



CERTIFICATE OF ANALYSIS FOR
COPPER SULPHIDE ORE REFERENCE MATERIAL
OREAS 110

Summary Statistics for OREAS 110

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)	<10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
As (ppm)	103	10	83	124	73	134	9.93%	19.9%	29.8%	98	108
Cd (ppm)	<2	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Co (ppm)	32	8	16	49	7	57	25.6%	51.2%	76.7%	31	34
Cu (wt.%)	0.160	0.005	0.149	0.170	0.144	0.175	3.20%	6.39%	9.59%	0.152	0.168
Fe (wt.%)	24.7	1.7	21.2	28.2	19.4	29.9	7.08%	14.2%	21.3%	23.4	25.9
Pb (ppm)	46	11	23	68	12	79	24.5%	49.1%	73.6%	43	48
Sb (ppm)	15	2	12	18	10	20	10.7%	21.5%	32.2%	14	16
Zn (ppm)	95	23	48	142	24	165	24.7%	49.5%	74.2%	90	100
4-Acid ICP											
Ag (ppm)	0.58	0.09	0.39	0.76	0.30	0.86	15.9%	31.9%	47.8%	0.55	0.61
As (ppm)	103	6	91	115	86	120	5.62%	11.2%	16.8%	98	108
Cd (ppm)	<0.5	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Co (ppm)	24	4	15	32	11	36	17.6%	35.1%	52.7%	23	25
Cu (wt.%)	0.162	0.006	0.151	0.174	0.145	0.180	3.52%	7.05%	10.6%	0.154	0.171
Fe (wt.%)	25.1	1.9	21.3	28.9	19.3	30.8	7.61%	15.2%	22.8%	23.8	26.3
Pb (ppm)	36.2	2.4	31.5	40.9	29.2	43.3	6.49%	13.0%	19.5%	34.4	38.0
Sb (ppm)	15.2	1.0	13.2	17.3	12.2	18.3	6.76%	13.5%	20.3%	14.5	16.0
Zn (ppm)	72.0	3.2	65.7	78.3	62.6	81.5	4.38%	8.76%	13.1%	68.4	75.6

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

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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 110 is a low 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 110 is one of a suite of five CRMs and was prepared from jasper rock material containing about 10% pyrite. 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 110

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 110

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

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

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

where

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

The confidence intervals 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 $(p-1)$.

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

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

where

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

The distribution of the values is assumed to be symmetrical about the mean in the calculation of the confidence interval.

The test for rejection of individual outliers from each laboratory data set 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:

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

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

where

T is the median value in a data set;

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

Table 1. Certified values and 95% confidence intervals for OREAS 110

Constituent	Certified Value	95% Confidence Interval	
		Low	High
Sodium Peroxide Fusion ICP			
Silver, Ag (ppm)	<10	IND	IND
Arsenic, As (ppm)	103	99	108
Cadmium, Cd (ppm)	<2	IND	IND
Cobalt, Co (ppm)	32	18	47
Copper, Cu (wt.%)	0.160	0.155	0.164
Iron, Fe (wt.%)	24.7	23.2	26.1
Lead, Pb (ppm)	46	28	64
Antimony, Sb (ppm)	15	12	19
Zinc, Zn (ppm)	95	71	119
4-Acid Digest ICP			
Silver, Ag (ppm)	0.58	0.51	0.65
Arsenic, As (ppm)	103	99	107
Cadmium, Cd (ppm)	<0.5	IND	IND
Cobalt, Co (ppm)	24	21	27
Copper, Cu (wt.%)	0.162	0.159	0.166
Iron, Fe (wt.%)	25.1	23.6	26.5
Lead, Pb (ppm)	36.2	34.4	38.0
Antimony, Sb (ppm)	15.2	14.4	16.1
Zinc, Zn (ppm)	72.0	70.7	73.4

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 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:

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

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 110.

