Bundesanstalt für Materialforschung und -prüfung (BAM)

Certification Report

Certified Reference Material

BAM-M316a

AlSi12(Fe)

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Summary

This report describes preparation, analysis and certification of the aluminium alloy reference material BAM-M316a. The certified reference material (CRM) is available in the form of discs (50 mm diameter and 30 mm height). It is intended for establishing and checking the calibration of optical emission and X-ray spectrometers (excluding micro-analysis) for the analysis of samples of similar matrix composition. It is also suitable for validation and quality control of wet chemical analysis methods.
The following mass fractions and uncertainties have been certified:

Element	**Mass fraction [1] in %**	**Uncertainty [2] in %**
Si	11.87	0.16
Fe	0.986	0.018
Cu	0.0290	0.0006
Mn	0.0240	0.0008
Mg	0.0473	0.0012
Ni	0.0251	0.0007
Zn	0.0593	0.0011
Ti	0.0791	0.0014
	in mg/kg	**in mg/kg**
Cr	62.6	1.4
Ag	184	6
Be	4.6	0.5
Bi	151	6
Ca	17.9	1.4
Cd	19.5	0.9
Ga	95.4	2.0
Pb	89	5
Sb	47	4
Sn	100.5	2.8
Sr	298	8
V	98.4	1.9
Zr	29.1	1.5

[1] Unweighted mean value of the means of accepted sets of data (consisting of at least 5 single results), each set being obtained by a different laboratory and/or a different method of measurement.

[2] Estimated expanded uncertainty U with a coverage factor of $k = 2$, corresponding to a level of confidence of approx. 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement, (GUM, ISO/IEC Guide 98-3:2008).

Additionally, the mass fractions of B and Hg are given for information.

Element	Mass fraction [1)] in mg/kg	Uncertainty [2)] in mg/kg
B	2.5	0.6
Hg	38	5

1) Values were not certified, but given for information, when the number of accepted data sets was considered to be too low (< 5) or when the uncertainty from the inter-laboratory certification was considerably larger than the expected range or in case there were hints that the material was not homogeneous enough.

2) Estimated expanded uncertainty U with a coverage factor of $k = 2$, corresponding to a level of confidence of approx. 95 %, as defined in the Guide to the expression of uncertainty in measurement, (GUM, ISO/IEC Guide 98-3:2008).

This report contains detailed information on the preparation of the CRM as well as on homogeneity investigations and on the analytical methods used for certification analysis. The certified values are based on the results of ten laboratories which participated in the certification inter-laboratory comparison.

Content

List of abbreviations

(if not explained elsewhere)

CRM	certified reference material
FAAS	flame atomic absorption spectrometry
ICP-OES	inductively coupled plasma optical emission spectrometry
ICP-MS	inductively coupled plasma mass spectrometry
SOES	spark optical emission spectrometry
XRF	X-ray fluorescence spectrometry
M	mean value
n	number of accepted data sets
s	standard deviation of an individual data set
s_M	standard deviation of laboratory means
s_{rel}	relative standard deviation
$\bar{s}_i$	square root of mean of variances of data sets under repeatability conditions
M_i	single result
I	ICP-OES (Tables 2 – 28)
I(R)	ICP-OES, revised value (Tables 2 – 28)
IMS	ICP-MS (Tables 2 – 28)
A	FAAS (Tables 2 – 28)
FE	flame emission spectrometry (Tables 2 – 28)
P	spectrophotometry (Tables 2 – 28)
-s	dissolution in acid (Tables 2 – 28)
-a	dissolution in base (Tables 2 – 28)
-s(HF)	dissolution in acid incl. HF (Tables 2 – 28)

1. Introduction

In the metal-producing and metal-working industry mainly spark emission spectrometry (SOES) and X-ray fluorescence spectrometry (XRF) are used for reception inspection of raw materials, e.g. scrap, for quality control of end products and production control. These time-saving analytical techniques require suitable reference materials for calibration and recalibration. The certified reference material BAM-M316a is based on the aluminium alloy AlSi12(Fe), which has a lot of technical applications. It will replace ERM-EB316, which is out of stock.

The CRM was produced in close cooperation with the working group „Aluminium" of the Committee of Chemists of the Society of Metallurgists und Miners (GDMB). Since all the laboratories participating in this certification project are highly experienced with aluminium analysis and had already participated in earlier inter-laboratory comparisons, there was no preceding round robin for qualification necessary.
Certification was carried out on the basis of ISO 17034 [1] and the relevant ISO-Guides [2, 3].

2. Companies/laboratories involved

Manufacturing of the material:

- Constellium, Centre de Recherches de Voreppe, Voreppe, France

Test for homogeneity:

- Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany
- Constellium, Centre de Recherches de Voreppe, Voreppe, France

Participants in the certification inter-laboratory comparison:

AMAG Austria Metall AG, Ranshofen, Austria
Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany
Constellium, Centre de Recherches de Voreppe, Voreppe, France
Speira GmbH, R&D, Bonn, Germany
Leichtmetall Aluminium Giesserei Hannover GmbH, Hannover, Germany
Łukasiewicz Research Network – Institute of Non-Ferrous Metals, Gliwice, Poland
Novelis Koblenz GmbH, Koblenz, Germany
OTTO FUCHS KG, Meinerzhagen, Germany
Raghavendra Spectro Metallurgical Laboratory, Bangalore, India
revierlabor, Essen, Germany

Statistical evaluation of the data:

- Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany

3. Candidate material

The candidate material was produced by Constellium, Centre de Recherches de Voreppe, Voreppe, France. About 500 kg of an aluminium melt were doped with the desired elements. The melt was cast into six billets (A – F) with a length of 4450 mm each. 250 mm on both ends of each billet were discarded. The rods were cut into segments of 800 mm length. Between the segments 15-mm discs (A1, A2, A3, A4, A5, B1, B2, …, F4, F5) were taken for homogeneity testing (see Fig. 1).

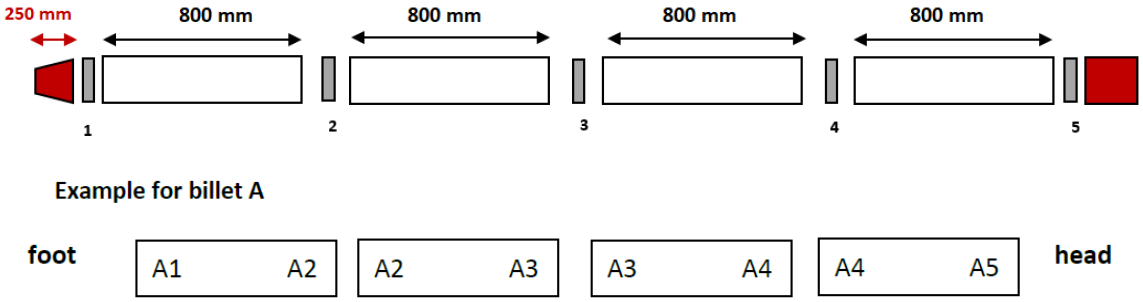


Fig. 1: Preparation of the rods cast (all figures in mm)

In total, 576 discs with a diameter of ca. 50 mm and 30 mm height were obtained.

4. Homogeneity testing

Possible reasons for an inhomogeneous distribution of elements in the raw material may be a change of the composition of the melt during the casting procedure because some elements may volatize or because of possible segregation during the solidification of the material. Since the raw material was produced by casting of a rod, concentration gradients can occur over the length of the rod (axial) as well as over the area of the rod (radial, see Fig. 2):

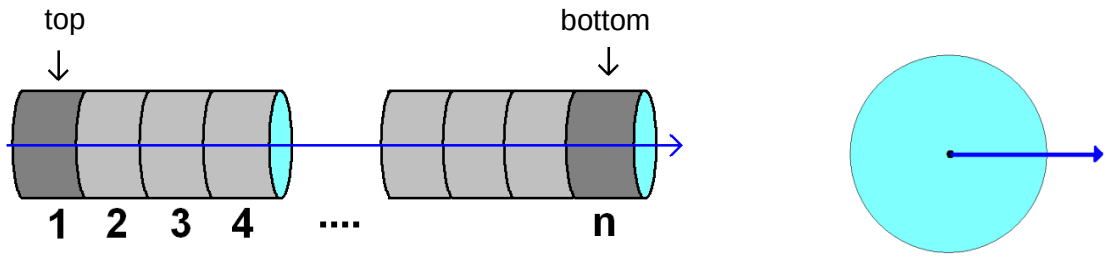


Fig. 2: Axial and radial composition gradient

Therefore, it is necessary to investigate the raw material for both axial and radial inhomogeneities. Axial homogeneity testing of the candidate material using spark emission spectrometry was performed at Constellium, Centre de Recherches de Voreppe on the discs taken from the rods as shown in Fig. 1. In total 30 discs were investigated (five sparks, all at a distance of 1.5 cm from the centre), this corresponding to ca. 5.5 % of the whole batch.

The estimate of analyte-specific inhomogeneity contribution u_{bb} to be included into the total uncertainty budget was calculated according to ISO Guide 35 [3] using Eq. (1) and Eq. (2):

$$s_{bb} = \sqrt{\frac{MS_{among} - MS_{within}}{n}} \qquad (1)$$

$$u_{bb}^{*} = \sqrt{\frac{MS_{within}}{n}} \sqrt[4]{\frac{2}{N(n-1)}} \qquad (2)$$

where:

MS_{among}	mean of squared deviations between discs (from 1-way ANOVA, see Annex 1)
MS_{within}	mean of squared deviations within one disc (from 1-way ANOVA)
n	number of replicate measurements per disc
N	number of discs selected for homogeneity study

s_{bb} signifies the between-discs standard deviation whereas u_{bb}^{*} denotes the maximum heterogeneity that can potentially be hidden by an insufficient repeatability of the applied measurement method (which has to be considered as the minimum uncertainty contribution). In any case the larger of the two values was used as $u_{bb}(1)$. Eq. (1) does not apply if MS_{within} is larger than MS_{among}.

In addition to the tests performed over the length of the rods three discs were tested for homogeneity over the area (possible segregation from the outer part to the centre) in BAM. To perform this test SOES analysis was carried out in circles (outer circle: 16 sparks, intermediate circle: 8 sparks, inner circle: 6 sparks; centre: 1 spark).

The analyte-specific within-disc uncertainty component $u_{bb}(2)$ was calculated in the same way as for the total batch. To calculate the necessary data an unbalanced ANOVA was carried out taking into account that the number of single measurements is different for the centre, the inner and the outer circle. For technical reasons, at r_0 (centre) only one measurement is possible. An ANOVA usually requires a minimum of two measurements per factor value. Thus, the value for r_0 is replaced by two dummy values, defined as follows:

The average standard deviation for within-group measurements $\overline{sd_{within}}$ is estimated from the data for r_in (inner circle), r_middle (intermediate circle) and r_out (outer circle). The measured value is replaced by $r_0 \pm \frac{\overline{sd_{within}}}{\sqrt{2}}$. Consequently, the two dummy values have a mean equal to the value measured, and a standard deviation equal to the average within-variation. As results from these calculations an inhomogeneity component for the radius of the disc is obtained. From these values a combined inhomogeneity component is calculated. This component is compared with the within standard deviation calculated from the ANOVA. From the three discs the median of the higher components is used for uncertainty calculation.

Annexes 1 and 2 show the results of the homogeneity calculations.

5. Characterisation study

5.1 Analytical methods

Ten laboratories participated in the certification inter-laboratory comparison. All laboratories were highly experienced in the analysis of aluminium and aluminium alloys and participated successfully in former certification inter-laboratory comparisons. For some elements part of the laboratories used more than one analytical method reporting more than one data set.

The laboratories were asked to analyse six subsamples. They were free to choose any suitable analytical method. Table 1 shows the analytical methods used by the participating laboratories.

For all analytical methods where a calibration was necessary this calibration was performed using liquid standard solutions. All participating laboratories were asked to use only standard solutions prepared from pure metals or stoichiometric compounds or well checked commercial calibration solutions.

Table 1: Analytical procedures used by the participating laboratories

Lab-No.	Element	Sample mass	Sample pretreatment	Analytical method
1*	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Ag, Be, Bi, Cd, Ga, Pb, Sb, Sn, Sr, V, Zr	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solution (Merck)
	B, Ca	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-OES, commercial mono-element solution (Merck)
2*	Si, Fe, Cu, Mn, Mg, Cr, Ni, Ti	0.5 g	Dissolution with NaOH	ICP-OES, calibration with pure metals or pure chemicals, matrix matching with pure Al (5N5)
	Zn, Sr	0.5 g	Dissolution with HNO_3/HF	ICP-OES, calibration with pure metals or chemicals, matrix matching with pure Al (5N5)
	Ag, Cd	0.5 g	Dissolution with HNO_3/HF	ICP-MS, commercial mono-element solution (Merck certipur), matrix matching with pure Al (5N5)
	Bi, V, Zr	0.5 g	Dissolution with aqua regia/HF	ICP-OES, calibration with pure metals or chemicals, matrix matching with pure Al (5N5)
	B, Be, Ga, Hg, Pb, Sb, Sn	0.5 g	Dissolution with aqua regia/HF	ICP-MS, commercial mono-element solution (Merck certipur), matrix matching with pure Al (5N5)
3*	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Bi, Pb, Sb, Sr, V, Zr	0.1 g	Dissolution with NaOH	ICP-OES, commercial mono-element solution
5*	Si, Cu, Mn, Mg, Cr, Ni, Zn, Bi, Cd, Ga, Pb, Sn, Sr, Zr	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Merck)
	V	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Labkings)
	Fe, Ti, Be	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Inorganic Ventures)
7*	Si	0.5 g	Dissolution with NaOH	Gravimetry
	Cu, Mn, Mg, Cr, Ni, Ti, Be, Bi, Cd, Ga, Pb, Sb, Sn, Sr, V, Zr	1 g	Dissolution with HNO_3/HF	ICP-MS, with matrix matched standards, commercial mono-element standard solutions (Merck, Perkin Elmer)
	Zn	1 g	Dissolution with HNO_3/HF	FAAS, with matrix matched standards, commercial mono-element standard solutions (VWR)
	Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Ag, Bi, Ca, Cd, Ga, Hg, Pb, Sb, Sn, Sr, V, Zr	0.5 g	Dissolution with HCl/HNO_3/HF	ICP-OES, with matrix matched standards, commercial mono-element standard solutions (Merck)

*accredited acc. to ISO IEC 17025

Table 1 (cont.): Analytical procedures used by the participating laboratories

8	Si, Ag	0.3 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Merck)
	Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Be, Bi, Ga, Pb, Sb, Sr, V, Zr	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Merck)
	Ca, Cd	0.5 g	Dissolution with HCl	ICP-OES, commercial mono-element solutions (Merck)
9*	Zr	0.5 g	Dissolution with NaOH	Spectrophotometry, calibration with commercial mono-element solutions (Merck)
	Si	0.25 g	Dissolution with NaOH	Spectrophotometry, calibration with commercial mono-element solutions (Merck)
	Fe, Cu, Mn, Mg, Ni	0.5 g	Dissolution with $HCl/HNO_3/HF$	FAAS, calibration with commercial mono-element solution (Merck)
	Mn	1 g	Dissolution with HNO_3	Spectrophotometry, calibration with commercial mono-element solutions (Merck)
	Cu, Cr, Ni, Zn, Ti, B, Be, Bi, Cd, Ga, Pb, Sb, Sn, V, Zr	1 g	Dissolution with $HF/HCl/HNO_3$, Addition of mannite	ICP-OES, calibration with matrix matched standards, commercial mono-element solutions
	Fe, Cu, Cr, Mn, Mg, Ni, Ti, Zn, Ag, Be, Cd, Ga, Pb, Sb, Sn, V, Zr	1 g	Dissolution with HCl/HNO_3, Addition of mannite	ICP-OES, calibration with matrix matched standards, commercial mono-element solutions
	Si, Fe, Cu, Mn, Mg, Cr, Ni, Ti, Be, Cd, Ga, Sr, V, Zr	0.25 g	Dissolution with NaOH	ICP-OES, calibration with matrix matched standards, commercial mono-element solution
	Cr, Cd, Pb	1 g	Dissolution with HCl/HNO_3	ETAAS, calibration with commercial mono-element solution (Merck)
11	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Ag, Be, Bi, Cd, Ga, Pb, Sb, Sn, Sr, V, Zr	0.25 g	Dissolution with NaOH	ICP-OES, calibration with commercial mono-element solutions (Bernd Kraft)
12	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Ag, B, Ca, Cd, Ga, Hg, Pb, Sn, Sr, V, Zr	0.5 g	Dissolution with NaOH	ICP-OES, calibration with matrix matched standards, commercial mono-element solutions (Merck)
16*	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Ag, B, Be, Bi, Ca, Cd, Ga, Hg, Pb, Sb, Sn, Sr, V, Zr	0.87 g	Dissolution with aqua regia/HF	ICP-OES, calibration with standards, commercial mono-element solutions (Merck)

*accredited acc. to ISO IEC 17025

5.2 Analytical results and statistical evaluation

The analytical results of the inter-laboratory certification comparison are listed in Tables 2 to 28. These tables show the single results (M_i) of each laboratory, the respective laboratories' mean values (M), absolute and relative intra-laboratory standard deviation (s and s_{rel}, respectively), the standard deviation of laboratory means (s_M), and in addition the square root of mean of variances of data sets under repeatability conditions ($\bar{S}_i$) where n is the number of accepted data sets. The continuous line marks the certified value

(mean of the laboratories' means), the broken lines mark the standard deviation, calculated from the laboratories' means.
In the related figures for each laboratory its mean value and single standard deviation is given. Outliers which have been excluded after consultation with the resp. laboratory are highlighted in yellow.

