-Acid Digest ICP			
Silver, Ag (ppm)	10.1	9.7	10.4
Arsenic, As (ppm)	220	209	231
Cadmium, Cd (ppm)	14.3	13.8	14.9
Cobalt, Co (ppm)	490	477	503
Copper, Cu (wt.%)	2.47	2.38	2.55
Iron, Fe (wt.%)	36.1	35.3	36.9
Lead, Pb (ppm)	393	382	404
Antimony, Sb (ppm)	21	19	22
Zinc, Zn (ppm)	4334	4229	4438

Note - intervals may appear asymmetric due to rounding; IND - indeterminate

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 111b

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
SP Fusion ICP											
Ag (ppm)	<20	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
As (ppm)	212	24	165	260	141	284	11.2%	22.5%	33.7%	202	223
Cd (ppm)	14.8	2.8	9.3	20.3	6.5	23.1	18.67%	37.3%	56.0%	14.1	15.6
Co (ppm)	488	13	461	514	448	528	2.72%	5.45%	8.17%	463	512
Cu (wt.%)	2.44	0.12	2.20	2.67	2.08	2.79	4.82%	9.65%	14.5%	2.31	2.56
Fe (wt.%)	35.5	2.9	29.7	41.3	26.8	44.2	8.20%	16.4%	24.6%	33.7	37.3
Pb (ppm)	397	13	371	423	358	435	3.23%	6.46%	9.69%	377	417
Sb (ppm)	19	5	10	29	5	33	24.1%	48.2%	72.3%	18	20
Zn (ppm)	4370	193	3983	4756	3789	4950	4.43%	8.85%	13.3%	4151	4588
4-Acid ICP											
Ag (ppm)	10.1	0.8	8.4	11.7	7.6	12.5	8.06%	16.1%	24.2%	9.6	10.6
As (ppm)	220	12	196	244	184	255	5.38%	10.8%	16.1%	209	231
Cd (ppm)	14.3	2.2	10.0	18.7	7.9	20.8	15.1%	30.2%	45.2%	13.6	15.1
Co (ppm)	490	29	433	547	405	576	5.82%	11.6%	17.5%	466	515
Cu (wt.%)	2.47	0.13	2.21	2.72	2.09	2.84	5.11%	10.2%	15.3%	2.34	2.59
Fe (wt.%)	36.1	1.5	33.0	39.2	31.5	40.8	4.29%	8.57%	12.9%	34.3	37.9
Pb (ppm)	393	24	345	442	320	466	6.17%	12.3%	18.5%	374	413
Sb (ppm)	21	6	9	32	3	38	28.3%	56.6%	84.9%	20	22
Zn (ppm)	4334	214	3905	4762	3691	4977	4.95%	9.89%	14.8%	4117	4550

Note - intervals may appear asymmetric due to rounding; IND - indeterminate

PARTICIPATING LABORATORIES

Acme Analytical Laboratories Ltd, Vancouver, BC, Canada
Activation Laboratories, Ancaster, ONtario, Canada
ALS Chemex, Brisbane, QLD, Australia
ALS Chemex, Vancouver, BC, Canada
Amdel Limited, Adelaide, SA, Australia
Genalysis Laboratory Services Pty Ltd, Perth, WA, Australia
Intertek Testing Services, Jakarta, Indonesia
OMAC Laboratories Ltd, Loughrea, County Galway, Ireland
SGS Australia, Perth, WA, Australia
Ultra Trace Pty Ltd, Perth, WA, Australia

PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

Reference material OREAS 111b has been prepared and certified by:

*Ore Research & Exploration Pty Ltd
6-8 Gatwick Road
Bayswater North VIC 3153
AUSTRALIA*

<i>Telephone</i>	<i>(03) 9729 0333</i>	<i>International</i>	<i>+613-9729 0333</i>
<i>Facsimile</i>	<i>(03) 9729 4777</i>	<i>International</i>	<i>+613-9729 4777</i>
<i>Email</i>	<i>info@ore.com.au</i>	<i>Web</i>	<i>www.ore.com.au</i>

OREAS 111b available in 10g units sealed under a nitrogen environment in laminated foil pouches.

INTENDED USE

OREAS 111b 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 111b is a reference material made from medium 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 OF THE REFERENCE MATERIAL

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.

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.