Constituent	Certified Value	Tolerance Interval 1- α =0.99, ρ =0.95	
		Low	High
Sodium Peroxide Fusion ICP			
Silver, Ag (ppm)	<10	IND	IND
Arsenic, As (ppm)	103	94	112
Cadmium, Cd (ppm)	<2	IND	IND
Cobalt, Co (ppm)	32	26	38
Copper, Cu (wt.%)	0.160	0.150	0.170
Iron, Fe (wt.%)	24.7	24.1	25.2
Lead, Pb (ppm)	46	41	50
Antimony, Sb (ppm)	15	15	15
Zinc, Zn (ppm)	95	77	113
4-Acid Digest ICP			
Silver, Ag (ppm)	0.58	0.19	0.97
Arsenic, As (ppm)	103	99	107
Cadmium, Cd (ppm)	<0.5	IND	IND
Cobalt, Co (ppm)	24	23	25
Copper, Cu (wt.%)	0.162	0.156	0.168
Iron, Fe (wt.%)	25.1	24.6	25.5
Lead, Pb (ppm)	36.2	34.9	37.5
Antimony, Sb (ppm)	15.2	14.2	16.3
Zinc, Zn (ppm)	72.0	68.9	75.1

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 110

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)	<10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
As (ppm)	103	10	83	124	73	134	9.93%	19.9%	29.8%	98	108
Cd (ppm)	<2	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Co (ppm)	32	8	16	49	7	57	25.6%	51.2%	76.7%	31	34
Cu (wt.%)	0.160	0.005	0.149	0.170	0.144	0.175	3.20%	6.39%	9.59%	0.152	0.168
Fe (wt.%)	24.7	1.7	21.2	28.2	19.4	29.9	7.08%	14.2%	21.3%	23.4	25.9
Pb (ppm)	46	11	23	68	12	79	24.5%	49.1%	73.6%	43	48
Sb (ppm)	15	2	12	18	10	20	10.7%	21.5%	32.2%	14	16
Zn (ppm)	95	23	48	142	24	165	24.7%	49.5%	74.2%	90	100
4-Acid ICP											
Ag (ppm)	0.58	0.09	0.39	0.76	0.30	0.86	15.9%	31.9%	47.8%	0.55	0.61
As (ppm)	103	6	91	115	86	120	5.62%	11.2%	16.8%	98	108
Cd (ppm)	<0.5	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Co (ppm)	24	4	15	32	11	36	17.6%	35.1%	52.7%	23	25
Cu (wt.%)	0.162	0.006	0.151	0.174	0.145	0.180	3.52%	7.05%	10.6%	0.154	0.171
Fe (wt.%)	25.1	1.9	21.3	28.9	19.3	30.8	7.61%	15.2%	22.8%	23.8	26.3
Pb (ppm)	36.2	2.4	31.5	40.9	29.2	43.3	6.49%	13.0%	19.5%	34.4	38.0
Sb (ppm)	15.2	1.0	13.2	17.3	12.2	18.3	6.76%	13.5%	20.3%	14.5	16.0
Zn (ppm)	72.0	3.2	65.7	78.3	62.6	81.5	4.38%	8.76%	13.1%	68.4	75.6

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

PARTICIPATING LABORATORIES

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PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

Reference material OREAS 110 has been prepared and certified by:

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OREAS 110 available in 10g units sealed under a nitrogen environment in laminated foil pouches.

INTENDED USE

OREAS 110 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 110 is a reference material made from low 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 110 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 110

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 110 (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*MS	Lab J -
1	< 10	<5	NR	7.0	NR	NR	NR	NR	<10	NR
2	< 10	<5	NR	7.0	NR	NR	NR	NR	<10	NR
3	< 10	<5	NR	6.0	NR	NR	NR	NR	<10	NR
4	< 10	<5	NR	6.0	NR	NR	NR	NR	<10	NR
5	< 10	<5	NR	7.0	NR	NR	NR	NR	<10	NR
Mean				6.6						
Median				7.0						
Std.Dev.				0.5						
Rel.Std.Dev.				8.30%						
PDM ³										

Table A3. Fusion results for As in OREAS 110 (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*MS	Lab J -
1	105	105	106	100	NR	NR	100	NR	53	NR
2	82	100	98	90	NR	NR	100	NR	59	NR
3	134	115	104	100	NR	NR	100	NR	55	NR
4	156	110	97	100	NR	NR	100	NR	51	NR
5	95	115	102	120	NR	NR	100	NR	53	NR
Mean	114	109	101	102			100		54	
Median	105	110	102	100			100		53	
Std.Dev.	30	7	4	11			0		3	
Rel.Std.Dev.	26.3%	5.98%	3.79%	10.7%			0.00%		5.60%	
PDM ³	10.8%	5.54%	-1.82%	-1.24%			-3.18%		-47.5%	