Table 2: Results for Si

Lab./Meth.	9/I-a	7/G	8/I-a	2/I-a	3/I-a(R)	1/I-a	5/I-a	9/P	16/I-s		
M_i [%]	11.77	11.71	11.80	11.86	11.80	11.79	11.91	12.04	12.29		*n*
	11.78	11.67	11.80	11.87	12.33	11.74	11.93	11.96	12.30		9
	11.46	11.62	11.76	11.90	11.75	11.85	11.90	12.05	12.28		
	11.65	11.64	11.85	11.72	11.83	12.04	11.92	12.08	12.28		
	11.60	11.75	11.75	11.74	11.42	12.01	11.90	12.08	12.29		
	11.47	11.71	11.75	11.71	11.82	11.98	11.91	12.02	12.29		
***M* [%]**	**11.62**	**11.68**	**11.78**	**11.80**	**11.83**	**11.90**	**11.91**	**12.04**	**12.29**		**11.87**
s [%]	0.142	0.049	0.040	0.087	0.292	0.126	0.011	0.044	0.008	s_M [%]	0.199
										$\bar{s}_i$ [%]	0.1224
s_{rel}	0.01224	0.00418	0.00336	0.00734	0.02467	0.01061	0.00090	0.00367	0.00063		0.01673

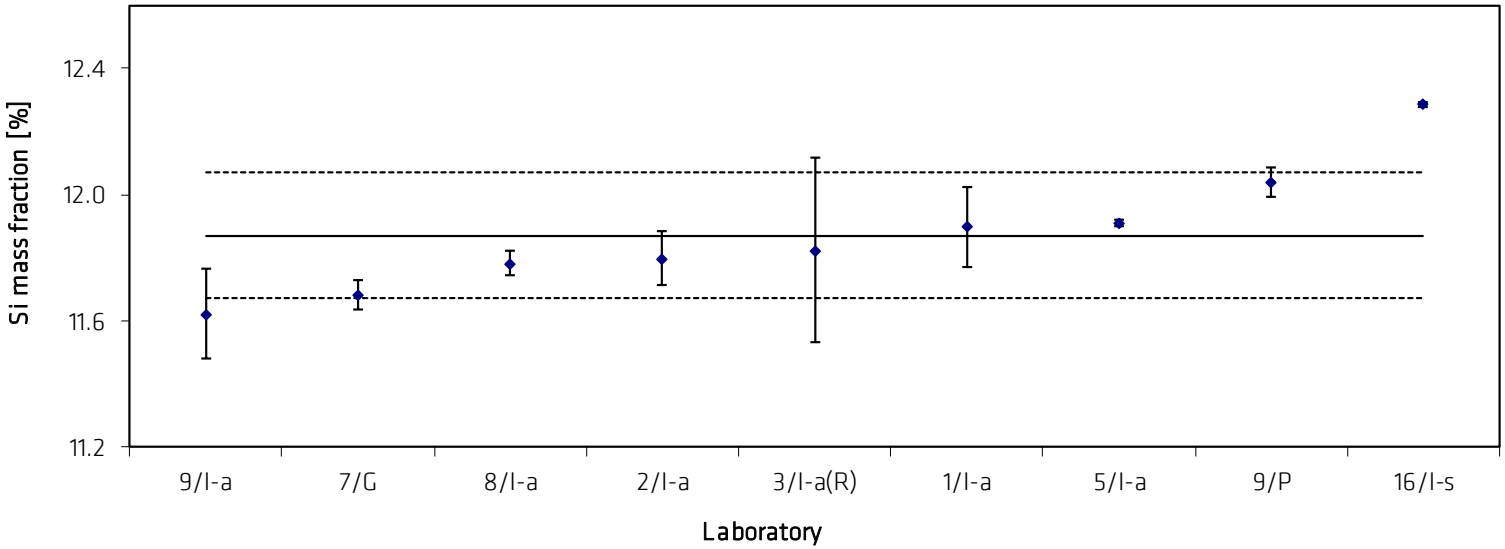


Table 3: Results for Fe

Lab./Meth.	3/I-a(R)	11/I-a	8/I-a	9/P	1/I-a	16/I-s	2/I-a	9/I-a	9/A-s	5/I-a	9/I-s	7/I-s_1	12/I-a	7/I-s_2		
M_i [%]	0.96	0.963	0.968	0.976	0.988	0.986	0.9841	0.9907	0.995	1.006	1.019	1.027	1.027	1.083		*n*
	0.94	0.977	0.974	0.971	0.956	0.987	0.9847	0.9949	1.010	1.006	1.019	1.023	1.077	1.075		14
	0.93	0.956	0.975	0.979	0.976	0.985	0.9861	0.9937	0.983	1.002	1.007	1.032	1.168	1.071		
	0.92	0.994	0.977	0.974	0.983	0.989	0.9865	0.9886	0.990	1.005	1.019	1.035	1.067	1.088		
	0.93	0.965	0.968	0.974	0.994	0.986	0.9913	0.9914	1.002	1.000	1.015	1.019	1.053	1.076		
	0.92	0.964	0.979		0.978	0.989	0.9894	0.9940		0.991	1.010	1.028		1.094		
***M* [%]**	**0.933**	**0.970**	**0.974**	**0.975**	**0.979**	**0.987**	**0.987**	**0.992**	**0.996**	**1.002**	**1.015**	**1.027**	**1.078**	**1.081**		**0.986**
s [%]	0.0151	0.0136	0.0046	0.0031	0.0131	0.0017	0.0028	0.0024	0.0105	0.0057	0.0052	0.0058	0.0532	0.0088	s_M [%]	0.0239
															$\bar{s}_i$ [%]	0.0083
s_{rel}	0.01613	0.01407	0.00471	0.00319	0.01340	0.00177	0.00281	0.00242	0.01051	0.00565	0.00516	0.00566	0.04933	0.00815		0.02420

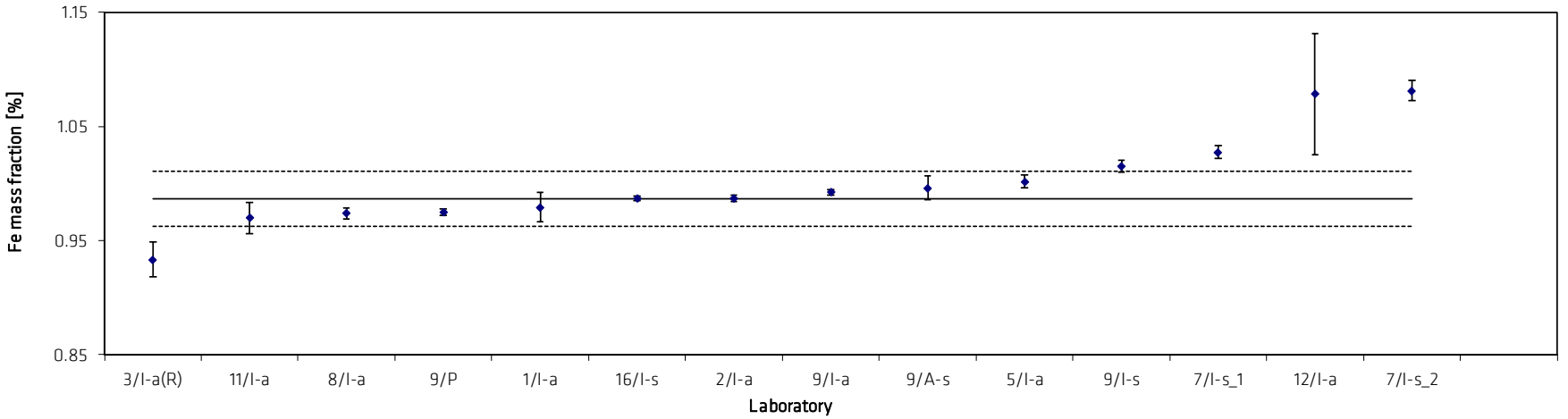


Table 4: Results for Cu

Lab./Meth.	3/I-a(R)	9/I-a	7/I-s_2	16/I-s	7/IMS	1/I-a	9/I-s(HF)	2/I-a	5/I-a	8/I-a	12/I-a	9/I-s	11/I-a	7/I-s_1	9/A-s		
M_i [%]	0.027	0.0279	0.0287	0.0280	0.0285	0.0297	0.0284	0.0293	0.0294	0.0292	0.0293	0.0295	0.0289	0.0303	0.0308		*n*
	0.027	0.0284	0.0283	0.0290	0.0299	0.0291	0.0286	0.0291	0.0294	0.0293	0.0288	0.0292	0.0296	0.0301	0.0303		15
	0.026	0.0281	0.0281	0.0300	0.0281	0.0289	0.0288	0.0293	0.0291	0.0292	0.0318	0.0294	0.0307	0.0299	0.0311		
	0.027	0.0276	0.0286	0.0290	0.0286	0.0291	0.0284	0.0291	0.0293	0.0294	0.0284	0.0298	0.0299	0.0290	0.0311		
	0.027	0.0288	0.0283	0.0280	0.0292	0.0289	0.0294	0.0293	0.0293	0.0294	0.0284	0.0297	0.0296	0.0295	0.0315		
	0.027	0.0283	0.0275	0.0270	0.0286	0.0291	0.0313	0.0292	0.0293	0.0295		0.0294	0.0285	0.0290	0.0312		
***M* [%]**	**0.0268**	**0.0282**	**0.0283**	**0.0285**	**0.0288**	**0.0291**	**0.0291**	**0.0292**	**0.0293**	**0.0293**	**0.0293**	**0.0295**	**0.0295**	**0.0296**	**0.0310**		**0.0290**
s [%]	0.0004	0.0004	0.0004	0.0010	0.0006	0.0003	0.0011	0.0001	0.0001	0.0001	0.0014	0.0002	0.0008	0.0006	0.0004	s_M [%]	0.00091
																$\bar{s}_i$ [%]	0.00066
s_{rel}	0.01521	0.01445	0.01514	0.03680	0.02210	0.01010	0.03793	0.00285	0.00354	0.00437	0.04854	0.00741	0.02611	0.01881	0.01304		0.03116

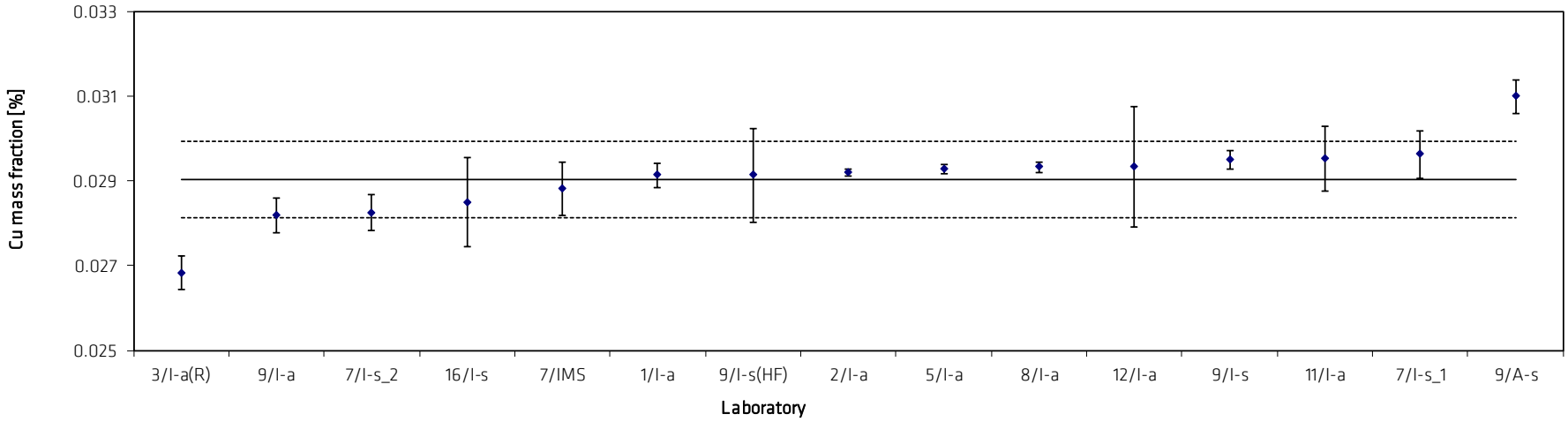


Table 5: Results for Mn

Lab./Meth.	3/I-a	9/I-s	9/I-s(HF)	9/A-s	1/I-a	8/I-a	2/I-a	9/P	7/IMS	12/I-a	9/I-a	5/I-a	7/I-s_2	7/I-s_1	16/I-s	11/I-a		
M_i [%]	0.016	0.0218	0.0220	0.0234	0.0234	0.0233	0.0234	0.0237	0.0241	0.0239	0.0242	0.0245	0.0246	0.0242	0.0240	0.0279		*n*
	0.014	0.0217	0.0222	0.0234	0.0232	0.0234	0.0233	0.0240	0.0240	0.0238	0.0244	0.0244	0.0248	0.0253	0.0250	0.0281		16
	0.016	0.0216	0.0222	0.0231	0.0231	0.0233	0.0234	0.0237	0.0238	0.0258	0.0244	0.0245	0.0248	0.0249	0.0250	0.0272		
	0.016	0.0220	0.0219	0.0231	0.0233	0.0235	0.0234	0.0239	0.0242	0.0235	0.0241	0.0245	0.0247	0.0242	0.0260	0.0268		
	0.014	0.0219	0.0222	0.0231	0.0235	0.0234	0.0235	0.0239	0.0234	0.0232	0.0242	0.0244	0.0246	0.0253	0.0240	0.0273		
	0.013	0.0217	0.0225	0.0227	0.0232	0.0232	0.0234	0.0240	0.0243		0.0242	0.0242	0.0252	0.0249	0.0250	0.0273		
				0.0233				0.0240										
								0.0237										
***M* [%]**	**0.0148**	**0.0218**	**0.0222**	**0.0232**	**0.0233**	**0.0234**	**0.0234**	**0.0239**	**0.0240**	**0.0240**	**0.0243**	**0.0244**	**0.0248**	**0.0248**	**0.0248**	**0.0274**		**0.0240**
s [%]	0.0013	0.0001	0.0002	0.0003	0.0001	0.0001	0.0000	0.0001	0.0003	0.0010	0.0001	0.0001	0.0002	0.0005	0.0008	0.0005	s_M [%]	0.00131
																	$\bar{s}_i$ [%]	0.00040
s_{rel}	0.08961	0.00588	0.00896	0.01088	0.00632	0.00465	0.00199	0.00588	0.01363	0.04248	0.00483	0.00447	0.00899	0.02008	0.03031	0.01751		0.05478

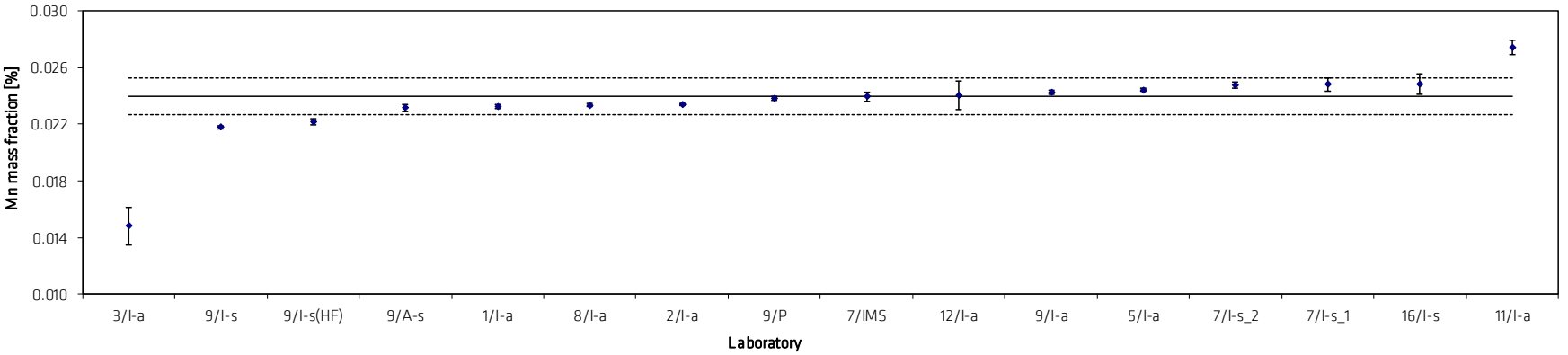


Table 6: Results for Mg

Lab./Meth.	3/I-a(R)	7/IMS	8/I-a	9/I-s	7/I-s_2	9/A-s	9/I-a	2/I-a	1/I-a	5/I-a	7/I-s_1	11/I-a	16/I-s(R)	12/I-a(R)		
M_i [%]	0.023	0.0454	0.0453	0.0460	0.0460	0.0465	0.0463	0.0467	0.0470	0.0471	0.0481	0.0463	0.0510	0.0504		*n*
	0.023	0.0448	0.0455	0.0458	0.0438	0.0461	0.0466	0.0466	0.0468	0.0472	0.0497	0.0500	0.0490	0.0490		14
	0.023	0.0452	0.0456	0.0462	0.0472	0.0465	0.0465	0.0468	0.0466	0.0471	0.0489	0.0505	0.0510	0.0512		
	0.023	0.0442	0.0457	0.0464	0.0463	0.0462	0.0461	0.0461	0.0470	0.0470	0.0493	0.0515	0.0500	0.0506		
	0.022	0.0441	0.0457	0.0457	0.0460	0.0463	0.0468	0.0466	0.0468	0.0468	0.0492	0.0493	0.0510	0.0493		
	0.023	0.0448	0.0457	0.0461	0.0477	0.0463	0.0462	0.0467	0.0468	0.0465	0.0503	0.0487	0.0490	0.0515		
M **[%]**	**0.0228**	**0.0448**	**0.0456**	**0.0460**	**0.0462**	**0.0463**	**0.0464**	**0.0466**	**0.0468**	**0.0469**	**0.0493**	**0.0494**	**0.0502**	**0.0504**		**0.0473**
s [%]	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.001	s_M [%]	0.00184
															$\bar{s}_i$ [%]	0.00079
s_{rel}	0.0179	0.0116	0.0034	0.0056	0.0292	0.0032	0.0052	0.0055	0.0032	0.0053	0.0151	0.0363	0.0196	0.0199		0.03893

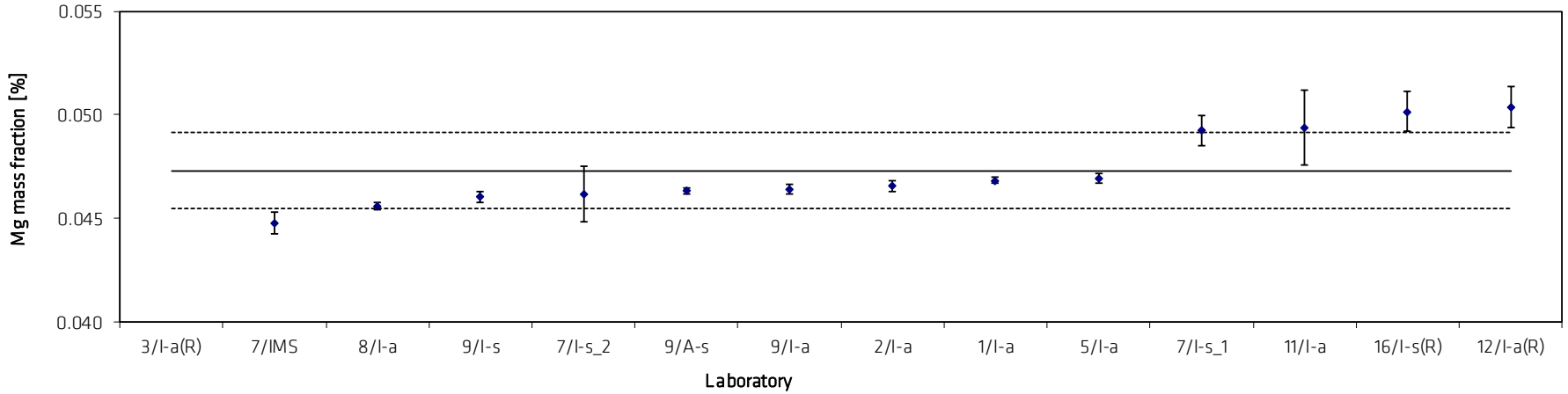


Table 7: Results for Ni

Lab./Meth.	3/I-a	7/IMS	11/I-a	7/I-s_2(R)	2/I-s	8/I-a	5/I-a	1/I-a	9/I-a	16/I-s	7/I-s_1	9/I-s(HF)	9/I-s	9/A-s	12/I-a		
M_i [%]	0.021	0.0235	[0.0211]	0.0248	0.0249	0.0249	0.0251	0.0246	0.0250	0.0255	0.0254	0.0257	0.0255	0.0250	0.0253		n
	0.022	0.0234	0.0244	0.0249	0.0249	0.0249	0.0250	0.0251	0.0253	0.0257	0.0259	0.0256	0.0255	0.0259	0.0263		15
	0.021	0.0234	0.0238	0.0243	0.0250	0.0248	0.0251	0.0250	0.0250	0.0251	0.0257	0.0254	0.0257	0.0259	0.0285		
	0.023	0.0236	0.0239	0.0245	0.0247	0.0250	0.0250	0.0251	0.0250	0.0250	0.0248	0.0254	0.0259	0.0265	0.0261		
	0.021	0.0231	0.0232	0.0243	0.0250	0.0248	0.0249	0.0250	0.0251	0.0252	0.0251	0.0256	0.0260	0.0260	0.0259		
	0.022	0.0244	0.0232	0.0248	0.0249	0.0251	0.0246	0.0252	0.0251	0.0251	0.0248	0.0258	0.0257	0.0262			
														0.0252			
M [%]	**0.0217**	**0.0236**	**0.0237**	**0.0246**	**0.0249**	**0.0249**	**0.0250**	**0.0250**	**0.0251**	**0.0253**	**0.0253**	**0.0256**	**0.0257**	**0.0258**	**0.0264**		**0.0251**
s [%]	0.0008	0.0004	0.0005	0.0003	0.0001	0.0001	0.0002	0.0002	0.0001	0.0003	0.0005	0.0002	0.0002	0.0005	0.0012	s_M [%]	0.00077
																$\bar{s}_i$ [%]	0.00045
s_{rel}	0.03768	0.01872	0.02151	0.01091	0.00475	0.00453	0.00694	0.00839	0.00456	0.01081	0.01828	0.00688	0.00773	0.02062	0.04623		0.03056