CERTIFYING OFFICER:

Craig Hamlyn (B.Sc. Hons - Geology)

REFERENCES

ISO Guide 35 (2006), Certification of reference materials - General and statistical principals.
ISO Guide 3207 (1975), Statistical interpretation of data - Determination of a statistical tolerance interval.

APPENDIX

Analytical Data for OREAS 111b

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 111b (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	5.0	10.0	15.0	NR	NR	NR	NR	<20	NR
2	<10	5.0	10.0	16.0	NR	NR	NR	NR	<20	NR
3	< 10	5.0	9.0	17.0	NR	NR	NR	NR	<20	NR
4	< 10	5.0	10.0	18.0	NR	NR	NR	NR	<20	NR
5	< 10	5.0	10.0	16.0	NR	NR	NR	NR	<20	NR
Mean		5.0	9.8	16.4						
Median		5.0	10.0	16.0						
Std.Dev.		0.0	0.4	1.1						
Rel.Std.Dev.		0.00%	4.56%	6.95%						
PDM ³		-51.9%	-5.77%	57.7%						

Table A3. Fusion results for As in OREAS 111b (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	195	225	225	250	NR	NR	200	NR	183	NR
2	187	225	232	230	NR	NR	200	NR	155	NR
3	193	230	218	250	NR	NR	200	NR	198	NR
4	170	225	222	290	NR	NR	200	NR	222	NR
5	259	220	223	260	NR	NR	200	NR	180	NR
Mean	201	225	224	256			200		188	
Median	193	225	223	250			200		183	
Std.Dev.	34	4	5	22			0		25	
Rel.Std.Dev.	16.9%	1.57%	2.30%	8.56%			0.00%		13.1%	
PDM ³	-5.41%	5.98%	5.51%	20.6%			-5.79%		-11.6%	

Table A4. Fusion results for Cd in OREAS 111b (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	14.0	10.0	15.0	15.9	NR	NR	NR	NR	65.0	NR
2	14.0	20.0	15.0	15.8	NR	NR	NR	NR	<50	NR
3	14.0	10.0	15.0	16.2	NR	NR	NR	NR	85.0	NR
4	13.0	20.0	15.0	17.7	NR	NR	NR	NR	<50	NR
5	14.0	10.0	15.0	16.7	NR	NR	NR	NR	<50	NR
Mean	13.8	14.0	15.0	16.5					75.0	
Median	14.0	10.0	15.0	16.2					75.0	
Std.Dev.	0.4	5.5	0.0	0.8					14.1	
Rel.Std.Dev.	3.24%	39.1%	0.00%	4.72%					18.9%	
PDM ³	-6.85%	-5.50%	1.25%	11.1%					406%	

Table A5. Fusion results for Co in OREAS 111b (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	474	500	NR	486	NR	NR	480	NR	NR	NR
2	473	500	NR	480	NR	NR	480	NR	NR	NR
3	470	500	NR	491	NR	NR	500	NR	NR	NR
4	432	520	NR	535	NR	NR	480	NR	NR	NR
5	480	500	NR	499	NR	NR	480	NR	NR	NR
Mean	466	504		498			484			
Median	473	500		491			480			
Std.Dev.	19	9		22			9			
Rel.Std.Dev.	4.13%	1.77%		4.36%			1.85%			
PDM ³	-4.51%	3.32%		2.13%			-0.78%			

Table A6. Fusion results for Cu in OREAS 111b (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	2.19	2.47	2.57	2.62	2.45	2.33	2.45	NR	2.34	NR
2	2.52	2.38	2.61	2.55	2.34	2.29	2.46	NR	2.26	NR
3	2.27	2.42	2.63	2.40	2.41	2.42	2.42	NR	2.43	NR
4	2.16	2.53	2.59	2.53	2.43	2.30	2.33	NR	2.46	NR
5	2.49	2.50	2.59	2.56	2.40	2.37	2.39	NR	2.38	NR
Mean	2.33	2.46	2.60	2.53	2.41	2.34	2.41		2.37	
Median	2.27	2.47	2.59	2.55	2.41	2.33	2.42		2.38	
Std.Dev.	0.17	0.06	0.02	0.08	0.04	0.05	0.05		0.08	
Rel.Std.Dev.	7.25%	2.46%	0.92%	3.20%	1.73%	2.29%	2.18%		3.48%	
PDM ³	-4.49%	1.01%	6.71%	3.97%	-1.20%	-3.83%	-1.04%		-2.48%	