Table A4. Fusion results for Cd in OREAS 110 (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*MS	Lab J -
1	< 2	<10	NR	NR	NR	NR	NR	NR	<50	NR
2	< 2	<10	NR	0.50	NR	NR	NR	NR	<50	NR
3	< 2	<10	NR	1.20	NR	NR	NR	NR	<50	NR
4	< 2	<10	NR	NR	NR	NR	NR	NR	<50	NR
5	< 2	<10	NR	NR	NR	NR	NR	NR	<50	NR
Mean				0.85						
Median				0.85						
Std.Dev.				0.49						
Rel.Std.Dev.				58.23%						
PDM ³										

Table A5. Fusion results for Co in OREAS 110 (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	22	40	NR	27	NR	NR	40	NR	NR	NR
2	22	40	NR	26	NR	NR	40	NR	NR	NR
3	22	40	NR	25	NR	NR	40	NR	NR	NR
4	23	40	NR	28	NR	NR	40	NR	NR	NR
5	23	40	NR	35	NR	NR	40	NR	NR	NR
Mean	22	40		28			40			
Median	22	40		27			40			
Std.Dev.	1	0		4			0			
Rel.Std.Dev.	2.45%	0.00%		14.1%			0.00%			
PDM ³	-30.5%	24.1%		-12.5%			24.1%			

Table A6. Fusion results for Cu in OREAS 110 (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	0.154	0.154	0.169	0.162	0.140	0.160	0.159	NR	0.357	NR
2	0.155	0.158	0.163	0.153	0.140	0.160	0.154	NR	0.338	NR
3	0.157	0.162	0.169	0.150	0.150	0.160	0.161	NR	0.323	NR
4	0.163	0.160	0.168	0.152	0.160	0.160	0.164	NR	0.351	NR
5	0.161	0.158	0.171	0.165	0.140	0.160	0.159	NR	0.349	NR
Mean	0.158	0.158	0.168	0.156	0.146	0.160	0.159		0.343	
Median	0.157	0.158	0.169	0.153	0.140	0.160	0.159		0.349	
Std.Dev.	0.004	0.003	0.003	0.007	0.009	0.000	0.004		0.014	
Rel.Std.Dev.	2.45%	1.87%	1.68%	4.26%	6.13%	0.00%	2.29%		3.98%	
PDM ³	-1.02%	-0.77%	5.07%	-2.02%	-8.54%	0.23%	-0.14%		115%	

Table A7. Fusion results for Fe in OREAS 110 (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	27.3	26.8	25.8	25.8	21.5	24.0	24.4	NR	22.9	NR
2	26.8	26.4	25.5	24.5	21.8	24.0	24.4	NR	23.1	NR
3	26.3	27.0	26.0	23.9	22.0	24.4	24.5	NR	23.4	NR
4	26.4	26.5	25.4	24.5	22.3	23.8	24.6	NR	23.1	NR
5	27.3	27.1	26.2	26.9	20.9	23.7	24.5	NR	21.8	NR
Mean	26.8	26.8	25.8	25.1	21.7	24.0	24.5		22.9	
Median	26.8	26.8	25.8	24.5	21.8	24.0	24.5		23.1	
Std.Dev.	0.5	0.3	0.3	1.2	0.5	0.3	0.1		0.6	
Rel.Std.Dev.	1.78%	1.14%	1.29%	4.83%	2.52%	1.12%	0.34%		2.67%	
PDM ³	8.75%	8.50%	4.52%	1.85%	-12.0%	-2.77%	-0.74%		-7.31%	

Table A8. Fusion results for Pb in OREAS 110 (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	37.0	40.0	51.0	54.0	NR	NR	<100	NR	NR	NR
2	37.0	30.0	51.0	61.0	NR	NR	<100	NR	NR	NR
3	36.0	40.0	50.0	47.0	NR	NR	<100	NR	NR	NR
4	36.0	40.0	54.0	69.0	NR	NR	<100	NR	NR	NR
5	37.0	30.0	63.0	62.0	NR	NR	<100	NR	NR	NR
Mean	36.6	36.0	53.8	58.6						
Median	37.0	40.0	51.0	61.0						
Std.Dev.	0.5	5.5	5.4	8.4						
Rel.Std.Dev.	1.50%	15.2%	9.96%	14.3%						
PDM ³	-19.9%	-21.2%	17.8%	28.3%						