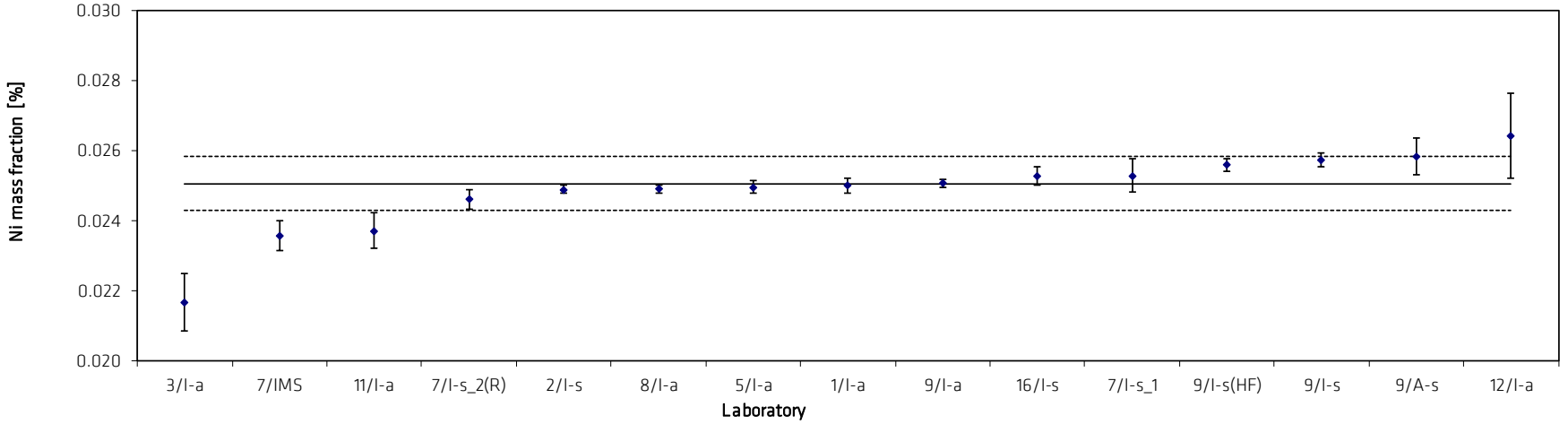


Table 8: Results for Zn

Lab./Meth.	11/I-a	8/I-a	2/I-s	5/I-a	7/I-s_2	3/I-a(R)	1/I-a	9/I-s	9/I-a	12/I-a	7/I-s_1	9/I-s(HF)	16/I-s(R)	7/A		
M_i [%]	0.0503	0.0565	0.0574	0.0586	0.0583	0.059	0.0580	0.0593	0.0592	0.0597	0.0594	0.0593	0.0620	0.0620		*n*
	0.0491	0.0566	0.0573	0.0585	0.0575	0.059	0.0591	0.0587	0.0597	0.0594	0.0618	0.0600	0.0620	0.0606		14
	0.0486	0.0570	0.0574	0.0583	0.0589	0.059	0.0589	0.0579	0.0597	0.0642	0.0603	0.0601	0.0600	0.0613		
	0.0496	0.0567	0.0589	0.0585	0.0587	0.058	0.0598	0.0590	0.0591	0.0582	0.0591	0.0590	0.0600	0.0633		
	0.0484	0.0567	0.0584	0.0591	0.0588	0.059	0.0596	0.0600	0.0593	0.0575	0.0592	0.0599	0.0600	0.0602		
	0.0466	0.0577	0.0588	0.0581	0.0596	0.059	0.0590	0.0599	0.0596		0.0591	0.0611	0.0630	0.0603		
M [%]	**0.0488**	**0.0569**	**0.0580**	**0.0585**	**0.0586**	**0.0588**	**0.0591**	**0.0591**	**0.0594**	**0.0598**	**0.0598**	**0.0599**	**0.0612**	**0.0613**		**0.0593**
s [%]	0.0013	0.0004	0.0008	0.0003	0.0007	0.0004	0.0006	0.0008	0.0003	0.0026	0.0011	0.0007	0.0013	0.0012	s_M [%]	0.00120
															$\bar{s}_i$ [%]	0.00105
s_{rel}	0.02596	0.00732	0.01340	0.00583	0.01190	0.00694	0.01069	0.01312	0.00440	0.04375	0.01793	0.01214	0.02173	0.01957		0.02018

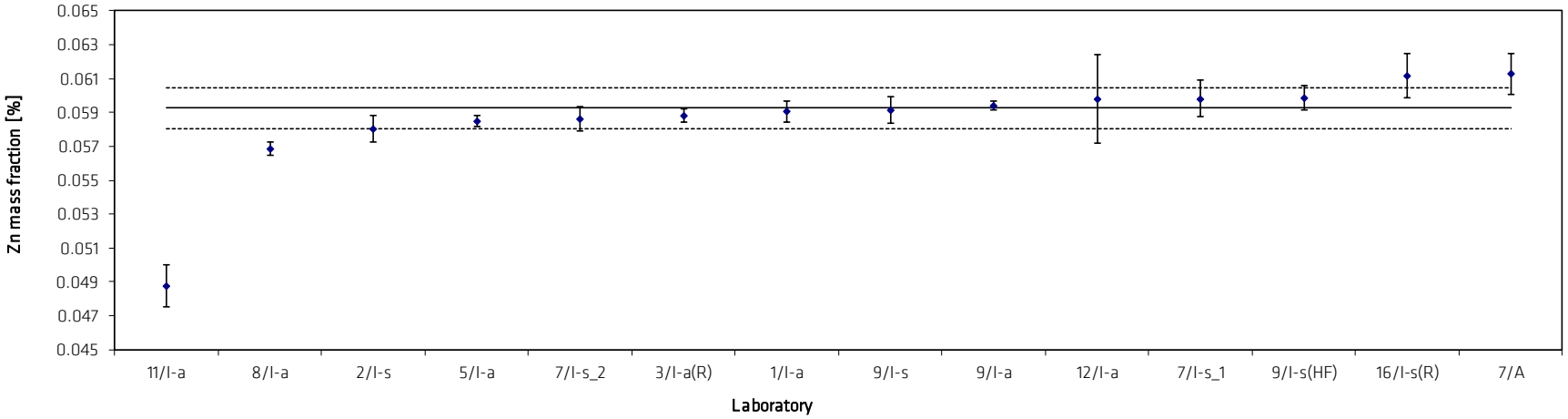


Table 9: Results for Ti

Lab./Meth.	11/I-a	16/I-s	7/IMS	7/I-s_2	2/I-a	1/I-a	8/I-a	5/I-a	9/I-a	9/I-s(HF)	3/I-a(R)	7/I-s_1	9/I-s	12/I-a		
M_i [%]	0.0750	0.0765	0.0764	0.0759	0.0785	0.0790	0.0786	0.0798	0.0801	0.0817	0.079	0.0794	0.0822	0.0818		*n*
	0.0743	0.0764	0.0773	0.0759	0.0784	0.0792	0.0790	0.0795	0.0803	0.0801	0.080	0.0831	0.0822	0.0815		14
	0.0747	0.0770	0.0763	0.0764	0.0786	0.0791	0.0792	0.0795	0.0799	0.0790	0.080	0.0821	0.0811	0.0883		
	0.0752	0.0758	0.0769	0.0781	0.0790	0.0794	0.0793	0.0798	0.0800	0.0806	0.081	0.0796	0.0820	0.0811		
	0.0746	0.0756	0.0784	0.0791	0.0788	0.0789	0.0791	0.0793	0.0801	0.0785	0.082	0.0799	0.0823	0.0799		
	0.0712	0.0762	0.0785	0.0801	0.0783	0.0789	0.0796	0.0793	0.0801	0.0809	0.079	0.0801	0.0815			
M [%]	**0.0742**	**0.0763**	**0.0773**	**0.0776**	**0.0786**	**0.0791**	**0.0791**	**0.0795**	**0.0801**	**0.0801**	**0.0802**	**0.0807**	**0.0819**	**0.0825**		**0.0791**
s [%]	0.00149	0.00050	0.00096	0.00179	0.00027	0.00019	0.00032	0.00025	0.00012	0.00121	0.00117	0.00152	0.00048	0.00331	s_M [%]	0.00221
															$\bar{s}_i$ [%]	0.00129
s_{rel}	0.02005	0.00662	0.01244	0.02303	0.00349	0.00245	0.00409	0.00314	0.00152	0.01515	0.01458	0.01889	0.00585	0.04012		0.02795

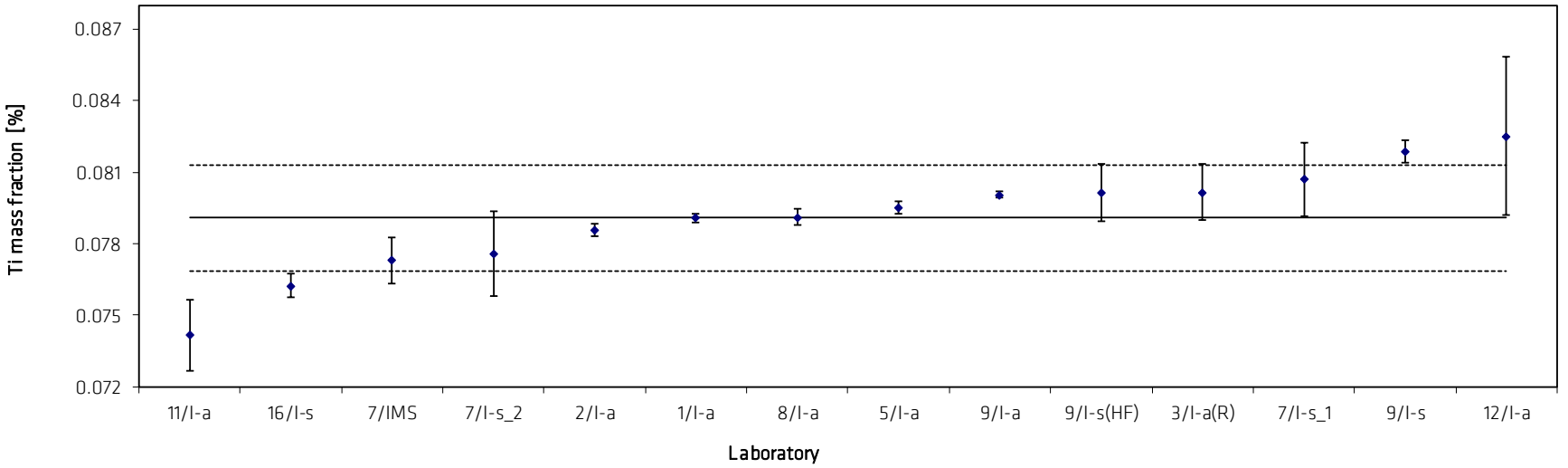


Table 10: Results for Cr

Lab./Meth.	3/I-a	7/I-s_2	12/I-a(R)	9/I-s(HF)	8/I-a	16/I-s	9/I-s	5/I-a	2/I-s	9/I-a	1/I-a	9/EA	7/IMS	7/I-s_1	11/I-a		
M_i [mg/kg]	40	59	59.5	60.5	60.4	61	59.5	62.5	63.4	62.9	62	66	66	65	64.5		*n*
	60	60	58.2	61.7	60.7	60	60.4	62.3	61.6	63.5	63	67	66	67	69.0		15
	50	59	60.2	59.8	60.5	63	60.5	62.4	62.2	62.9	63	62	65	69	67.0		
	50	60	60.5	60.1	60.7	62	60.8	62.2	61.9	63.0	63	61	65	64	68.6		
	50	61	60.2	59.4	61.0	63	64.3	62.1	62.0	63.0	63		63	64	67.0		
	50	60	61.2	61.2	61.4	61	65.2	61.5	62.2	63.2	65		67	65	66.6		
***M* [mg/kg]**	**50.0**	**59.8**	**59.9**	**60.4**	**60.8**	**61.7**	**61.8**	**62.2**	**62.2**	**63.1**	**63.2**	**63.9**	**65.3**	**65.7**	**67.1**		**62.6**
s [mg/kg]	6.32	0.75	1.03	0.86	0.37	1.21	2.38	0.36	0.63	0.27	0.98	3.17	1.37	1.97	1.61	s_M [mg/kg]	2.22
																$\bar{s}_i$ [mg/kg]	1.45
s_{rel}	0.126	0.013	0.017	0.014	0.006	0.020	0.039	0.006	0.010	0.004	0.016	0.050	0.021	0.030	0.024		0.035

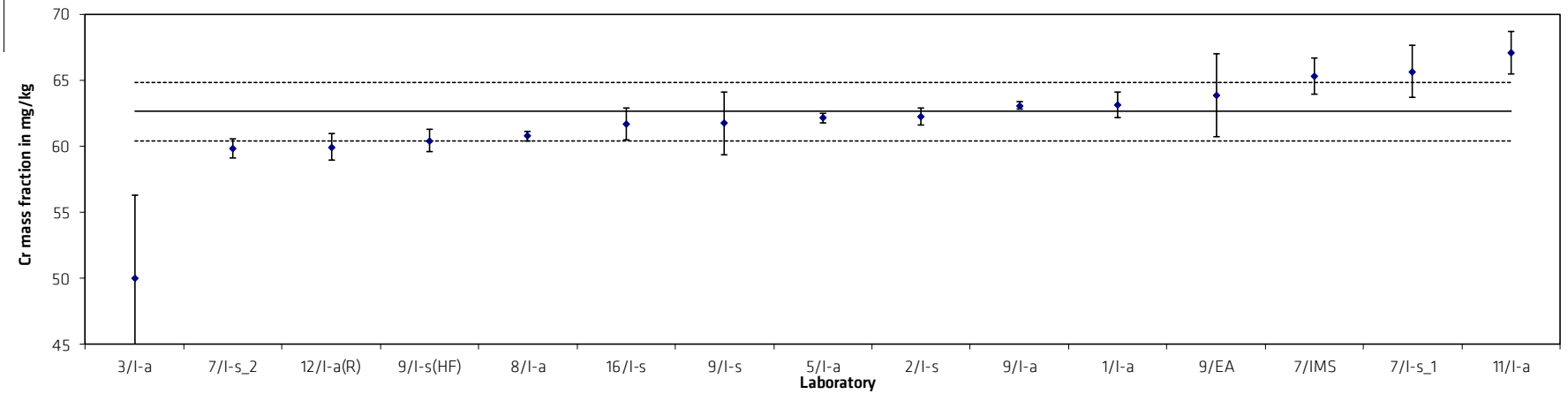


Table 11: Results for Ag

Lab./Meth.	7/I-s_2(R)	7/I-s_1(R)	7/A	11/I-a	16/I-s	9/I-s	5/I-a	8/I-a	1/I-a	2/IMS-s		
M_i [mg/kg]	176	176.6	181.0	189.0	180.0	191.9	187.9	192.7	194.9	192.5		*n*
	168	178.3	178.0	176.0	182.0	188.3	188.3	192.9	194.7	192.8		10
	167	170.7	179.0	168.0	181.0	189.8	188.3	193.1	193.5	193.0		
	175	173.6	172.0	[158]	184.0	186.8	188.2	193.9	196.1	197.3		
	173	174.8	175.0	187.0	180.0	184.8	188.1	191.2	193.7	199.6		
	174	175.3	172.0	186.0	181.0	184.5	189.4	191.8	195.2	195.1		
***M* [mg/kg]**	**172.2**	**174.9**	**176.2**	**181.2**	**181.3**	**187.7**	**188.4**	**192.6**	**194.7**	**195.0**		**184.4**
s [mg/kg]	3.76	2.61	3.76	8.93	1.51	2.89	0.53	0.96	0.97	2.89	s_M [mg/kg]	8.44
											$\bar{s}_i$ [mg/kg]	3.69
s_{rel}	0.0219	0.0149	0.0214	0.0493	0.0083	0.0154	0.0028	0.0050	0.0050	0.0148		0.046

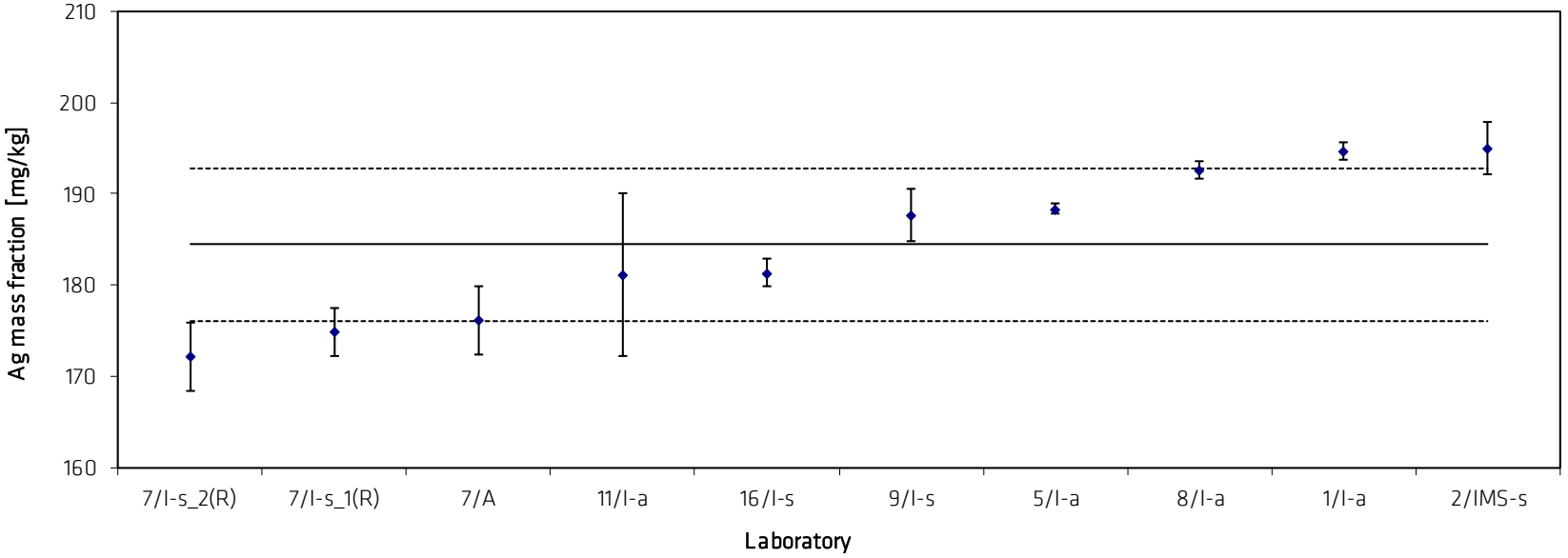


Table 12: Results for B

Lab./Meth.	1/I-s	2/IMS-s	16/I-s	9/I-s(HF)	12/I-a		
M_i [mg/kg]	2.3	2.37	2.0	3.03	10.0		*n*
	2.7	2.32	2.0	3.34	11.0		5
	2.2	2.25	3.0	2.91	11.0		
	2.2	2.23	2.0	3.25	12.0		
	2.1	2.27	3.0	3.35	11.0		
	2.2	2.44	2.0				
M [mg/kg]	**2.28**	**2.31**	**2.33**	**3.18**	**11.00**		**2.53**
s [mg/kg]	0.192	0.080	0.516	0.197	0.707	s_M [mg/kg]	0.434
						$\bar{s}_i$ [mg/kg]	0.295
s_{rel}	0.084	0.035	0.221	0.062	0.064		0.172