Table A7. Fusion results for Fe in OREAS 111b (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	35.0	37.8	38.3	41.8	32.7	32.2	33.7	NR	37.5	NR
2	34.0	36.7	38.5	41.2	31.9	32.3	33.6	NR	36.9	NR
3	33.1	37.0	38.1	38.6	32.0	32.9	34.9	NR	35.0	NR
4	33.6	37.3	37.7	40.3	32.0	32.5	34.6	NR	35.2	NR
5	33.9	36.9	38.2	40.9	32.1	32.3	34.3	NR	35.2	NR
Mean	33.9	37.1	38.2	40.6	32.1	32.4	34.2		36.0	
Median	33.9	37.0	38.2	40.9	32.0	32.3	34.3		35.2	
Std.Dev.	0.7	0.4	0.3	1.2	0.3	0.3	0.6		1.2	
Rel.Std.Dev.	2.06%	1.15%	0.76%	3.01%	1.06%	0.86%	1.65%		3.21%	
PDM ³	-4.43%	4.64%	7.50%	14.3%	-9.45%	-8.60%	-3.58%		1.32%	

Table A8. Fusion results for Pb in OREAS 111b (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	384	390	466	405	NR	NR	300	NR	NR	NR
2	385	390	402	411	NR	NR	300	NR	NR	NR
3	383	380	395	419	NR	NR	300	NR	NR	NR
4	350	410	394	442	NR	NR	300	NR	NR	NR
5	391	380	405	417	NR	NR	300	NR	NR	NR
Mean	379	390	412	419			300			
Median	384	390	402	417			300			
Std.Dev.	16	12	30	14			0			
Rel.Std.Dev.	4.30%	3.14%	7.35%	3.36%			0.00%			
PDM ³	-4.62%	-1.75%	3.90%	5.51%			-24.4%			

Table A9. Fusion results for Sb in OREAS 111b (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	14.0	20.0	18.3	28.6	NR	NR	NR	NR	85.0	NR
2	13.0	22.0	19.2	24.7	NR	NR	NR	NR	69.0	NR
3	13.0	22.0	18.7	22.1	NR	NR	NR	NR	99.0	NR
4	11.0	20.0	19.1	25.7	NR	NR	NR	NR	73.0	NR
5	13.0	20.0	18.8	22.9	NR	NR	NR	NR	<50	NR
Mean	12.8	20.8	18.8	24.8					81.5	
Median	13.0	20.0	18.8	24.7					79.0	
Std.Dev.	1.1	1.1	0.4	2.6					13.5	
Rel.Std.Dev.	8.56%	5.27%	1.89%	10.3%					16.6%	
PDM ³	-33.7%	7.74%	-2.51%	28.5%					322%	

Table A10. Fusion results for Zn in OREAS 111b (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	4400	4420	4683	4640	4300	4400	4200	NR	3892	NR
2	4300	4260	4709	4600	4000	4300	4200	NR	4101	NR
3	4400	4300	4671	4280	4500	4500	4300	NR	4375	NR
4	4300	4380	4607	4500	4100	4500	4300	NR	4191	NR
5	4400	4220	4666	4550	4200	4400	4200	NR	4246	NR
Mean	4360	4316	4667	4514	4220	4420	4240		4161	
Median	4400	4300	4671	4550	4200	4400	4200		4191	
Std.Dev.	55	83	38	141	192	84	55		180	
Rel.Std.Dev.	1.26%	1.92%	0.80%	3.12%	4.56%	1.89%	1.29%		4.33%	
PDM ³	-0.22%	-1.23%	6.81%	3.30%	-3.42%	1.15%	-2.97%		-4.77%	

Table A11. 4-acid results for Ag in OREAS 111b (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	10.0	11.0	11.0	9.0	12.0	9.3	9.5	10.0	10.4
2	10.0	10.0	11.0	11.0	11.0	11.0	9.4	9.5	11.6	10.3
3	10.0	10.5	12.0	11.0	9.0	10.0	9.0	9.5	9.5	10.5
4	10.0	10.5	11.0	12.0	9.0	9.0	10.6	9.5	10.5	10.5
5	10.0	10.0	11.0	12.0	8.0	9.0	10.4	9.6	10.2	10.3
Mean	10.0	10.2	11.2	11.4	9.2	10.2	9.7	9.5	10.3	10.4
Median	10.0	10.0	11.0	11.0	9.0	10.0	9.4	9.5	10.2	10.4
Std.Dev.	0.0	0.3	0.4	0.5	1.1	1.3	0.7	0.0	0.8	0.1
Rel.Std.Dev.	0.00%	2.68%	3.99%	4.80%	11.9%	12.8%	7.32%	0.47%	7.34%	1.09%
PDM ³	-0.57%	1.42%	11.4%	13.3%	-8.53%	1.42%	-3.16%	-5.35%	2.90%	3.52%