Table A9. Fusion results for Sb in OREAS 110 (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*MS	Lab J -
1	17.0	15.0	16.2	20.9	NR	NR	NR	NR	<10	NR
2	18.0	15.0	16.4	19.8	NR	NR	NR	NR	12.0	NR
3	16.0	15.0	15.5	19.4	NR	NR	NR	NR	12.0	NR
4	17.0	15.0	16.4	19.6	NR	NR	NR	NR	<10	NR
5	17.0	15.0	16.3	23.2	NR	NR	NR	NR	<10	NR
Mean	17.0	15.0	16.2	20.6					12.0	
Median	17.0	15.0	16.3	19.8					12.0	
Std.Dev.	0.7	0.0	0.4	1.6					0.0	
Rel.Std.Dev.	4.16%	0.00%	2.34%	7.66%					0.00%	
PDM ³	5.9%	-6.54%	0.69%	28.2%					-25.2%	

Table A10. Fusion results for Zn in OREAS 110 (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 -	Lab F PF*OES	Lab G PF*OES	Lab H -	Lab I PF*OES	Lab J -
1	80.0	80.0	94.0	130.0	NR	<100	<100	NR	109.0	NR
2	70.0	80.0	85.0	130.0	NR	100.0	<100	NR	96.0	NR
3	70.0	80.0	78.0	140.0	NR	<100	<100	NR	100.0	NR
4	70.0	80.0	86.0	140.0	NR	<100	<100	NR	103.0	NR
5	70.0	60.0	83.0	130.0	NR	100.0	<100	NR	110.0	NR
Mean	72.0	76.0	85.2	134.0		100.0			103.6	
Median	70.0	80.0	85.0	130.0		100.0			103.0	
Std.Dev.	4.5	8.9	5.8	5.5		0.0			5.9	
Rel.Std.Dev.	6.21%	11.8%	6.81%	4.09%		0.00%			5.73%	
PDM ³	-24.0%	-19.8%	-10.1%	41.4%		5.52%			9.32%	

Table A11. 4-acid results for Ag in OREAS 110 (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*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	0.54	0.50	0.60	NR	0.50	0.50	<0.5	0.50	<1	0.90
2	1.53	0.50	0.80	NR	0.50	0.60	<0.5	0.60	<1	1.04
3	0.50	0.50	0.60	NR	0.50	0.80	<0.5	0.60	<1	0.82
4	0.68	0.50	0.60	NR	0.50	0.70	<0.5	0.60	<1	0.95
5	0.75	0.50	0.60	NR	0.50	0.60	<0.5	0.60	<1	0.93
Mean	0.80	0.50	0.64		0.50	0.64		0.58		0.93
Median	0.68	0.50	0.60		0.50	0.60		0.60		0.93
Std.Dev.	0.42	0.00	0.09		0.00	0.11		0.04		0.08
Rel.Std.Dev.	52.6%	0.00%	14.0%		0.00%	17.8%		7.71%		8.51%
PDM ³	38.0%	-13.7%	10.4%		-13.7%	10.4%		0.07%		60.2%

Table A12. 4-acid results for As in OREAS 110 (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*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	140	105	101	112	103	92	111	104	101	102
2	130	110	100	113	108	96	108	106	97	104
3	120	105	97	106	110	97	102	100	99	99
4	110	105	96	108	111	89	103	105	98	102
5	120	105	97	111	106	93	103	108	96	102
Mean	124	106	98	110	108	93	105	105	98	102
Median	120	105	97	111	108	93	103	105	98	102
Std.Dev.	11	2	2	3	3	3	4	3	2	2
Rel.Std.Dev.	9.19%	2.11%	2.21%	2.65%	2.98%	3.44%	3.71%	2.84%	1.92%	1.73%
PDM ³	20.4%	2.94%	-4.63%	6.83%	4.49%	-9.30%	2.36%	1.58%	-4.96%	-1.13%