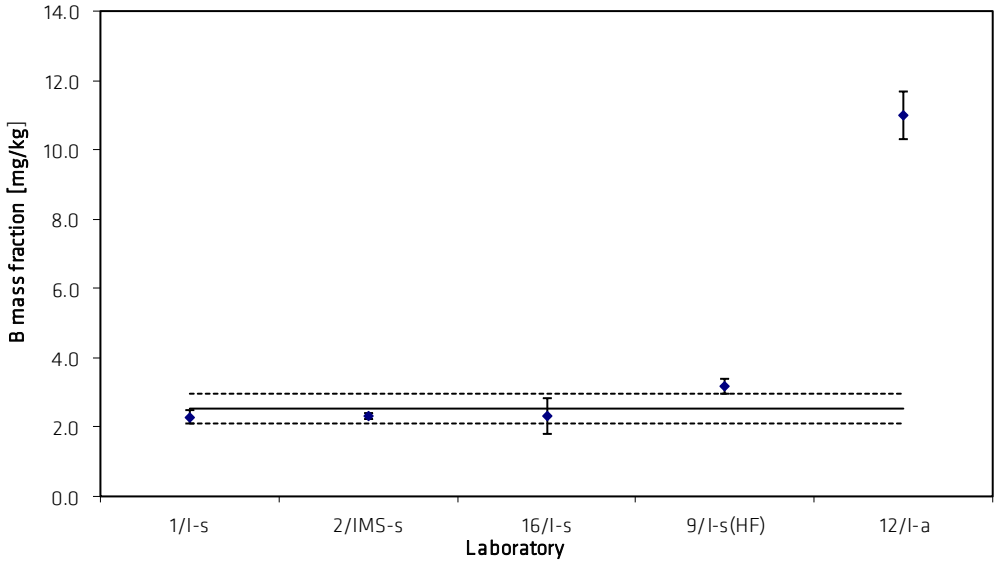


Table 13: Results for Be

Lab./Meth.	7/I-s_2	12/I-a	16/I-s	7/IMS	8/I-a	9/I-s(HF)	5/I-a	9/I-s	2/I-s	1/I-a	9/I-a	11/I-a	3/I-a		
M_i [mg/kg]	3.9	4.0	4.0	4.5	4.6	4.76	4.8	4.76	4.67	4.9	5.0	5.2	<20		*n*
	4.3	4.0	4.0	4.5	4.6	4.83	4.8	4.74	4.86	4.8	5.0	5.4	<20		12
	4.1	5.0	5.0	4.4	4.6	4.68	4.8	4.75	4.72	4.8	5.0	5.3	<20		
	4.1	4.0	4.0	4.4	4.6	4.73	4.7	4.78	4.93	4.8	4.8	5.5	<20		
	4.1	4.0	5.0	4.5	4.6	4.64	4.7	4.76	4.72	4.8	4.8	5.3	<20		
	4.0		4.0	4.5	4.7	4.72	4.7	4.75	4.85	4.8	4.9	5.3	<20		
M [mg/kg]	**4.08**	**4.20**	**4.33**	**4.47**	**4.62**	**4.73**	**4.75**	**4.76**	**4.79**	**4.81**	**4.92**	**5.33**	**<20**		**4.65**
s [mg/kg]	0.133	0.447	0.516	0.052	0.041	0.065	0.055	0.013	0.104	0.052	0.073	0.103		s_M [mg/kg]	0.340
														$\bar{s}_i$ [mg/kg]	0.201
s_{rel}	0.033	0.106	0.119	0.012	0.009	0.014	0.012	0.003	0.022	0.011	0.015	0.019			0.073

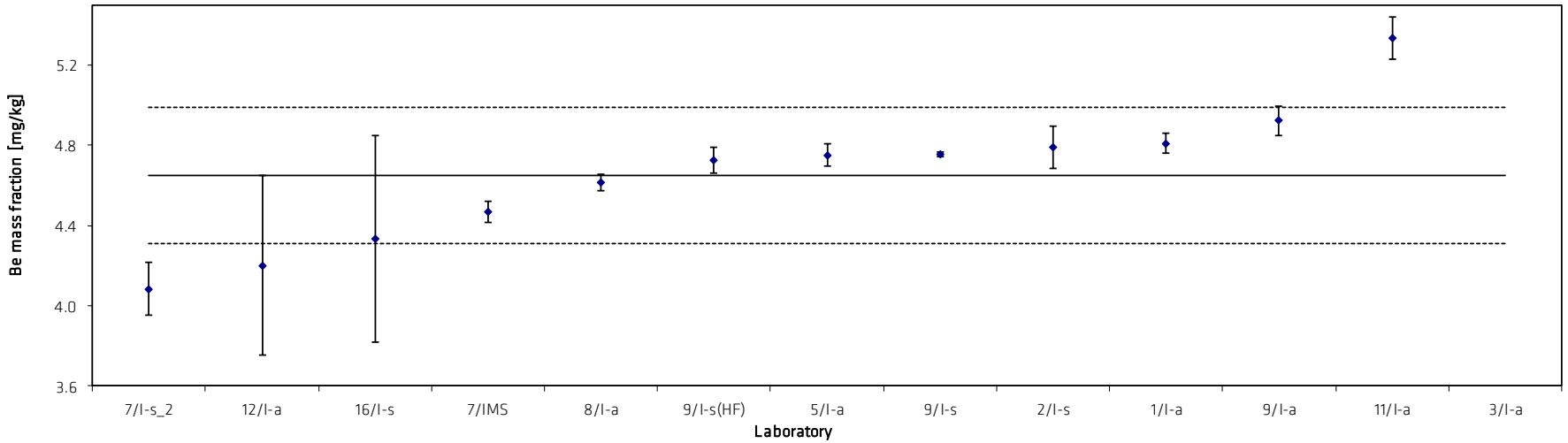


Table 14: Results for Bi

Lab./Meth.	3/I-a(R)	8/I-a	2/I-s	16/I-s	1/I-s	9/I-s(HF)	5/I-a	7/IMS	12/I-a	7/I-s_2	11/I-a		
M_i [mg/kg]	120	140.2	144.2	145	142.4	153.1	153.0	151.2	150	160	161		*n*
	120	140.2	144.7	146	146.1	150.3	156.0	163.3	157	161	170		11
	120	139.8	144.4	147	144.8	151.5	154.5	152.0	170	155	156		
	130	140.0	146.3	142	147.0	150.3	157.1	155.8	154	156	158		
	120	142.2	143.0	143	147.0	152.0	154.6	159.1	155	160	150		
	130	143.2	144.8	145	146.3	150.8	155.9	158.4		157	168		
M [mg/kg]	**123.3**	**140.9**	**144.6**	**144.7**	**145.6**	**151.3**	**155.2**	**156.6**	**157.2**	**158.2**	**160.5**		**151.5**
s [mg/kg]	5.16	1.41	1.07	1.86	1.77	1.12	1.44	4.59	7.60	2.48	7.53	s_M [mg/kg]	6.98
												$\bar{s}_i$ [mg/kg]	3.93
s_{rel}	0.042	0.010	0.007	0.013	0.012	0.007	0.009	0.029	0.048	0.016	0.047		0.046

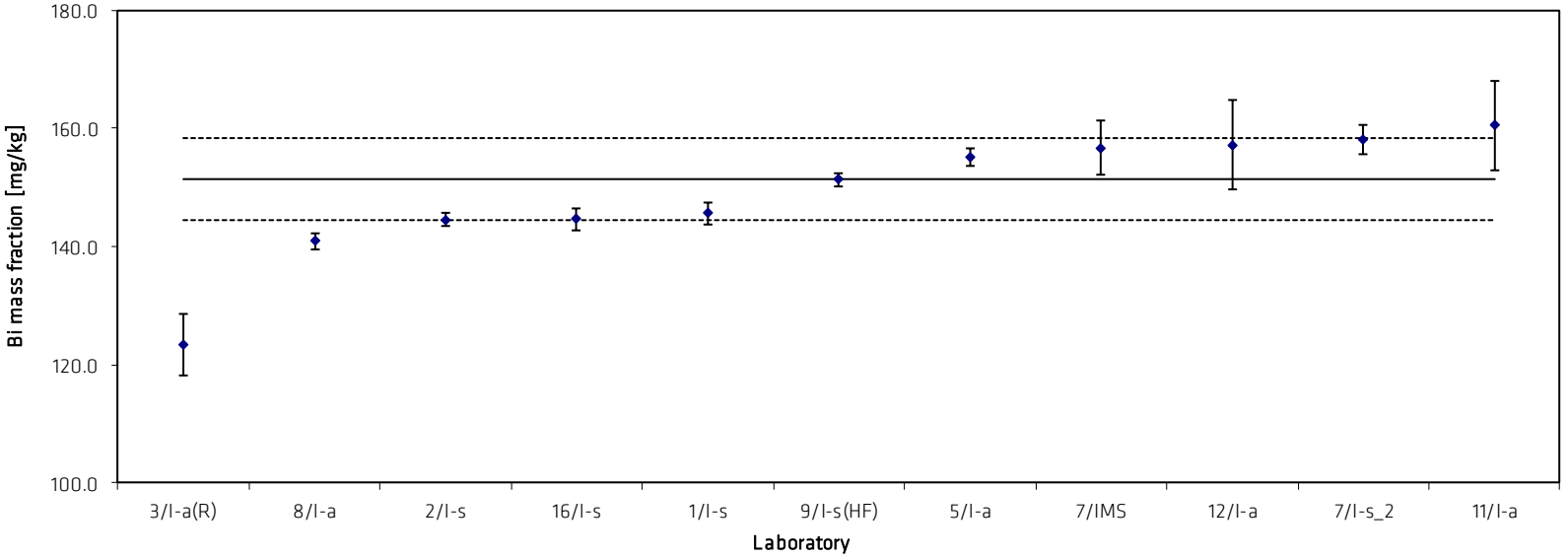


Table 15: Results for Ca

Lab./Meth.	16/l-s	12/l-a	8/l-s	7/l-s_2	7/l-s_1	2/l-s	1/l-s		
M_i [mg/kg]	16.0	14.0	15.9	15.0	18.1	18.5	21.3		*n*
	15.0	17.0	16.6	20.0	17.4	18.6	21.3		7
	16.0	17.0	18.5	18.0	20.5	18.7	21.5		
	16.0	16.0	19.1	18.0	17.0	18.6	21.4		
	17.0	20.0	17.2	21.0	17.2	18.3	21.1		
	16.0		14.6	13.0	18.3	18.6	21.2		
M [mg/kg]	**16.0**	**16.8**	**17.0**	**17.5**	**18.1**	**18.6**	**21.3**		**17.9**
s [mg/kg]	0.63	2.17	1.66	3.02	1.29	0.14	0.14	s_M [mg/kg]	1.72
								$\bar{s}_i$ [mg/kg]	1.63
s_{rel}	0.040	0.129	0.098	0.172	0.071	0.008	0.007		0.096

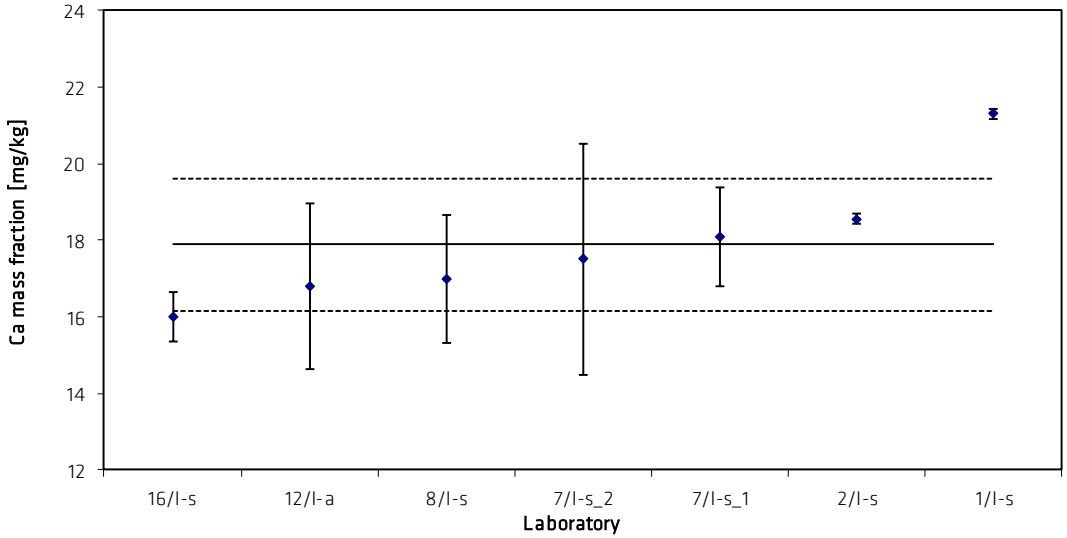


Table 16: Results for Cd

Lab./Meth.	11/I-a	7/I-s_1	7/IMS	7/I-s_2(R)	9/I-s	2/IMS-s	1/I-a	9/I-a	5/I-a	9/I-s(HF)	9/EA	12/I-a	16/I-s	8/I-s		
M_i [mg/kg]	14.5	18.7	18.0	18.4	18.9	19.6	19.1	19.5	19.7	19.9	21.0	20.0	21.0	21.8		*n*
	17.3	19.0	18.3	19.2	18.8	19.2	19.4	19.4	19.7	20.4	20.4	20.0	22.0	21.7		14
	15.9	18.4	18.1	17.9	18.9	19.2	19.4	19.2	19.6	19.7	19.9	22.0	20.0	21.6		
	16.9	17.7	18.0	17.8	19.0	18.9	19.7	19.3	19.7	19.7	20.9	19.0	21.0	21.7		
	15.6	17.1	18.2	18.3	18.9	19.2	19.2	19.6	19.7	19.3	19.3	20.0	21.0	21.5		
	15.3	17.8	18.3	18.7	18.9	19.0	19.4	19.7	19.7	19.6	18.5		21.0	21.6		
***M* [mg/kg]**	**15.9**	**18.1**	**18.2**	**18.4**	**18.9**	**19.2**	**19.4**	**19.4**	**19.7**	**19.8**	**20.0**	**20.2**	**21.0**	**21.7**		**19.5**
s [mg/kg]	1.04	0.71	0.14	0.52	0.08	0.24	0.20	0.18	0.04	0.37	0.98	1.10	0.63	0.10	s_M [mg/kg]	1.05
															$\bar{s}_i$ [mg/kg]	0.53
s_{rel}	0.0651	0.0392	0.0076	0.0282	0.0044	0.0126	0.0103	0.0094	0.0021	0.0187	0.0491	0.0542	0.0301	0.0048		0.0537

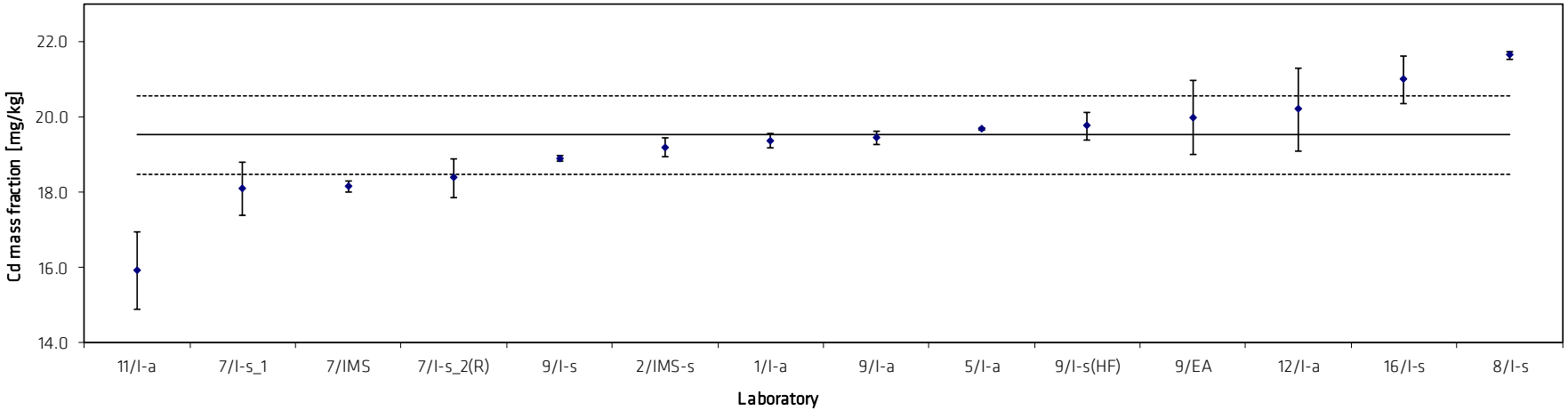


Table 17: Results for Ga

Lab./Meth.	7/IMS	8/I-a	1/I-a	7/I-s_2(R)	7/I-s_1	2/IMS-s	12/I-a	9/I-a	11/I-a	5/I-a	16/I-s(R)	9/I-s	9/I-s(HF)		
M_i [mg/kg]	88.8	89.3	94.2	93	95.4	94.1	95.0	100.4	97.5	97.5	99.0	98.6	99.6		*n*
	90.4	91.3	94.4	96	98.3	94.0	94.0	92.6	101.0	97.5	98.0	98.2	101.1		13
	88.7	90.0	93.7	96	96.9	93.7	104.0	94.1	96.2	97.3	101.0	99.0	98.8		
	89.4	89.5	94.4	96	91.7	94.8	93.0	88.5	95.1	97.1	99.0	101.0	98.9		
	87.4	90.0	94.0	95	91.3	95.7	91.0	106.3	95.0	97.2	98.0	99.8	97.5		
	90.9	91.0	95.0	91	93.4	95.3			93.7	97.6	99.0	98.3	99.7		
M [mg/kg]	**89.3**	**90.2**	**94.3**	**94.5**	**94.5**	**94.6**	**95.4**	**96.4**	**96.4**	**97.4**	**99.0**	**99.1**	**99.3**		**95.4**
s [mg/kg]	1.26	0.80	0.44	2.14	2.83	0.77	5.03	7.01	2.58	0.20	1.10	1.08	1.18	s_M [mg/kg]	3.11
														$\bar{s}_i$ [mg/kg]	2.78
s_{rel}	0.014	0.009	0.005	0.023	0.030	0.008	0.053	0.073	0.027	0.002	0.011	0.011	0.012		0.033