Table A12. 4-acid results for As in OREAS 111b (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	190	230	230	NR	<200	240	196	213	218	227
2	190	230	251	NR	<200	210	211	214	218	226
3	170	240	244	NR	<200	240	223	219	213	224
4	180	235	239	NR	<200	200	211	208	216	227
5	180	235	241	NR	<200	200	221	221	210	223
Mean	182	234	241			218	212	215	215	225
Median	180	235	241			210	211	214	216	226
Std.Dev.	8	4	8			20	11	5	3	2
Rel.Std.Dev.	4.60%	1.79%	3.17%			9.40%	5.04%	2.39%	1.61%	0.91%
PDM ³	-17.3%	6.38%	9.57%			-0.89%	-3.44%	-2.26%	-2.26%	2.46%

Table A13. 4-acid results for Cd in OREAS 111b (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	14.5	15.0	13.5	10.0	20.0	12.5	13.0	14.7	12.4
2	10.0	14.5	16.0	14.5	10.0	20.0	12.3	14.0	14.7	13.6
3	10.0	14.5	15.0	14.8	10.0	20.0	13.0	14.0	14.6	12.9
4	10.0	15.0	15.0	15.0	10.0	10.0	14.1	14.0	14.1	12.5
5	10.0	14.5	15.0	14.7	10.0	10.0	14.0	13.0	13.8	12.1
Mean	10.0	14.6	15.2	14.5	10.0	16.0	13.2	13.6	14.4	12.7
Median	10.0	14.5	15.0	14.7	10.0	20.0	13.0	14.0	14.6	12.5
Std.Dev.	0.0	0.2	0.4	0.6	0.0	5.5	0.8	0.5	0.4	0.6
Rel.Std.Dev.	0.00%	1.53%	2.94%	4.05%	0.00%	34.2%	6.33%	4.03%	3.05%	4.45%
PDM ³	-30.3%	1.82%	6.01%	1.12%	-30.3%	11.6%	-8.08%	-5.15%	0.29%	-11.5%

Table A14. 4-acid results for Co in OREAS 111b (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	540	505	527	433	460	510	447	500	504	481
2	540	510	551	450	460	480	453	502	497	483
3	530	505	530	468	460	500	472	511	497	489
4	520	505	529	458	470	450	463	494	487	493
5	540	500	533	463	470	450	456	507	475	477
Mean	534	505	534	454	464	478	458	503	492	485
Median	540	505	530	458	460	480	456	502	497	483
Std.Dev.	9	4	10	14	5	28	10	7	11	6
Rel.Std.Dev.	1.67%	0.70%	1.83%	3.01%	1.18%	5.81%	2.10%	1.30%	2.29%	1.27%
PDM ³	8.92%	3.00%	8.92%	-7.32%	-5.36%	-2.50%	-6.54%	2.56%	0.35%	-1.17%

Table A15. 4-acid results for Cu in OREAS 111b (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	2.49	2.43	2.65	2.21	2.44	2.78	2.46	2.33	2.59	2.45
2	2.40	2.46	2.68	2.38	2.37	2.58	2.42	2.38	2.55	2.48
3	2.50	2.39	2.62	2.29	2.51	2.73	2.45	2.28	2.55	2.48
4	2.40	2.43	2.66	2.29	2.43	2.38	2.56	2.24	2.49	2.47
5	2.35	2.51	2.68	2.32	2.48	2.46	2.53	2.29	2.49	2.40
Mean	2.43	2.44	2.65	2.30	2.45	2.59	2.48	2.30	2.54	2.46
Median	2.40	2.43	2.66	2.29	2.44	2.58	2.46	2.29	2.55	2.47
Std.Dev.	0.06	0.04	0.02	0.06	0.05	0.17	0.06	0.05	0.04	0.03
Rel.Std.Dev.	2.66%	1.82%	0.94%	2.67%	2.08%	6.61%	2.36%	2.31%	1.68%	1.39%
PDM ³	-1.51%	-0.86%	7.69%	-6.78%	-0.80%	4.90%	0.76%	-6.54%	2.87%	-0.31%