Table A13. 4-acid results for Cd in OREAS 110 (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*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	<10	<0.5	0.10	0.30	0.30	<0.5	<0.5	<1	<2	<1
2	<10	<0.5	0.10	0.20	0.30	<0.5	<0.5	<1	<2	<1
3	<10	<0.5	0.20	0.10	0.30	<0.5	<0.5	<1	<2	<1
4	<10	<0.5	0.10	0.10	0.30	<0.5	<0.5	<1	<2	<1
5	<10	<0.5	0.20	0.40	0.30	<0.5	<0.5	<1	<2	<1
Mean			0.14	0.22	0.30					
Median			0.10	0.20	0.30					
Std.Dev.			0.05	0.13	0.00					
Rel.Std.Dev.			39.1%	59.3%	0.00%					
PDM ³			-36.4%	0.00%	36.4%					

Table A14. 4-acid results for Co in OREAS 110 (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*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	30.0	25.0	22.5	25.0	24.2	19.0	21.0	41.0	25.1	16.2
2	30.0	30.0	22.5	25.8	25.0	19.0	20.0	42.0	25.4	18.3
3	30.0	30.0	22.1	23.7	26.1	19.0	19.0	41.0	25.5	20.8
4	30.0	30.0	21.6	24.8	25.8	17.0	18.0	44.0	25.1	20.4
5	30.0	30.0	22.1	25.2	25.8	18.0	22.0	43.0	24.8	19.5
Mean	30.0	29.0	22.2	24.9	25.4	18.4	20.0	42.2	25.2	19.0
Median	30.0	30.0	22.1	25.0	25.8	19.0	20.0	42.0	25.1	19.5
Std.Dev.	0.0	2.2	0.4	0.8	0.8	0.9	1.6	1.3	0.3	1.9
Rel.Std.Dev.	0.00%	7.71%	1.68%	3.08%	3.06%	4.86%	7.91%	3.09%	1.11%	9.74%
PDM ³	26.0%	21.8%	-6.95%	4.56%	6.57%	-22.7%	-16.0%	77.2%	5.67%	-20.1%

Table A15. 4-acid results for Cu in OREAS 110 (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*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	0.172	0.154	0.166	0.162	0.151	0.160	0.160	0.166	0.167	0.167
2	0.165	0.160	0.163	0.157	0.154	0.166	0.167	0.164	0.160	0.167
3	0.172	0.157	0.162	0.143	0.157	0.161	0.155	0.163	0.163	0.166
4	0.174	0.157	0.171	0.157	0.155	0.155	0.161	0.170	0.163	0.165
5	0.175	0.159	0.168	0.163	0.153	0.160	0.162	0.166	0.160	0.167
Mean	0.172	0.157	0.166	0.156	0.154	0.160	0.161	0.166	0.162	0.166
Median	0.172	0.157	0.166	0.157	0.154	0.160	0.161	0.166	0.163	0.167
Std.Dev.	0.004	0.002	0.004	0.008	0.002	0.004	0.004	0.003	0.003	0.001
Rel.Std.Dev.	2.28%	1.46%	2.35%	5.11%	1.56%	2.44%	2.57%	1.62%	1.63%	0.70%
PDM ³	5.65%	-3.10%	2.18%	-3.71%	-5.33%	-1.25%	-1.00%	2.08%	-0.02%	2.44%

Table A16. 4-acid results for Fe in OREAS 110 (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*MS	Lab F 4A*AAS	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	26.4	26.4	27.1	27.5	23.6	21.4	22.6	27.1	25.2	24.8
2	25.8	26.7	27.2	26.6	24.0	22.4	22.8	26.5	24.1	24.9
3	26.3	26.8	26.8	25.1	24.0	21.7	21.6	26.7	24.5	24.7
4	26.5	26.7	26.4	26.8	23.5	21.0	22.3	26.8	24.3	24.6
5	26.7	26.6	27.0	27.3	23.9	21.5	22.6	27.7	24.1	24.9
Mean	26.3	26.6	26.9	26.7	23.8	21.6	22.4	27.0	24.4	24.8
Median	26.4	26.7	27.0	26.8	23.9	21.5	22.6	26.8	24.3	24.8
Std.Dev.	0.3	0.2	0.3	0.9	0.3	0.5	0.5	0.5	0.5	0.1
Rel.Std.Dev.	1.28%	0.57%	1.21%	3.54%	1.08%	2.38%	2.11%	1.73%	1.95%	0.44%
PDM ³	5.08%	6.28%	7.35%	6.36%	-5.09%	-13.8%	-10.7%	7.56%	-2.60%	-1.13%