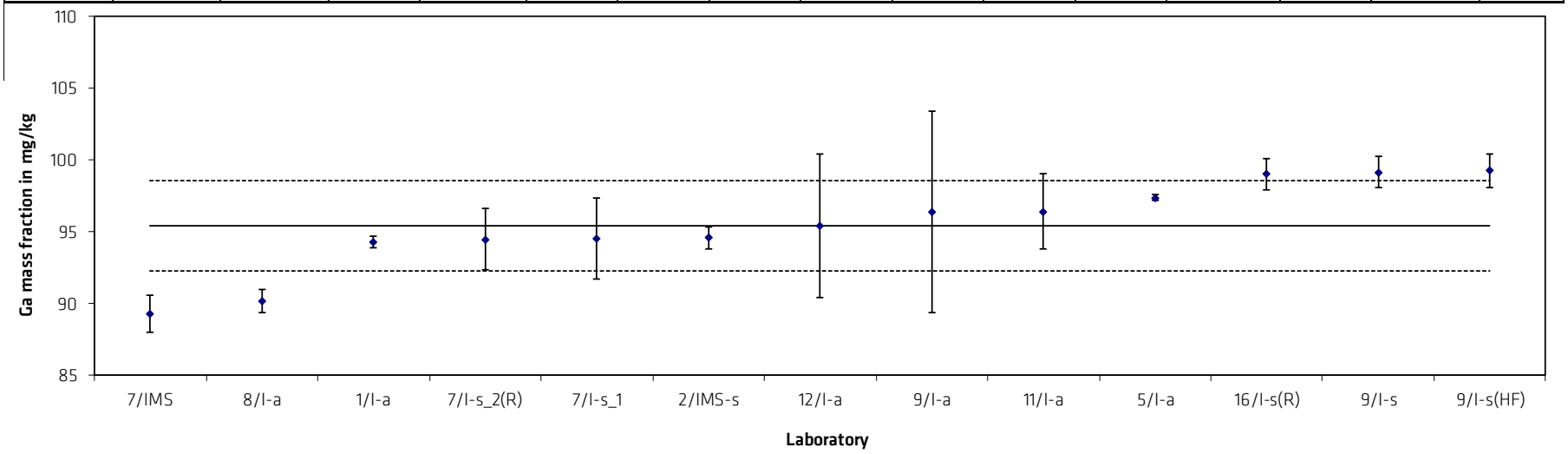


Table 18: Results for Hg

Lab./Meth.	16/I-s(R)	7/I-s_1	12/I-a	2/IMS-s		
M_i [mg/kg]	32.0	36.2	30.0	43.3		*n*
	30.0	37.5	39.0	43.7		4
	34.0	35.8	36.0	42.7		
	32.0	40.8	50.0	43.4		
	33.0	39.3	48.0	42.7		
	31.0	35.5		43.6		
M [mg/kg]	**32.0**	**37.5**	**40.6**	**43.2**		**38.3**
s [mg/kg]	1.41	2.14	8.35	0.43	s_M [mg/kg]	4.82
					$\bar{s}_i$ [mg/kg]	4.37
s_{rel}	0.044	0.057	0.206	0.010		0.126

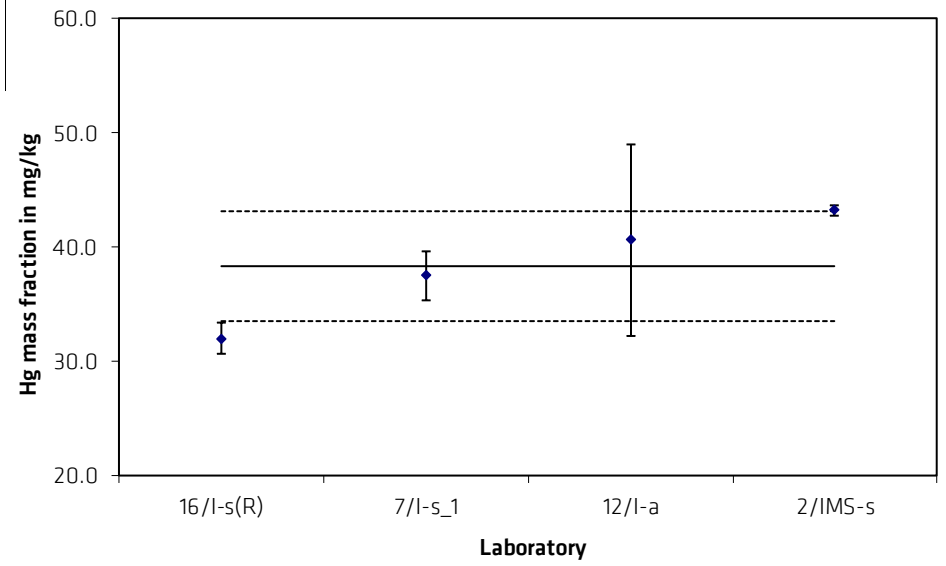


Table 23: Results for Pb

Lab./Meth.	16/I-s(R)	2/IMS-s	9/I-s	1/I-s	5/I-a	9/I-s(HF)	8/I-a	9/EA	12/I-a	7/IMS	11/I-a	7/I-s_2(R)	7/I-s_1		
M_i [mg/kg]	79	80.9	80.7	81.8	81.7	87.4	88.9	93.3	90	89.6	89.0	100	102.3		*n*
	79	82.0	82.4	81.5	83.9	87.8	86.9	82.3	91	89.7	104.0	101	105.1		13
	79	82.1	83.2	81.4	82.3	87.5	85.4	88.5	95	88.4	89.9	102	99.3		
	82	80.3	80.5	82.7	83.8	85.8	87.3	93.7	83	98.9	92.9	102	108.2		
	81	80.4	81.5	81.9	81.9	87.6	88.3	95.5	101	99.0	95.0	101	99.7		
	80	81.8	80.4	81.6	81.3	85.5	90.4	93.7		89.5	94.8	102	102.3		
								83.9							
								82.7							
M [mg/kg]	**80.0**	**81.2**	**81.5**	**81.8**	**82.5**	**86.9**	**87.9**	**89.2**	**92.0**	**92.5**	**94.3**	**101.2**	**102.8**		**88.8**
s [mg/kg]	1.26	0.81	1.15	0.47	1.11	1.01	1.73	5.56	6.63	5.01	5.37	0.93	3.36	s_M [mg/kg]	7.56
														$\bar{s}_i$ [mg/kg]	3.40
s_{rel}	0.0158	0.0100	0.0141	0.0058	0.0134	0.0116	0.0197	0.0624	0.0721	0.0541	0.0570	0.0092	0.0327		0.085

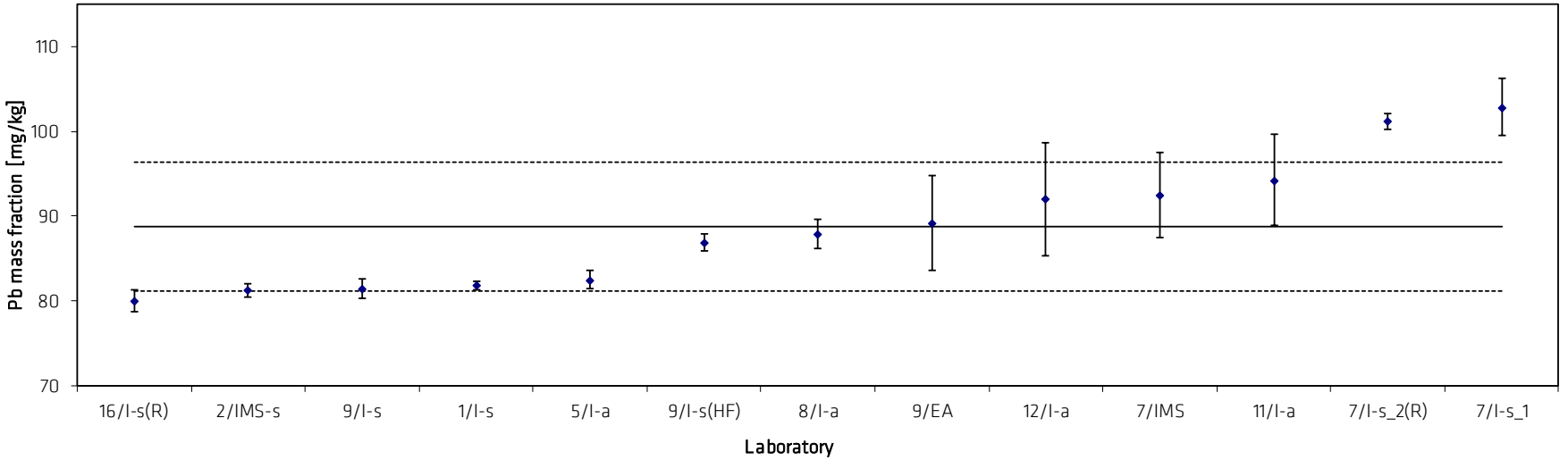


Table 24: Results for Sb

Lab./Meth.	9/I-s(HF)	9/I-s	3/I-a	8/I-a	1/I-s	2/IMS-s	7/IMS	7/I-s_1	7/I-s_2(R)	16/I-s(R)	11/I-a		
M_i [mg/kg]	45.3	43.9	40.0	45.6	47.6	47.1	46.9	46.1	49.1	47.0	54.4		*n*
	46.5	43.5	48.0	46.5	46.0	47.8	47.7	51.7	49.1	50.0	53.5		11
	35.6	43.0	46.0	45.9	46.0	48.5	47.3	51.8	50.3	49.0	56.5		
	42.1	43.8	46.0	46.4	46.0	47.3	47.5	48.1	48.0	51.0	54.3		
	40.7	40.8	43.0	47.1	46.0	46.1	48.4	47.0	48.7	48.0	49.1		
	38.8	40.8	45.0	46.6	47.0	44.8	48.8	48.2	47.9	49.0	49.1		
***M* [mg/kg]**	**41.5**	**42.6**	**44.7**	**46.4**	**46.4**	**46.9**	**47.8**	**48.8**	**48.9**	**49.0**	**52.8**		**46.9**
s [mg/kg]	4.07	1.47	2.80	0.53	0.71	1.32	0.71	2.41	0.88	1.41	3.05	s_M [mg/kg]	3.17
												$\bar{s}_i$ [mg/kg]	2.08
s_{rel}	0.098	0.034	0.063	0.011	0.015	0.028	0.015	0.049	0.018	0.029	0.058		0.068

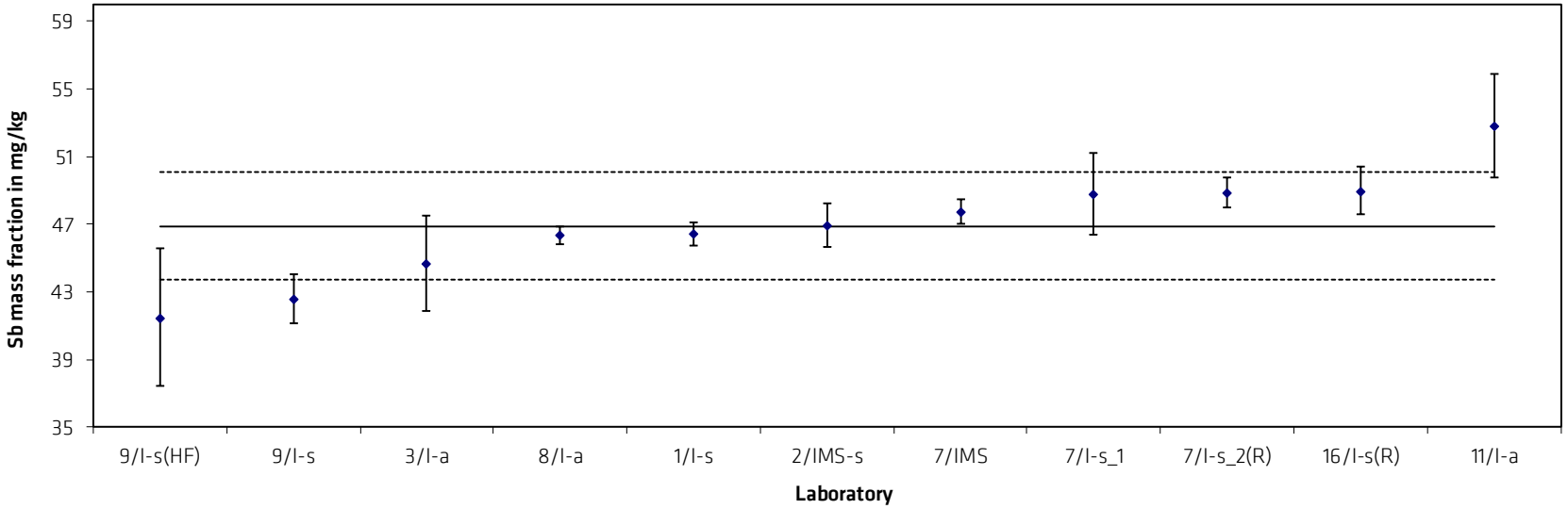


Table 25: Results for Sn

Lab./Meth.	16/I-s	7/I-s_1	11/I-a	9/I-s	12/I-a(R)	5/I-a_1	9/I-s(HF)	1/I-a	2/IMS-s	8/I-a(R)	7/I-s_2	7/IMS		
M_i [mg/kg]	96.0	97.7	96.9	99.2	98	101.2	100.9	102.0	103.7	98.5	102	104.1		*n*
	95.0	97.1	100.0	98.6	101	101.3	103.8	101.9	103.4	103.3	107	110.7		12
	94.0	95.3	97.2	97.8	98	101.8	101.0	101.6	104.9	111.8	102	102.4		
	95.0	97.6	98.9	97.3	101.3	100.1	101.0	102.9	103.8	107.0	105	104.0		
	95.0	96.8	93.4	98.3		100.5	101.4	101.5	104.4	105.6	104	104.7		
	95.0	97.4	95.6	98.4		102.7	102.0	102.0	105.2	99.4	107	104.0		
***M* [mg/kg]**	**95.0**	**97.0**	**97.0**	**98.3**	**99.8**	**101.3**	**101.7**	**102.0**	**104.2**	**104.3**	**104.5**	**105.0**		**100.5**
s [mg/kg]	0.63	0.89	2.35	0.66	1.73	0.93	1.09	0.50	0.73	4.98	2.26	2.90	s_M [mg/kg]	3.29
													$\bar{s}_i$ [mg/kg]	1.97
s_{rel}	0.007	0.009	0.024	0.007	0.017	0.009	0.011	0.005	0.007	0.048	0.022	0.028		0.033

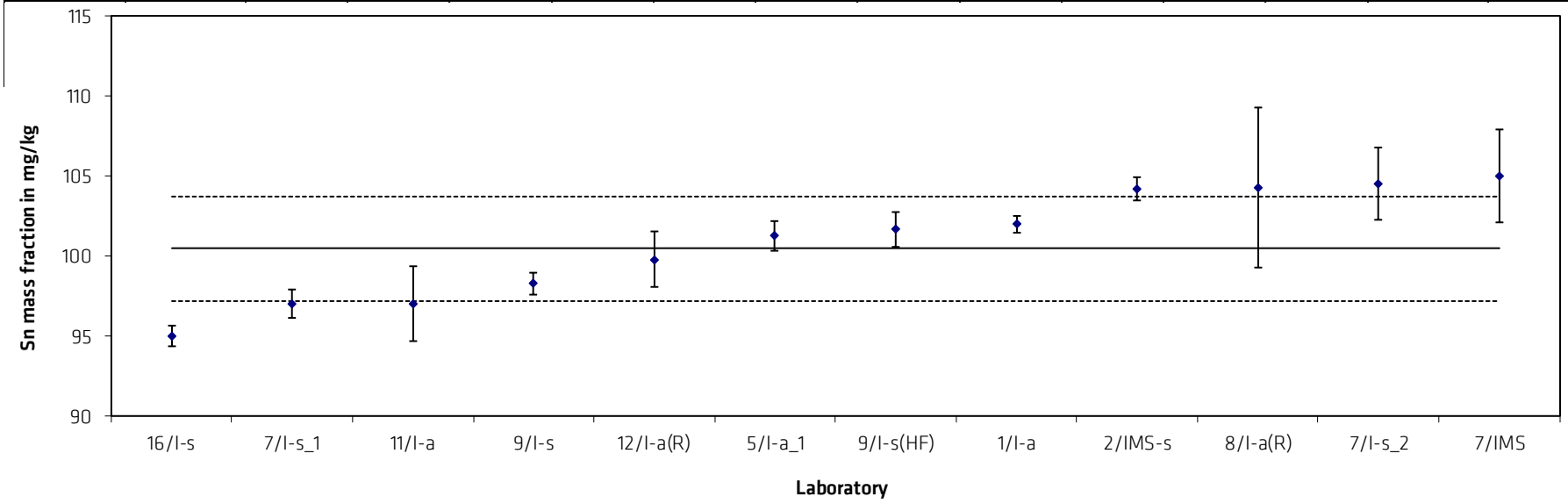


Table 26: Results for Sr

Lab./Meth.	16/I-s	7/IMS	5/I-a	11/I-a	9/I-a	12/I-a	1/I-a	2/I-s	7/I-s_1(R)	7/I-s_2	8/I-a	3/I-a(R)		
M_i [mg/kg]	280.0	289.0	292.2	305	295.1	296	290.2	301.8	301.4	300	301.4	313		*n*
	286.0	288.6	291.4	300	296.2	298	299.0	302.9	304.3	300	304.7	314		12
	284.0	288.4	292.3	297	295.2	317	298.0	301.2	305.2	307	303.3	310		
	285.0	288.6	291.1	286	293.2	291	300.0	294.6	300.7	306	305.4	311		
	284.0	284.8	287.7	289	295.2	282	298.0	299.8	304.5	305	307.0	312		
	287.0	293.0	290.5	287	292.7		300.0	296.2	303.4	303	306.9	315		
***M* [mg/kg]**	**284.3**	**288.7**	**290.9**	**294.0**	**294.6**	**296.8**	**297.5**	**299.4**	**303.3**	**303.5**	**304.8**	**312.5**		**297.5**
s [mg/kg]	2.42	2.60	1.69	7.80	1.34	12.87	3.72	3.31	1.81	3.02	2.16	1.87	s_M [mg/kg]	7.78
													$\overline{s}_i$ [mg/kg]	4.91
s_{rel}	0.009	0.009	0.006	0.027	0.005	0.043	0.013	0.011	0.006	0.010	0.007	0.006		0.026

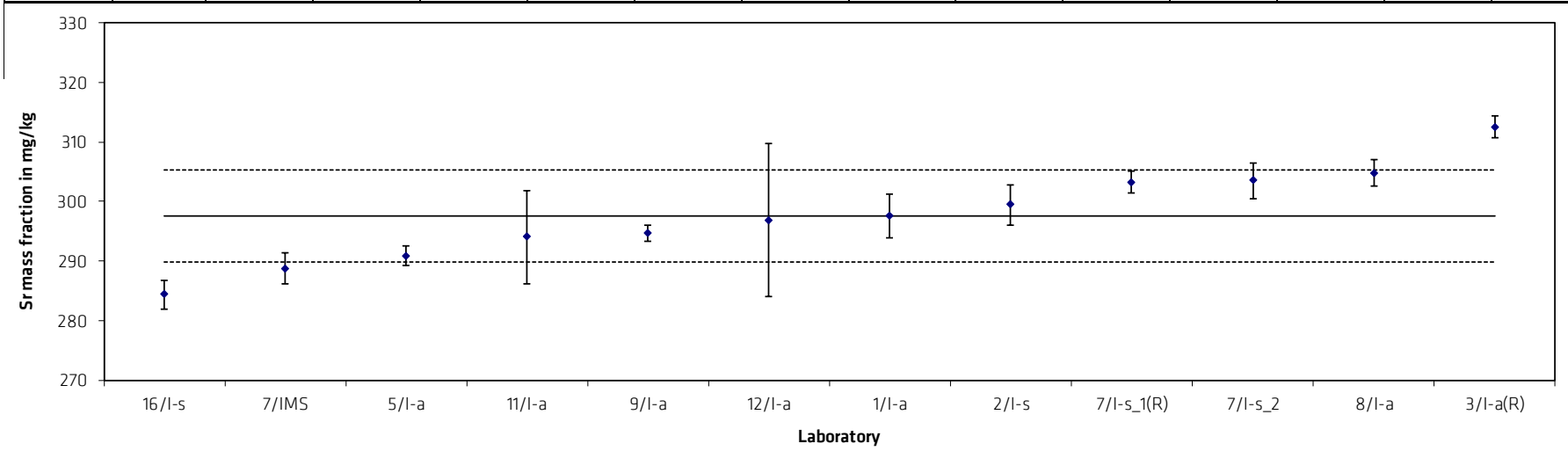


Table 27: Results for V

Lab./Meth.	16/I-s(R)	11/I-a	9/I-s(HF)	1/I-a	9/I-a	2/I-a	12/I-a	7/I-s_1	9/I-s	5/I-a	7/I-s_2	3/I-a	7/IMS	8/I-a(R)		
M_i [mg/kg]	95	96.4	96.8	97.0	97.3	98.1	98	99.9	99.4	99.7	100	100	102.3	102.7		*n*
	93	95.7	98.6	96.7	98.3	98.5	97	102.5	99.1	99.6	99	100	100.6	103.3		14
	94	94.2	95.6	96.4	97.5	98.7	106	102.5	99.2	99.6	98	100	100.2	103.0		
	94	93.2	96.0	97.1	96.6	97.9	95	97.4	100.2	99.5	101	100	100.8	103.6		
	93	92.8	94.7	96.3	97.8	97.8	96	95.8	99.5	99.4	100	100	96.9	103.7		
	95	94.2	96.1	96.7	97.4	98.2		97.1	99.3	98.8	102	100	101.4	103.3		
***M* [mg/kg]**	**94.0**	**94.4**	**96.3**	**96.7**	**97.5**	**98.2**	**98.4**	**99.2**	**99.4**	**99.4**	**100.0**	**100.0**	**100.4**	**103.3**		**98.37**
s [mg/kg]	0.89	1.40	1.34	0.32	0.56	0.36	4.39	2.87	0.40	0.33	1.41	0.00	1.85	0.37	s_M [mg/kg]	2.46
															$\bar{s}_i$ [mg/kg]	1.66
s_{rel}	0.010	0.015	0.014	0.003	0.006	0.004	0.045	0.029	0.004	0.003	0.014	0.000	0.018	0.004		0.025