Table A16. 4-acid results for Fe in OREAS 111b (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	37.1	36.9	38.5	34.2	35.3	37.9	31.8	36.5	38.0	35.0
2	35.9	37.2	38.8	37.3	34.4	35.6	32.8	37.3	37.2	35.4
3	35.9	36.8	38.0	38.4	35.2	36.0	34.0	35.9	37.3	35.7
4	36.1	36.7	38.5	37.5	35.8	33.5	34.8	35.9	36.8	35.8
5	35.2	37.0	38.4	37.3	34.9	33.5	34.4	35.5	36.3	35.1
Mean	36.0	36.9	38.4	36.9	35.1	35.3	33.6	36.2	37.1	35.4
Median	35.9	36.9	38.5	37.3	35.2	35.6	34.0	35.9	37.2	35.4
Std.Dev.	0.7	0.2	0.3	1.6	0.5	1.9	1.2	0.7	0.7	0.3
Rel.Std.Dev.	1.90%	0.52%	0.70%	4.33%	1.47%	5.27%	3.68%	1.94%	1.76%	0.99%
PDM ³	-0.22%	2.22%	6.42%	2.27%	-2.80%	-2.27%	-7.09%	0.28%	2.79%	-2.05%

Table A17. 4-acid results for Pb in OREAS 111b (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	410	386	388	378	400	450	345	344	440	373
2	410	384	403	405	400	410	345	345	430	375
3	400	380	397	415	400	420	374	345	430	380
4	400	378	405	416	400	380	379	351	420	379
5	400	380	412	414	400	390	376	350	400	373
Mean	404	382	401	406	400	410	364	347	424	376
Median	400	380	403	414	400	410	374	345	430	375
Std.Dev.	5	3	9	16	0	27	17	3	15	3
Rel.Std.Dev.	1.36%	0.86%	2.25%	3.95%	0.00%	6.68%	4.74%	0.93%	3.58%	0.91%
PDM ³	2.74%	-2.96%	1.98%	3.14%	1.72%	4.26%	-7.48%	-11.76%	7.82%	-4.41%

Table A18. 4-acid results for Sb in OREAS 111b (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	30.0	21.8	17.8	NR	<100	<50	26.0	23.0	<50	17.3
2	30.0	21.0	18.0	NR	<100	<50	<5	23.0	<50	14.3
3	30.0	22.8	17.6	NR	<100	<50	10.0	24.0	<50	14.6
4	30.0	21.6	17.6	NR	<100	<50	<5	24.0	<50	14.7
5	30.0	20.8	18.0	NR	<100	<50	11.0	22.0	<50	14.6
Mean	30.0	21.6	17.8				15.7	23.2		15.1
Median	30.0	21.6	17.8				11.0	23.0		14.6
Std.Dev.	0.0	0.8	0.2				9.0	0.8		1.2
Rel.Std.Dev.	0.00%	3.65%	1.12%				57.2%	3.61%		8.11%
PDM ³	45.9%	5.06%	-13.4%				-23.8%	12.8%		-26.6%

Table A19. 4-acid results for Zn in OREAS 111b (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	4920	4380	4682	3930	4300	4880	4120	3920	4550	4231
2	4780	4330	4730	4200	4300	4430	4190	4170	4440	4243
3	4750	4330	4651	4620	4300	4740	4350	4050	4400	4300
4	4750	4350	4701	4340	4400	4020	4200	4070	4410	4290
5	4700	4360	4694	4270	4300	4290	4140	4000	4330	4245
Mean	4780	4350	4692	4272	4320	4472	4200	4042	4426	4262
Median	4750	4350	4694	4270	4300	4430	4190	4050	4410	4245
Std.Dev.	83	21	29	249	45	345	90	92	80	31
Rel.Std.Dev.	1.74%	0.49%	0.61%	5.83%	1.04%	7.73%	2.15%	2.28%	1.81%	0.73%
PDM ³	10.3%	0.38%	8.26%	-1.42%	-0.31%	3.19%	-3.08%	-6.73%	2.13%	-1.66%