Table A17. 4-acid results for Pb in OREAS 110 (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*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	40.0	33.0	39.0	34.0	37.4	56.0	35.0	20.0	35.9	36.3
2	40.0	33.0	36.0	34.0	37.6	45.0	31.0	17.0	34.8	36.9
3	40.0	33.0	35.0	32.0	37.0	38.0	29.0	14.0	35.3	37.7
4	40.0	34.0	36.0	33.0	38.2	40.0	35.0	20.0	33.8	38.0
5	40.0	33.0	35.0	34.0	36.4	38.0	35.0	20.0	34.9	36.7
Mean	40.0	33.2	36.2	33.4	37.3	43.4	33.0	18.2	34.9	37.1
Median	40.0	33.0	36.0	34.0	37.4	40.0	35.0	20.0	34.9	36.9
Std.Dev.	0.0	0.4	1.6	0.9	0.7	7.6	2.8	2.7	0.8	0.7
Rel.Std.Dev.	0.00%	1.35%	4.54%	2.68%	1.80%	17.5%	8.57%	14.7%	2.20%	1.93%
PDM ³	10.5%	-8.30%	-0.01%	-7.75%	3.08%	19.9%	-8.85%	-49.7%	-3.52%	2.54%

Table A18. 4-acid results for Sb in OREAS 110 (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*MS	Lab F 4A*OES	Lab G 4A*OES	Lab H 4A*OES	Lab I 4A*OES	Lab J 4A*OES
1	30.0	15.0	15.0	16.6	15.9	22.0	16.0	21.0	13.7	15.6
2	10.0	14.2	15.2	16.0	17.0	23.0	17.0	19.0	12.8	14.3
3	10.0	14.4	15.4	14.2	16.5	24.0	9.0	21.0	13.9	15.3
4	10.0	13.6	14.9	15.8	17.3	21.0	14.0	20.0	14.4	14.7
5	10.0	14.6	15.5	16.7	15.6	25.0	16.0	17.0	13.5	15.5
Mean	14.0	14.4	15.2	15.9	16.5	23.0	14.4	19.6	13.6	15.1
Median	10.0	14.4	15.2	16.0	16.5	23.0	16.0	20.0	13.7	15.3
Std.Dev.	8.9	0.5	0.2	1.0	0.7	1.6	3.2	1.7	0.6	0.6
Rel.Std.Dev.	63.9%	3.61%	1.54%	6.33%	4.35%	6.87%	22.3%	8.54%	4.33%	3.72%
PDM ³	-8.18%	-5.82%	-0.52%	4.02%	7.95%	50.8%	-5.56%	28.5%	-10.5%	-1.12%

Table A19. 4-acid results for Zn in OREAS 110 (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	80.0	72.0	72.0	75.0	75.0	74.0	72.0	64.0	71.4	62.7
2	70.0	72.0	69.0	74.0	78.0	79.0	74.0	73.0	70.4	62.6
3	70.0	76.0	70.0	67.0	75.0	74.0	69.0	69.0	71.6	63.1
4	70.0	74.0	74.0	74.0	78.0	67.0	72.0	72.0	70.1	63.0
5	70.0	72.0	73.0	77.0	79.0	67.0	73.0	71.0	68.1	63.1
Mean	72.0	73.2	71.6	73.4	77.0	72.2	72.0	69.8	70.3	62.9
Median	70.0	72.0	72.0	74.0	78.0	74.0	72.0	71.0	70.4	63.0
Std.Dev.	4.5	1.8	2.1	3.8	1.9	5.2	1.9	3.6	1.4	0.2
Rel.Std.Dev.	6.21%	2.44%	2.90%	5.15%	2.43%	7.16%	2.60%	5.11%	1.98%	0.32%
PDM ³	-0.02%	1.65%	-0.58%	1.92%	6.92%	0.26%	-0.02%	-3.07%	-2.36%	-12.6%