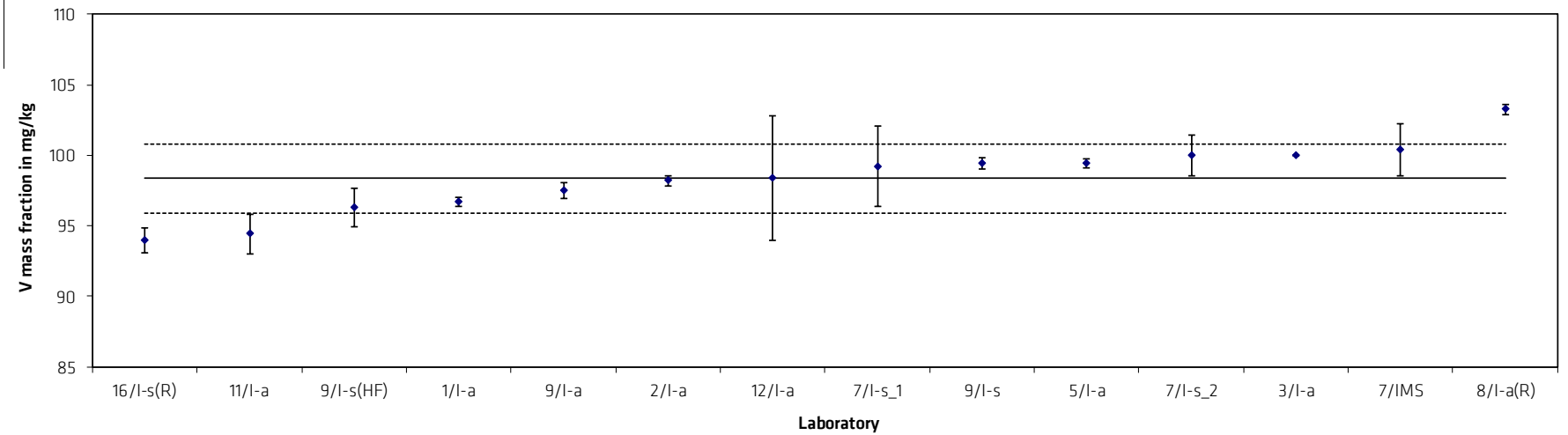
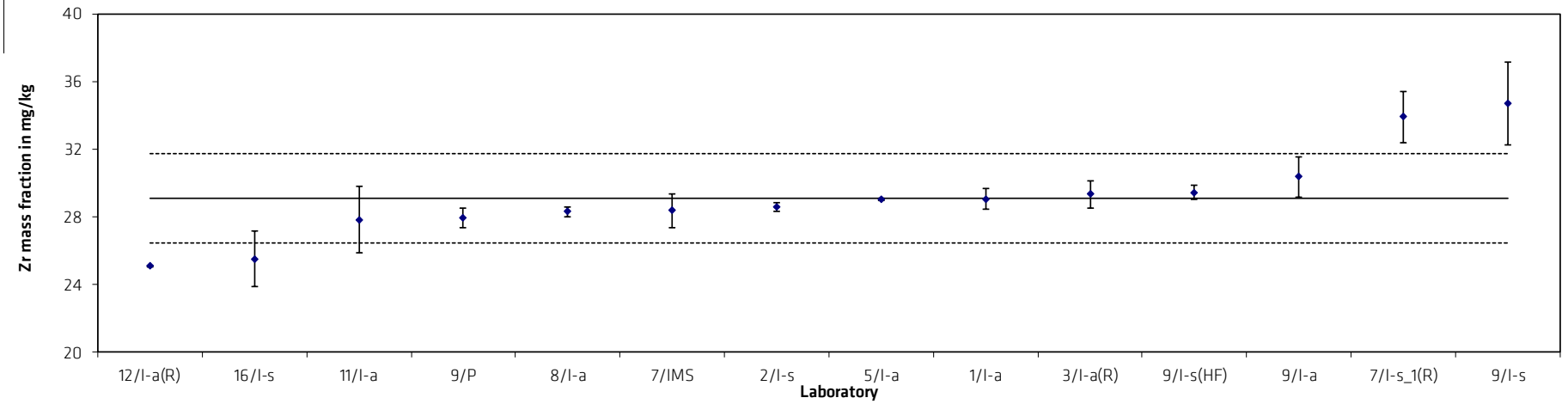


Table 28: Results for Zr

Lab./Meth.	12/I-a(R)	16/I-s	11/I-a	9/P	8/I-a	7/IMS	2/I-s	5/I-a	1/I-a	3/I-a(R)	9/I-s(HF)	9/I-a	7/I-s_1(R)	9/I-s		
M_i [mg/kg]	25.1	25.0	23.9	27.6	28.0	27.7	28.6	29.0	30.3	29	29.6	30.6	33.2	37.3		*n*
	25.1	27.0	28.9	27.5	28.1	27.8	28.7	29.1	28.8	30	30.2	29.8	36.7	35.1		14
	25.1	28.0	28.2	27.5	28.3	27.7	28.9	29.1	28.7	30	29.2	32.6	33.1	37.1		
	25.1	24.0	29.2	27.5	28.6	28.1	28.3	28.9	28.8	28	29.4	30.0	34.4	35.0		
		25.0	28.7	28.1	28.1	28.5	28.2	29.0	28.6	29	28.9	29.1	32.5	32.3		
		24.0	28.0	27.7	28.6	30.3	28.7	29.0	29.1	30	29.4	29.9	33.5	31.3		
				29.2												
				28.2												
***M* [mg/kg]**	**25.1**	**25.5**	**27.8**	**27.9**	**28.3**	**28.4**	**28.6**	**29.0**	**29.0**	**29.3**	**29.4**	**30.4**	**33.9**	**34.7**		**29.1**
s [mg/kg]	0.00	1.64	1.97	0.57	0.26	1.00	0.26	0.08	0.63	0.82	0.44	1.21	1.50	2.44	s_M [mg/kg]	2.63
															$\overline{s}_i$ [mg/kg]	1.17
s_{rel}	0.000	0.064	0.071	0.020	0.009	0.035	0.009	0.003	0.022	0.028	0.015	0.040	0.044	0.071		0.090



Using the BAM-software eCerto [4] the data was statistically evaluated to detect outlying values (Grubbs, Nalimov, Dixon, Cochran). The Cochran-test was performed only once. The following results were obtained:

Tab. 29: Outcome of statistical tests on the results obtained for Si and Cu

	Si	Cu
Number of data sets	9	15
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 16	Lab. 3, Lab. 9/A
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	Lab. 16	Lab. 3
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 3	Lab. 12
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 30: Outcome of statistical tests on the results obtained for Fe

	1st run	2nd run
Number of data sets	14	12
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	Labs. 12 and 7/I-s_2	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 12	---
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were removed.

Tab. 31: Outcome of statistical tests on the results obtained Ti and Ag

	Ti	Ag
Number of data sets	14	10
Scheffe's test (data compatible?)	---	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 12	Lab. 12
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 32: Outcome of statistical tests on the results obtained for Mn

	1st run	2nd run
Number of data sets	16	15
Scheffe's test (data compatible?)	---	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 3	Lab. 11
Dixon (α = 0.01)	Lab. 3	---
Grubbs (α = 0.05)	Lab. 3	Lab. 11
Grubbs (α = 0.01)	Lab. 3	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 3	Lab. 12
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier (Lab. 3, 1st run) was removed.

Tab. 33: Outcome of statistical tests on the results obtained for Mg

	1st run	2nd run
Number of data sets	14	13
Scheffe's test (data compatible?)	---	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 3	---
Dixon (α = 0.01)	Lab. 3	---
Grubbs (α = 0.05)	Lab. 3	---
Grubbs (α = 0.01)	Lab. 3	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 11	Lab. 11
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier (Lab. 3, 1st run) was removed.

Tab. 34: Outcome of statistical tests on the results obtained for Cr

	1st run	2nd run
Number of data sets	15	14
Scheffe's test (data compatible?)	---	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 3	---
Dixon (α = 0.01)	Lab. 3	---
Grubbs (α = 0.05)	Lab. 3	---
Grubbs (α = 0.01)	Lab. 3	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 3	Lab. 9/I-s
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier (Lab. 3, 1st run) was removed.

Tab. 35: Outcome of statistical tests on the results obtained for Ni

	1st run	2nd run
Number of data sets	15	14
Scheffe's test (data compatible?)	---	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	Lab. 3	---
Grubbs (α = 0.01)	Lab. 3	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 12	Lab. 9/I-s
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier (Lab. 3, 1st run) was removed.

Tab. 36: Outcome of statistical tests on the results obtained for Zn

	1st run	2nd run
Number of data sets	14	13
Scheffe's test (data compatible?)	---	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 11	---
Dixon (α = 0.01)	Lab. 11	---
Grubbs (α = 0.05)	Lab. 11	---
Grubbs (α = 0.01)	Lab. 11	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 12	Lab. 12
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier (Lab. 11, 1st run) was removed.

Tab. 37: Outcome of statistical tests on the results obtained for Be and Ca

	Be	Ca
Number of data sets	12	7
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	Lab. 1
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	Lab. 1
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 16	Labs. 7/I-s_2
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 38: Outcome of statistical tests on the results obtained for B

	1st run	2nd run
Number of data sets	5	4
Scheffe's test (data compatible?)	---	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 12	Lab. 9
Dixon (α = 0.01)	Lab. 12	Lab. 9
Grubbs (α = 0.05)	Lab. 12	Lab. 9
Grubbs (α = 0.01)	Lab. 12	Lab. 9
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	---	Lab. 16
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier (Lab. 12, 1st run) was removed.

Tab. 39: Outcome of statistical tests on the results obtained for Bi

	1st run	2nd run
Number of data sets	11	10
Scheffe's test (data compatible?)	---	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 3	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	Lab. 3	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	---	Lab. 12
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier (Lab. 3, 1st run) was removed.

Tab. 40: Outcome of statistical tests on the results obtained for Ga and Hg

	Ga	Hg
Number of data sets	13	4
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 9/I-a	Lab. 12
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 41: Outcome of statistical tests on the results obtained for Pb and Sb

	Pb	Sb
Number of data sets	13	11
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	---	Lab. 9/I-s(HF)
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 42: Outcome of statistical tests on the results obtained for Sn and Sr

	Sn	Sr
Number of data sets	12	12
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 8	Lab. 12
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 43: Outcome of statistical tests on the results obtained for V and Zr

	V	Zr
Number of data sets	14	14
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	Lab. 9/I-s
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 12	Lab. 9/I-s
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

The certified mass fractions of all elements were calculated as mean of the accepted data sets. These values are given in Table 44.
The resp. combined uncertainties were calculated from the spread resulting from the certification inter-laboratory comparison (u_{ilc}) and the uncertainty contributions from

possible inhomogeneity over the length ($u_{bb}(1)$) and over area ($u_{bb}(2)$) of the material using Equation 4.

$$u_{\text{combined}} = \sqrt{u_{ilc}^2 + u_{bb}^2(1) + u_{bb}^2(2)} \qquad (4)$$

with

$u_{ilc} = \sqrt{\frac{s_M^2}{n}}$: uncertainty contribution resulting from inter-laboratory comparison

n : number of data sets used for calculating the certified mass fraction of each element

Table 44: Uncertainty calculation (u_{bb}(rel) was calculated with the data from the homogeneity test (see Annex 1 and 2) and used for the calculation of $u_{bb}(1)$ and $u_{bb}(2)$)

	uncertainty contribution from								u_{bb}(rel)		
	M	n	s_M	u_{ilc}	$u_{bb}(1)$** Length	$u_{bb}(2)$** Area	u(comb)	U	Length	Area	
	%		%	%	%	%	%	%			
Si	11.87	9	0.19858	0.0662	0.0257	0.0300	0.0771	0.1542	0.2161	0.2530	
Fe	0.9860	12	0.02387	0.0069	0.0025	0.0051	0.0090	0.0179	0.2529	0.5223	
Cu	0.0290	15	0.00091	0.0002	0.0001	0.0001	0.0003	0.00055	0.4351	0.2436	
Mn	0.0240	15	0.00131	0.0003	0.0001	0.0001	0.0004	0.00071	0.3491	0.2969	
Mg	0.0473	13	0.00184	0.0005	0.0002	0.0001	0.0006	0.00116	0.5188	0.2772	
Ni	0.0251	14	0.00077	0.0002	0.0001	0.0003	0.0003	0.00067	0.2948	1.0084	
Zn	0.0593	13	0.00120	0.0003	0.0004	0.0002	0.0005	0.00108	0.6401	0.3175	
Ti	0.0791	14	0.00221	0.0006	0.0003	0.0002	0.0007	0.00137	0.3835	0.2015	
	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			
Cr	62.60	14	2.218	0.5929	0.1303	0.3372	0.694	1.389	0.2081	0.5386	
Ag	184.40	10	8.436	2.6676	0.8855	1.0256	2.992	5.984	0.4802	0.5562	
B	2.53	4	0.434	0.2170	0.1828	0.0506	0.288	0.576	7.2249	2.0000	*
Be	4.65	12	0.340	0.0982	0.0082	0.1808	0.206	0.412	0.1769	3.8892	
Bi	151.5	10	6.984	2.2084	0.6058	1.0599	2.523	5.047	0.3998	0.6996	
Ca	17.9	7	1.724	0.6516	0.0520	0.0769	0.658	1.316	0.2905	0.4300	
Cd	19.5	13	1.049	0.2908	0.0387	0.2765	0.403	0.806	0.1985	1.4180	
Ga	95.4	13	3.113	0.8633	0.2642	0.3391	0.964	1.929	0.2770	0.3555	
Hg	38.3	4	4.823	2.4115	0.1203	0.1240	2.418	4.835	0.3138	0.3236	
Pb	88.8	13	7.560	2.0967	0.7766	0.9440	2.427	4.854	0.8746	1.0630	
Sb	46.9	11	3.174	0.9569	0.9225	0.9380	1.627	3.254	1.9670	2.0000	*
Sn	100.5	12	3.290	0.9497	0.3397	0.9279	1.371	2.741	0.3380	0.9233	
Sr	297.5	12	7.782	2.2466	1.3461	2.6734	3.742	7.485	0.4525	0.8986	
V	98.4	14	2.463	0.6581	0.5140	0.4097	0.930	1.860	0.5224	0.4164	
Zr	29.1	14	2.626	0.7019	0.0345	0.2606	0.750	1.499	0.1185	0.8956	

**calculated from u_{bb}(rel): $u_{bb} = \frac{M \cdot u_{bb}(rel)}{100}$

* estimated from other element

The expanded uncertainties U are calculated by multiplication of u_{combined} with a coverage factor of $k = 2$ using Equation 5.

$$U = k \cdot u_{\text{combined}} \qquad (5)$$

The calculated mass fractions and their resp. expanded uncertainties are given on Page 3 of this report. Rounding was done according to DIN 1333 [5].

In addition to the wet chemical characterisation an accompanying inter-laboratory comparison with spark emission was performed to check if there is agreement between SOES and wet chemistry. Tab. 45 shows the mean values of wet chemical and spark emission results as well as their standard deviations. The data obtained with wet chemistry and SOES are consistent for all elements considering their uncertainties. The data from the spark emission inter-laboratory comparison was not used for the calculation of the certified values.

Tab. 45: Comparison wet chemistry vs. SOES

Element	Wet chemical analysis			Spark emission		
	Mass fraction in %	Std.-dev. in %	*n*	Mass fraction in %	Std.-dev. in %	*n*
Si	11.87	0.20	9	11.99	0.17	14
Fe	0.986	0.024	12	0.987	0.017	13
Cu	0.0290	0.0010	15	0.0299	0.0013	15
Mn	0.0240	0.0014	15	0.0231	0.0019	14
Mg	0.0473	0.0019	12	0.0491	0.0024	13
Ni	0.0251	0.0008	14	0.0242	0.0011	12
Zn	0.0593	0.0012	13	0.0597	0.0028	13
Ti	0.0791	0.0023	14	0.0796	0.0028	13
	in mg/kg	in mg/kg		in mg/kg	in mg/kg	
Cr	62.6	2.3	14	63.4	4.0	12
Ag	184.4	8.5	10	217	37	10
B	2.53	0.44	4	5.6	2.6	8
Be	4.65	0.34	12	5.10	0.67	10
Bi	151.5	7.0	10	136.8	15.7	12
Ca	17.9	1.8	7	19.1	1.7	12
Cd	19.5	1.1	13	18.8	2.2	11
Ga	95.4	3.2	13	101.3	8.5	11
Hg	38.3	4.9	4	39.9	10.9	10
Pb	88.8	7.6	13	86.3	6.2	12
Sb	46.9	3.2	11	42.1	7.8	7
Sn	100.5	3.3	12	107.6	7.4	13
Sr	297.5	7.8	12	304.0	21.6	12
V	98.4	2.5	14	96.5	4.1	11
Zr	29.1	2.7	14	28.5	3.4	12

6. Instructions for users and stability

The certified reference material BAM-M316a is intended for the calibration and quality control of spark emission and X-ray fluorescence spectrometers used for the analysis of similar materials. It is also suitable for validation and quality control of wet chemical analysis methods. If chips prepared from the compact material are used for wet chemical analysis, a minimum sample intake of 0.2 g has to be used.
The surface of the material should be cleaned by turning or milling before analysis.
The material will remain stable provided that it is not subjected to excessive heat (eg, during preparation of the working surface).

7. Metrological Traceability

To ensure traceability of the certified mass fractions to the SI (Système International d'Unités) calibration was performed using standard solutions prepared from pure metals or stoichiometric compounds or traceable commercial calibration solutions.

8. Information on and purchase of the CRM

Certified reference material BAM-M316a is supplied by

Bundesanstalt für Materialforschung und -prüfung (BAM)
Division 1.6 „Inorganic Reference Materials"
Richard-Willstätter-Str. 11, D-12489 Berlin, Germany
Phone +49 (0)30 - 8104 2061
Fax: +49 (0)30 – 8104 72061
E-Mail: sales.crm@bam.de

Each disc of BAM-M316a will be distributed together with a detailed certificate containing the certified values and their uncertainties, the mean values and standard deviations of all accepted data sets and information on the analytical methods used and the names of the participating laboratories.
Information on certified reference materials can be obtained from BAM:
https://www.bam.de.
Tel. +49 30 8104 1111.

9. References

[1] DIN EN ISO 17034, General requirements for the competence of reference material producers, 2017

[2] ISO Guide 31, Reference materials - Contents of certificates, labels and accompanying documentation, 2015

[3] ISO Guide 35, Reference materials - Guidance for characterization and assessment of homogeneity and stability, 2017

[4] J. Lisec, eCerto Software, BAM 2021

[5] DIN 1333:1992-02 Zahlenangaben

Annex 1: Calculation of uncertainty contribution of potential inhomogeneity (length), SOES

(u_{bb}(rel.) here means u_{bb} (rel) Length in Table 43)

Silicon (mass fraction in %):

	1	2	3	4	5
A1	11.77	11.74	11.75	11.78	11.80
A2	11.85	11.80	11.85	11.78	11.86
A3	11.86	11.84	11.85	11.84	11.81
A4	11.86	11.85	11.88	11.92	11.92
A5	11.82	11.82	11.88	11.85	11.85
B1	11.81	11.81	11.82	11.83	11.82
B2	11.84	11.84	11.85	11.87	11.89
B3	11.84	11.88	11.84	11.82	11.87
B4	11.83	11.86	11.89	11.86	11.88
B5	11.82	11.88	11.84	11.88	11.88
C1	11.88	11.87	11.83	11.83	11.85
C2	11.86	11.84	11.83	11.83	11.89
C3	11.87	11.84	11.88	11.86	11.86
C4	11.83	11.85	11.84	11.84	11.90
C5	11.85	11.84	11.89	11.88	11.96
D1	11.79	11.80	11.81	11.84	11.86
D2	11.84	11.83	11.87	11.94	11.90
D3	11.85	11.85	11.86	11.89	11.87
D4	11.80	11.80	11.80	11.84	11.83
D5	11.90	11.87	11.86	11.88	11.90
E1	11.80	11.87	11.84	11.80	11.88
E2	11.83	11.88	11.84	11.90	11.88
E3	11.90	11.86	11.88	11.88	11.90
E4	11.81	11.84	11.86	11.83	11.89
E5	11.79	11.83	11.87	11.84	11.87
F1	11.80	11.81	11.81	11.83	11.82
F2	11.84	11.85	11.81	11.83	11.84
F3	11.85	11.83	11.83	11.82	11.87
F4	11.83	11.88	11.86	11.86	11.85
F5	11.83	11.81	11.85	11.80	11.83

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.096067	29	0.00331267	4.800966	4.74251E-10	1.562071
Within groups	0.0828	120	0.00069			
Total	0.178867	149				
within-sd	0.026268					
effective n	4.00					
s_{bb}	0.025606					
u^*_{bb}	0.004719					
u_{bb}	0.025606					
u_{bb}(rel.)	0.216137					

Iron (mass fraction in %):

	1	2	3	4	5
A1	0.9747	0.9792	0.9833	0.9814	0.9828
A2	0.9833	0.9801	0.9823	0.9735	0.9851
A3	0.9878	0.9880	0.9846	0.9805	0.9855
A4	0.9755	0.9823	0.9816	0.9809	0.9878
A5	0.9771	0.9734	0.9816	0.9805	0.9857
B1	0.9798	0.9750	0.9774	0.9756	0.9831
B2	0.9798	0.9796	0.9770	0.9854	0.9827
B3	0.9859	0.9878	0.9821	0.9814	0.9879
B4	0.9862	0.9867	0.9858	0.9837	0.9862
B5	0.9702	0.9820	0.9804	0.9825	0.9897
C1	0.9814	0.9850	0.9791	0.9790	0.9812
C2	0.9776	0.9825	0.9859	0.9838	0.9906
C3	0.9831	0.9730	0.9804	0.9781	0.9836
C4	0.9841	0.9800	0.9773	0.9820	0.9891
C5	0.9777	0.9756	0.9829	0.9883	0.9903
D1	0.9803	0.9840	0.9833	0.9886	0.9861
D2	0.9819	0.9889	0.9878	0.9982	0.9942
D3	0.9769	0.9844	0.9814	0.9829	0.9861
D4	0.9750	0.9759	0.9719	0.9838	0.9831
D5	0.9841	0.9811	0.9825	0.9913	0.9860
E1	0.9698	0.9838	0.9821	0.9752	0.9840
E2	0.9749	0.9765	0.9798	0.9827	0.9849
E3	0.9887	0.9773	0.9816	0.9845	0.9838
E4	0.9797	0.9864	0.9832	0.9844	0.9868
E5	0.9809	0.9844	0.9883	0.9868	0.9841
F1	0.9741	0.9752	0.9734	0.9783	0.9833
F2	0.9738	0.9853	0.9757	0.9809	0.9837
F3	0.9824	0.9835	0.9821	0.9806	0.9855
F4	0.9806	0.9827	0.9862	0.9868	0.9794
F5	0.9779	0.9785	0.9784	0.9778	0.9802

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.001221	29	4.2107E-05	2.414926	0.000461314	1.562071
Within groups	0.002092	120	1.7436E-05			
Total	0.003313	149				
within-sd	0.004176					
effective n	4.00					
s_{bb}	0.002483					
u^*_{bb}	0.00075					
u_{bb}	0.002483					
u_{bb}(rel.)	0.252892					

Copper (mass fraction in %):

	1	2	3	4	5
A1	0.0297	0.0298	0.0299	0.0298	0.0299
A2	0.0298	0.0297	0.0298	0.0296	0.0300
A3	0.0298	0.0303	0.0298	0.0298	0.0301
A4	0.0298	0.0299	0.0301	0.0299	0.0302
A5	0.0295	0.0296	0.0296	0.0299	0.0298
B1	0.0298	0.0295	0.0297	0.0297	0.0296
B2	0.0300	0.0299	0.0299	0.0299	0.0298
B3	0.0298	0.0300	0.0298	0.0298	0.0300
B4	0.0300	0.0302	0.0303	0.0302	0.0302
B5	0.0297	0.0297	0.0298	0.0299	0.0299
C1	0.0300	0.0300	0.0299	0.0297	0.0301
C2	0.0299	0.0298	0.0298	0.0297	0.0299
C3	0.0299	0.0298	0.0299	0.0299	0.0299
C4	0.0296	0.0297	0.0296	0.0298	0.0300
C5	0.0299	0.0296	0.0299	0.0299	0.0300
D1	0.0298	0.0298	0.0298	0.0298	0.0300
D2	0.0297	0.0302	0.0301	0.0304	0.0302
D3	0.0299	0.0302	0.0300	0.0301	0.0302
D4	0.0296	0.0296	0.0298	0.0299	0.0297
D5	0.0301	0.0298	0.0299	0.0299	0.0300
E1	0.0297	0.0298	0.0298	0.0297	0.0300
E2	0.0298	0.0297	0.0298	0.0299	0.0298
E3	0.0302	0.0298	0.0299	0.0299	0.0300
E4	0.0296	0.0299	0.0300	0.0300	0.0299
E5	0.0298	0.0297	0.0300	0.0299	0.0300
F1	0.0297	0.0296	0.0294	0.0298	0.0297
F2	0.0297	0.0299	0.0297	0.0299	0.0298
F3	0.0297	0.0298	0.0298	0.0296	0.0299
F4	0.0300	0.0298	0.0298	0.0297	0.0298
F5	0.0295	0.0297	0.0297	0.0296	0.0298

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.49E-06	29	8.586E-08	4.674761	9.47002E-10	1.562071
Within groups	2.2E-06	120	1.8367E-08			
Total	4.69E-06	149				
within-sd	0.000136					
effective n	4.00					
s_{bb}	0.00013					
u^*_{bb}	2.43E-05					
u_{bb}	0.00013					
u_{bb}(rel.)	0.435128					

Manganese (mass fraction in %):

	1	2	3	4	5
A1	0.0230	0.0230	0.0230	0.0231	0.0230
A2	0.0231	0.0232	0.0231	0.0231	0.0233
A3	0.0232	0.0230	0.0229	0.0231	0.0231
A4	0.0230	0.0233	0.0231	0.0230	0.0232
A5	0.0231	0.0232	0.0231	0.0232	0.0231
B1	0.0230	0.0230	0.0231	0.0232	0.0228
B2	0.0229	0.0229	0.0229	0.0229	0.0228
B3	0.0232	0.0232	0.0232	0.0230	0.0231
B4	0.0228	0.0228	0.0229	0.0227	0.0228
B5	0.0229	0.0231	0.0230	0.0232	0.0232
C1	0.0228	0.0230	0.0230	0.0229	0.0228
C2	0.0230	0.0231	0.0231	0.0233	0.0232
C3	0.0233	0.0231	0.0231	0.0229	0.0231
C4	0.0231	0.0231	0.0230	0.0231	0.0232
C5	0.0231	0.0231	0.0230	0.0231	0.0229
D1	0.0232	0.0230	0.0230	0.0231	0.0230
D2	0.0233	0.0231	0.0230	0.0230	0.0228
D3	0.0230	0.0230	0.0229	0.0229	0.0229
D4	0.0230	0.0231	0.0230	0.0230	0.0230
D5	0.0231	0.0232	0.0230	0.0231	0.0231
E1	0.0229	0.0230	0.0232	0.0229	0.0229
E2	0.0231	0.0231	0.0232	0.0231	0.0230
E3	0.0232	0.0231	0.0231	0.0232	0.0230
E4	0.0232	0.0231	0.0230	0.0231	0.0231
E5	0.0230	0.0231	0.0230	0.0231	0.0229
F1	0.0231	0.0230	0.0232	0.0230	0.0231
F2	0.0231	0.0231	0.0230	0.0232	0.0232
F3	0.0233	0.0230	0.0230	0.0231	0.0230
F4	0.0232	0.0231	0.0231	0.0232	0.0230
F5	0.0231	0.0231	0.0230	0.0231	0.0230

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.03E-06	29	3.5439E-08	3.717386	2.13922E-07	1.562071
Within groups	1.14E-06	120	9.5333E-09			
Total	2.17E-06	149				
within-sd	9.76E-05					
effective n	4.00					
s_{bb}	8.05E-05					
u^*_{bb}	1.75E-05					
u_{bb}	8.05E-05					
u_{bb}(rel.)	0.349067					

Magnesium (mass fraction in %):

	1	2	3	4	5
A1	0.0469	0.0467	0.0472	0.0470	0.0469
A2	0.0473	0.0474	0.0471	0.0470	0.0472
A3	0.0470	0.0474	0.0470	0.0467	0.0473
A4	0.0475	0.0478	0.0476	0.0474	0.0479
A5	0.0471	0.0471	0.0468	0.0473	0.0473
B1	0.0472	0.0478	0.0470	0.0473	0.0470
B2	0.0477	0.0475	0.0480	0.0476	0.0474
B3	0.0471	0.0472	0.0472	0.0471	0.0471
B4	0.0478	0.0477	0.0480	0.0480	0.0477
B5	0.0474	0.0471	0.0472	0.0472	0.0472
C1	0.0481	0.0478	0.0475	0.0473	0.0478
C2	0.0473	0.0472	0.0471	0.0473	0.0472
C3	0.0475	0.0472	0.0473	0.0473	0.0471
C4	0.0469	0.0474	0.0472	0.0471	0.0473
C5	0.0478	0.0474	0.0474	0.0475	0.0474
D1	0.0471	0.0469	0.0470	0.0468	0.0471
D2	0.0468	0.0477	0.0475	0.0473	0.0471
D3	0.0479	0.0480	0.0478	0.0476	0.0477
D4	0.0470	0.0472	0.0474	0.0471	0.0468
D5	0.0476	0.0475	0.0474	0.0476	0.0476
E1	0.0474	0.0473	0.0474	0.0472	0.0475
E2	0.0480	0.0471	0.0474	0.0475	0.0472
E3	0.0477	0.0475	0.0476	0.0476	0.0477
E4	0.0469	0.0472	0.0471	0.0472	0.0473
E5	0.0472	0.0473	0.0470	0.0468	0.0472
F1	0.0472	0.0472	0.0472	0.0473	0.0470
F2	0.0471	0.0470	0.0472	0.0475	0.0472
F3	0.0469	0.0472	0.0473	0.0468	0.0470
F4	0.0477	0.0475	0.0473	0.0473	0.0472
F5	0.0499	0.0473	0.0470	0.0473	0.0472

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	9.55E-06	29	3.292E-07	3.739545	1.88105E-07	1.562071
Within groups	1.06E-05	120	8.8033E-08			
Total	2.01E-05	149				
within-sd	0.000297					
effective n	4.00					
s_{bb}	0.000246					
u^*_{bb}	5.33E-05					
u_{bb}	0.000246					
u_{bb}(rel.)	0.518803					

Chromium (mass fraction in %):

	1	2	3	4	5
A1	0.0058	0.0059	0.0059	0.0058	0.0058
A2	0.0059	0.0059	0.0059	0.0058	0.0058
A3	0.0059	0.0059	0.0060	0.0059	0.0058
A4	0.0058	0.0058	0.0058	0.0059	0.0059
A5	0.0058	0.0058	0.0058	0.0059	0.0059
B1	0.0057	0.0059	0.0059	0.0058	0.0059
B2	0.0058	0.0058	0.0058	0.0058	0.0059
B3	0.0059	0.0059	0.0059	0.0059	0.0058
B4	0.0059	0.0058	0.0059	0.0059	0.0058
B5	0.0058	0.0059	0.0059	0.0058	0.0059
C1	0.0059	0.0059	0.0059	0.0059	0.0059
C2	0.0058	0.0059	0.0059	0.0059	0.0059
C3	0.0059	0.0059	0.0058	0.0059	0.0058
C4	0.0058	0.0059	0.0058	0.0059	0.0059
C5	0.0058	0.0058	0.0058	0.0058	0.0059
D1	0.0059	0.0058	0.0059	0.0059	0.0058
D2	0.0059	0.0059	0.0059	0.0059	0.0059
D3	0.0058	0.0059	0.0058	0.0059	0.0059
D4	0.0058	0.0058	0.0058	0.0059	0.0059
D5	0.0059	0.0058	0.0059	0.0059	0.0059
E1	0.0058	0.0059	0.0058	0.0058	0.0059
E2	0.0058	0.0059	0.0058	0.0058	0.0058
E3	0.0059	0.0058	0.0059	0.0059	0.0059
E4	0.0059	0.0059	0.0059	0.0058	0.0059
E5	0.0058	0.0058	0.0059	0.0059	0.0059
F1	0.0058	0.0058	0.0058	0.0059	0.0058
F2	0.0059	0.0059	0.0058	0.0058	0.0059
F3	0.0059	0.0059	0.0059	0.0058	0.0059
F4	0.0058	0.0059	0.0058	0.0058	0.0058
F5	0.0058	0.0058	0.0058	0.0058	0.0059

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	9.36E-08	29	3.2276E-09	1.225666	0.221725101	1.562071
Within groups	3.16E-07	120	2.6333E-09			
Total	4.1E-07	149				
within-sd	5.13E-05					
effective n	4.00					
s_{bb}	1.22E-05					
u^*_{bb}	9.22E-06					
u_{bb}	1.22E-05					
u_{bb}(rel.)	0.20814					

Nickel (mass fraction in %):

	1	2	3	4	5
A1	0.0241	0.0242	0.0244	0.0244	0.0244
A2	0.0244	0.0244	0.0245	0.0244	0.0245
A3	0.0243	0.0244	0.0243	0.0244	0.0245
A4	0.0244	0.0243	0.0244	0.0242	0.0244
A5	0.0242	0.0244	0.0243	0.0243	0.0245
B1	0.0243	0.0242	0.0244	0.0242	0.0243
B2	0.0244	0.0242	0.0242	0.0244	0.0243
B3	0.0245	0.0244	0.0244	0.0244	0.0244
B4	0.0246	0.0244	0.0245	0.0245	0.0245
B5	0.0242	0.0243	0.0243	0.0243	0.0243
C1	0.0244	0.0243	0.0242	0.0242	0.0244
C2	0.0243	0.0244	0.0243	0.0243	0.0243
C3	0.0244	0.0241	0.0244	0.0242	0.0243
C4	0.0243	0.0242	0.0243	0.0244	0.0246
C5	0.0244	0.0243	0.0243	0.0244	0.0244
D1	0.0243	0.0246	0.0245	0.0246	0.0244
D2	0.0243	0.0244	0.0244	0.0242	0.0243
D3	0.0243	0.0243	0.0243	0.0245	0.0244
D4	0.0243	0.0244	0.0246	0.0246	0.0245
D5	0.0243	0.0242	0.0244	0.0242	0.0242
E1	0.0242	0.0240	0.0243	0.0244	0.0243
E2	0.0242	0.0241	0.0243	0.0241	0.0243
E3	0.0242	0.0242	0.0244	0.0243	0.0242
E4	0.0242	0.0245	0.0245	0.0244	0.0246
E5	0.0243	0.0244	0.0243	0.0243	0.0245
F1	0.0240	0.0242	0.0242	0.0244	0.0242
F2	0.0243	0.0244	0.0245	0.0244	0.0244
F3	0.0243	0.0244	0.0244	0.0243	0.0244
F4	0.0243	0.0243	0.0244	0.0244	0.0244
F5	0.0244	0.0241	0.0244	0.0243	0.0243

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	8.94E-07	29	3.0825E-08	3.012243	1.35247E-05	1.562071
Within groups	1.23E-06	120	1.0233E-08			
Total	2.12E-06	149				
within-sd	0.000101					
effective n	4.00					
s_{bb}	7.17E-05					
u^*_{bb}	1.82E-05					
u_{bb}	7.17E-05					
u_{bb}(rel.)	0.294772					

Zinc (mass fraction in %):

	1	2	3	4	5
A1	0.0603	0.0612	0.0612	0.0618	0.0616
A2	0.0612	0.0608	0.0612	0.0614	0.0615
A3	0.0612	0.0615	0.0610	0.0610	0.0619
A4	0.0608	0.0609	0.0606	0.0606	0.0608
A5	0.0604	0.0600	0.0602	0.0614	0.0614
B1	0.0597	0.0602	0.0608	0.0607	0.0609
B2	0.0601	0.0603	0.0604	0.0603	0.0601
B3	0.0606	0.0618	0.0618	0.0617	0.0615
B4	0.0609	0.0602	0.0605	0.0611	0.0609
B5	0.0602	0.0606	0.0612	0.0611	0.0614
C1	0.0604	0.0612	0.0602	0.0604	0.0609
C2	0.0612	0.0610	0.0615	0.0609	0.0612
C3	0.0608	0.0611	0.0609	0.0612	0.0615
C4	0.0599	0.0615	0.0607	0.0609	0.0617
C5	0.0603	0.0611	0.0607	0.0607	0.0615
D1	0.0610	0.0611	0.0609	0.0606	0.0624
D2	0.0612	0.0616	0.0617	0.0645	0.0622
D3	0.0604	0.0608	0.0609	0.0606	0.0609
D4	0.0608	0.0609	0.0616	0.0612	0.0611
D5	0.0605	0.0603	0.0609	0.0608	0.0613
E1	0.0602	0.0608	0.0603	0.0602	0.0610
E2	0.0609	0.0607	0.0608	0.0612	0.0612
E3	0.0609	0.0606	0.0607	0.0607	0.0612
E4	0.0609	0.0614	0.0613	0.0613	0.0622
E5	0.0613	0.0613	0.0619	0.0619	0.0624
F1	0.0598	0.0606	0.0600	0.0608	0.0613
F2	0.0606	0.0609	0.0614	0.0608	0.0611
F3	0.0609	0.0610	0.0609	0.0608	0.0611
F4	0.0606	0.0611	0.0609	0.0608	0.0611
F5	0.0603	0.0609	0.0606	0.0608	0.0611

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.42E-05	29	8.3411E-07	3.709376	2.2411E-07	1.562071
Within groups	2.7E-05	120	2.2487E-07			
Total	5.12E-05	149				
within-sd	0.000474					
effective n	4.00					
s_{bb}	0.00039					
u^*_{bb}	8.52E-05					
u_{bb}	0.00039					
u_{bb}(rel.)	0.64007					

Titanium (mass fraction in %):

	1	2	3	4	5
A1	0.0802	0.0809	0.0797	0.0804	0.0803
A2	0.0808	0.0802	0.0807	0.0798	0.0804
A3	0.0810	0.0808	0.0805	0.0813	0.0807
A4	0.0800	0.0800	0.0804	0.0800	0.0806
A5	0.0806	0.0802	0.0810	0.0808	0.0804
B1	0.0801	0.0811	0.0802	0.0817	0.0807
B2	0.0796	0.0795	0.0807	0.0804	0.0805
B3	0.0801	0.0801	0.0803	0.0804	0.0807
B4	0.0797	0.0796	0.0799	0.0795	0.0800
B5	0.0802	0.0805	0.0807	0.0802	0.0810
C1	0.0810	0.0798	0.0799	0.0800	0.0799
C2	0.0800	0.0811	0.0810	0.0807	0.0823
C3	0.0798	0.0804	0.0807	0.0806	0.0807
C4	0.0805	0.0809	0.0806	0.0807	0.0805
C5	0.0799	0.0797	0.0805	0.0803	0.0810
D1	0.0801	0.0804	0.0801	0.0804	0.0802
D2	0.0807	0.0809	0.0810	0.0821	0.0812
D3	0.0795	0.0796	0.0796	0.0795	0.0799
D4	0.0799	0.0800	0.0797	0.0814	0.0802
D5	0.0805	0.0799	0.0807	0.0803	0.0802
E1	0.0805	0.0807	0.0803	0.0804	0.0812
E2	0.0806	0.0803	0.0809	0.0803	0.0809
E3	0.0805	0.0800	0.0803	0.0805	0.0805
E4	0.0800	0.0808	0.0805	0.0805	0.0809
E5	0.0806	0.0808	0.0810	0.0808	0.0809
F1	0.0806	0.0806	0.0801	0.0801	0.0809
F2	0.0802	0.0802	0.0802	0.0803	0.0805
F3	0.0800	0.0809	0.0805	0.0809	0.0809
F4	0.0800	0.0800	0.0808	0.0808	0.0803
F5	0.0815	0.0806	0.0803	0.0800	0.0816

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.61E-05	29	5.5538E-07	3.181461	4.96414E-06	1.562071
Within groups	2.09E-05	120	1.7457E-07			
Total	3.71E-05	149				
within-sd	0.000418					
effective n	4.00					
s_{bb}	0.000309					
u^*_{bb}	7.51E-05					
u_{bb}	0.000309					
u_{bb}(rel.)	0.383542					

Silver (mass fraction in %):

	1	2	3	4	5
A1	0.0175	0.0175	0.0175	0.0175	0.0176
A2	0.0175	0.0175	0.0176	0.0175	0.0177
A3	0.0175	0.0176	0.0175	0.0176	0.0177
A4	0.0173	0.0173	0.0174	0.0174	0.0175
A5	0.0174	0.0174	0.0175	0.0176	0.0176
B1	0.0174	0.0174	0.0173	0.0174	0.0175
B2	0.0174	0.0174	0.0174	0.0174	0.0174
B3	0.0176	0.0176	0.0176	0.0175	0.0176
B4	0.0175	0.0174	0.0174	0.0175	0.0176
B5	0.0175	0.0175	0.0175	0.0175	0.0176
C1	0.0173	0.0173	0.0174	0.0173	0.0174
C2	0.0176	0.0175	0.0176	0.0175	0.0176
C3	0.0175	0.0175	0.0176	0.0175	0.0175
C4	0.0174	0.0175	0.0174	0.0175	0.0176
C5	0.0174	0.0174	0.0175	0.0176	0.0176
D1	0.0176	0.0176	0.0175	0.0175	0.0176
D2	0.0175	0.0177	0.0176	0.0179	0.0178
D3	0.0174	0.0175	0.0174	0.0174	0.0175
D4	0.0175	0.0175	0.0175	0.0176	0.0175
D5	0.0174	0.0174	0.0174	0.0174	0.0174
E1	0.0174	0.0175	0.0174	0.0175	0.0176
E2	0.0175	0.0174	0.0175	0.0176	0.0175
E3	0.0175	0.0174	0.0174	0.0174	0.0175
E4	0.0175	0.0176	0.0176	0.0177	0.0177
E5	0.0176	0.0176	0.0176	0.0176	0.0177
F1	0.0174	0.0174	0.0173	0.0174	0.0174
F2	0.0175	0.0176	0.0176	0.0175	0.0175
F3	0.0175	0.0176	0.0176	0.0175	0.0175
F4	0.0174	0.0174	0.0175	0.0175	0.0175
F5	0.0175	0.0175	0.0175	0.0175	0.0177

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	9.65E-07	29	3.329E-08	6.613839	4.30194E-14	1.562071
Within groups	6.04E-07	120	5.0333E-09			
Total	1.57E-06	149				
within-sd	7.09E-05					
effective n	4.00					
s_{bb}	8.4E-05					
u^*_{bb}	1.27E-05					
u_{bb}	8.4E-05					
u_{bb}(rel.)	0.48022					

Boron (mass fraction in mg/kg):

	1	2	3	4	5
A1	9.14	12.76	9.45	9.32	9.59
A2	9.71	9.63	10.80	8.50	8.67
A3	8.67	8.99	9.08	10.21	7.46
A4	7.85	9.23	8.65	7.66	8.83
A5	8.45	9.45	11.87	9.88	8.76
B1	9.27	12.93	8.73	12.12	9.16
B2	8.06	9.25	13.02	10.44	8.57
B3	7.92	7.64	8.18	8.54	7.50
B4	8.82	7.95	9.09	9.05	8.53
B5	9.02	9.84	9.69	8.69	8.65
C1	12.65	9.04	9.99	9.82	10.51
C2	8.56	13.08	9.40	9.74	14.72
C3	8.56	8.41	8.53	9.23	9.62
C4	8.80	8.34	8.30	8.48	8.59
C5	8.58	9.19	8.42	9.34	8.12
D1	7.55	8.64	8.33	9.01	7.98
D2	11.08	9.13	8.23	11.04	8.37
D3	7.31	8.64	8.38	9.17	8.46
D4	8.41	8.25	9.18	12.11	9.02
D5	7.92	8.71	10.83	9.35	10.45
E1	9.52	9.60	9.80	10.91	10.07
E2	10.15	7.88	9.60	9.25	9.70
E3	8.29	8.02	8.31	10.27	8.47
E4	8.36	9.19	7.23	8.17	8.55
E5	9.01	8.30	9.08	7.71	7.96
F1	11.81	10.53	9.98	9.38	9.02
F2	8.92	8.88	9.58	8.53	8.85
F3	9.25	9.40	8.77	11.30	7.97
F4	9.23	8.28	9.87	9.64	8.19
F5	13.39	10.26	8.72	8.25	13.41

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	93.97052	29	3.24036287	2.245336	0.001235065	1.562071
Within groups	173.1784	120	1.443153			
Total	267.1489	149				
within-sd	1.201313					
effective n	4.00					
s_{bb}	0.6703					
u^*_{bb}	0.215818					
u_{bb}	0.6703					
u_{bb}(rel.)	7.22488					

Beryllium (mass fraction in mg/kg):

	1	2	3	4	5
A1	5.20	5.20	5.25	5.20	5.18
A2	5.20	5.24	5.21	5.19	5.22
A3	5.20	5.26	5.18	5.21	5.26
A4	5.22	5.24	5.20	5.18	5.27
A5	5.19	5.23	5.19	5.28	5.20
B1	5.21	5.19	5.19	5.19	5.15
B2	5.20	5.23	5.22	5.20	5.16
B3	5.22	5.23	5.22	5.20	5.22
B4	5.18	5.18	5.19	5.21	5.20
B5	5.20	5.19	5.22	5.21	5.19
C1	5.20	5.22	5.17	5.09	5.22
C2	5.24	5.23	5.22	5.22	5.26
C3	5.26	5.20	5.24	5.20	5.23
C4	5.19	5.17	5.20	5.20	5.22
C5	5.23	5.20	5.22	5.22	5.20
D1	5.21	5.21	5.17	5.18	5.22
D2	5.18	5.26	5.22	5.23	5.21
D3	5.23	5.23	5.22	5.21	5.23
D4	5.20	5.18	5.23	5.21	5.18
D5	5.22	5.17	5.21	5.19	5.20
E1	5.19	5.19	5.22	5.16	5.23
E2	5.25	5.21	5.22	5.22	5.21
E3	5.25	5.19	5.22	5.21	5.19
E4	5.19	5.24	5.24	5.19	5.21
E5	5.22	5.22	5.21	5.21	5.23
F1	5.19	5.21	5.16	5.21	5.15
F2	5.19	5.23	5.23	5.25	5.22
F3	5.20	5.24	5.22	5.18	5.19
F4	5.28	5.21	5.21	5.22	5.19
F5	5.20	5.27	5.21	5.21	5.24

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.028757	29	0.00099163	1.520908	0.061021364	1.562071
Within groups	0.07824	120	0.000652			
Total	0.106997	149				
within-sd	0.025534					
effective n	4.00					
s_{bb}	0.009215					
u^*_{bb}	0.004587					
u_{bb}	0.009215					
u_{bb}(rel.)	0.176867					

Bismuth (mass fraction in %):

	1	2	3	4	5
A1	0.0138	0.0139	0.0140	0.0140	0.0138
A2	0.0143	0.0142	0.0140	0.0140	0.0142
A3	0.0140	0.0141	0.0138	0.0142	0.0143
A4	0.0142	0.0140	0.0141	0.0141	0.0140
A5	0.0139	0.0140	0.0139	0.0139	0.0140
B1	0.0138	0.0138	0.0140	0.0138	0.0140
B2	0.0140	0.0140	0.0142	0.0141	0.0138
B3	0.0139	0.0140	0.0140	0.0139	0.0140
B4	0.0141	0.0141	0.0143	0.0142	0.0139
B5	0.0138	0.0138	0.0137	0.0139	0.0142
C1	0.0141	0.0139	0.0137	0.0137	0.0140
C2	0.0143	0.0141	0.0138	0.0139	0.0137
C3	0.0141	0.0138	0.0139	0.0140	0.0142
C4	0.0143	0.0138	0.0141	0.0140	0.0143
C5	0.0141	0.0143	0.0139	0.0139	0.0140
D1	0.0138	0.0140	0.0141	0.0140	0.0139
D2	0.0137	0.0139	0.0141	0.0141	0.0138
D3	0.0139	0.0140	0.0141	0.0142	0.0142
D4	0.0139	0.0138	0.0143	0.0143	0.0143
D5	0.0139	0.0140	0.0142	0.0139	0.0141
E1	0.0140	0.0133	0.0138	0.0139	0.0141
E2	0.0138	0.0137	0.0141	0.0137	0.0141
E3	0.0140	0.0138	0.0142	0.0140	0.0139
E4	0.0139	0.0143	0.0140	0.0140	0.0143
E5	0.0140	0.0141	0.0140	0.0137	0.0140
F1	0.0139	0.0139	0.0139	0.0141	0.0138
F2	0.0139	0.0143	0.0143	0.0141	0.0140
F3	0.0140	0.0140	0.0139	0.0139	0.0139
F4	0.0141	0.0141	0.0139	0.0141	0.0140
F5	0.0143	0.0137	0.0140	0.0141	0.0139

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.16E-06	29	3.9991E-08	1.455976	0.082851775	1.562071
Within groups	3.3E-06	120	2.7467E-08			
Total	4.46E-06	149				
within-sd	0.000166					
effective n	4.00					
s_{bb}	5.6E-05					
u^*_{bb}	2.98E-05					
u_{bb}	5.6E-05					
u_{bb}(rel.)	0.399836					

Calcium (mass fraction in mg/kg):

	1	2	3	4	5
A1	17.01	17.04	17.08	16.84	16.94
A2	16.90	16.89	16.96	16.93	17.13
A3	17.00	16.88	17.01	17.01	17.08
A4	16.92	17.03	17.04	17.01	17.02
A5	16.99	16.93	17.15	17.18	17.06
B1	17.11	17.05	17.06	17.06	17.00
B2	16.84	17.01	16.87	16.99	17.13
B3	16.92	17.04	16.86	16.96	16.96
B4	16.94	16.97	17.06	17.04	17.17
B5	16.93	17.10	17.13	17.01	17.02
C1	17.00	16.98	17.06	17.15	17.04
C2	16.82	16.94	16.99	17.00	17.24
C3	16.99	16.96	17.02	17.00	17.07
C4	16.98	17.13	16.94	17.16	17.06
C5	17.03	16.94	17.14	17.25	17.26
D1	16.91	16.89	16.86	16.89	16.91
D2	17.15	16.97	16.97	17.02	17.16
D3	16.83	17.02	17.03	17.00	17.08
D4	16.84	16.86	16.75	17.11	17.11
D5	17.22	17.00	17.07	17.17	17.17
E1	17.02	17.03	16.98	16.80	17.17
E2	16.97	16.95	17.04	17.08	17.10
E3	17.08	16.97	17.01	16.95	17.02
E4	16.77	17.03	16.89	16.93	17.05
E5	17.03	16.95	17.01	16.92	17.17
F1	16.90	17.08	16.91	16.99	17.04
F2	16.80	16.97	16.93	16.76	17.02
F3	16.83	16.97	17.01	16.94	17.08
F4	16.94	17.13	17.09	17.09	17.06
F5	17.13	17.51	16.99	16.94	17.29

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.588717	29	0.0203006	1.927638	0.007413552	1.562071
Within groups	1.26376	120	0.01053133			
Total	1.852477	149				
within-sd	0.102622					
effective n	4.00					
s_{bb}	0.04942					
u^*_{bb}	0.018436					
u_{bb}	0.04942					
u_{bb}(rel.)	0.290509					

Cadmium (mass fraction in mg/kg):

	1	2	3	4	5
A1	20.19	19.95	20.28	19.95	19.67
A2	20.12	20.23	20.05	20.06	19.99
A3	20.22	20.60	20.07	19.76	20.00
A4	20.41	20.16	20.29	20.10	20.22
A5	20.30	20.26	19.90	20.21	20.01
B1	20.37	19.87	20.07	19.94	19.59
B2	20.19	20.19	20.18	20.14	19.89
B3	20.06	20.10	20.01	20.03	20.02
B4	20.10	20.17	20.09	20.29	20.03
B5	20.28	20.05	20.23	20.02	20.09
C1	20.26	20.24	20.13	19.86	20.19
C2	20.45	20.04	20.15	20.20	20.18
C3	20.25	20.26	20.19	20.25	19.99
C4	20.23	19.92	20.03	20.17	19.83
C5	20.41	20.05	20.18	20.24	19.90
D1	20.20	19.98	19.92	19.99	19.70
D2	20.09	20.35	20.08	19.76	20.04
D3	20.43	20.53	20.32	20.23	19.93
D4	20.33	20.03	20.16	20.01	19.88
D5	20.35	20.05	20.26	20.08	19.90
E1	20.23	20.17	20.16	19.84	20.05
E2	20.19	20.07	20.29	20.34	20.03
E3	20.16	20.07	20.13	20.11	20.07
E4	20.08	20.14	20.25	20.09	19.88
E5	20.19	20.02	19.78	19.91	19.86
F1	20.21	20.16	19.78	20.00	19.94
F2	20.28	20.19	20.22	20.24	19.92
F3	20.04	20.19	20.05	19.83	19.73
F4	20.48	19.96	20.06	20.22	20.03
F5	20.01	20.11	19.94	20.03	20.04

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.019414	29	0.03515221	1.2211	0.225675242	1.562071
Within groups	3.45448	120	0.02878733			
Total	4.473894	149				
within-sd	0.169668					
effective n	4.00					
s_{bb}	0.03989					
u^*_{bb}	0.030481					
u_{bb}	0.03989					
u_{bb}(rel.)	0.19846					

Gallium (mass fraction in mg/kg):

	1	2	3	4	5
A1	96.92	97.20	98.60	97.31	97.64
A2	97.19	96.59	97.11	98.18	98.13
A3	97.90	98.17	96.92	97.17	98.06
A4	97.47	97.21	99.49	98.00	98.02
A5	96.74	96.76	96.95	98.05	97.21
B1	97.34	97.24	97.93	98.16	96.54
B2	97.37	97.94	98.22	98.24	97.66
B3	97.37	97.75	97.36	96.61	97.74
B4	98.19	98.04	98.18	98.18	98.30
B5	97.45	97.38	99.27	97.91	97.32
C1	97.46	98.24	97.95	97.48	98.29
C2	96.88	97.27	96.99	97.97	98.03
C3	98.04	97.57	97.73	97.77	97.37
C4	97.81	97.39	96.39	97.30	97.82
C5	98.20	97.73	97.69	98.35	98.40
D1	97.54	97.44	97.00	97.17	98.03
D2	97.61	98.88	98.58	97.60	98.00
D3	97.56	98.50	98.07	98.06	99.88
D4	97.26	97.21	96.24	97.74	98.05
D5	98.72	97.73	97.31	98.61	98.04
E1	97.95	97.73	98.14	97.41	98.38
E2	98.17	98.16	98.40	97.49	98.08
E3	99.07	97.17	97.44	97.81	98.14
E4	96.69	97.53	96.98	97.11	97.30
E5	97.64	97.00	97.83	96.60	98.32
F1	97.74	97.85	96.77	97.40	97.82
F2	97.05	97.19	96.79	97.31	98.06
F3	97.13	97.37	97.50	96.97	98.06
F4	98.07	97.95	97.62	97.93	97.31
F5	97.72	97.48	96.92	97.55	97.31

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	17.14814	29	0.59131503	1.980738	0.005530045	1.562071
Within groups	35.82392	120	0.29853267			
Total	52.97206	149				
within-sd	0.546381					
effective n	4.00					
s_{bb}	0.270547					
u^*_{bb}	0.098159					
u_{bb}	0.270547					
u_{bb}(rel.)	0.276991					

Mercury (mass fraction in mg/kg):

	1	2	3	4	5
A1	37.48	37.58	38.44	37.34	37.81
A2	37.48	37.65	37.37	36.90	37.64
A3	37.34	38.24	37.40	36.94	38.05
A4	38.34	38.08	37.71	37.97	38.82
A5	37.54	38.05	37.62	38.54	37.80
B1	37.11	37.41	37.81	37.43	37.40
B2	37.59	38.18	38.47	37.76	37.26
B3	37.19	38.79	37.90	37.99	38.63
B4	37.48	37.59	38.03	38.36	37.42
B5	37.55	37.34	37.59	37.75	38.04
C1	38.73	38.27	36.85	36.90	38.72
C2	38.06	37.65	38.20	37.70	38.06
C3	37.32	37.74	37.79	37.55	37.44
C4	37.56	37.65	36.89	38.09	37.92
C5	37.54	36.63	37.63	38.18	37.85
D1	37.32	37.71	36.71	37.61	38.68
D2	37.21	38.71	38.23	38.20	38.30
D3	38.16	37.43	37.28	37.96	38.54
D4	37.03	37.39	36.72	37.70	37.22
D5	37.53	36.66	37.67	37.81	37.49
E1	37.07	38.29	37.95	37.15	38.09
E2	39.06	37.90	38.16	38.40	37.90
E3	38.45	38.34	37.33	38.08	37.22
E4	37.20	38.47	37.15	37.08	37.60
E5	37.44	38.70	37.90	37.50	38.22
F1	36.80	38.51	37.74	38.12	37.41
F2	37.25	38.21	37.74	38.20	38.42
F3	37.22	37.57	38.08	37.28	38.07
F4	38.75	37.67	37.70	37.14	37.86
F5	36.90	38.10	37.50	37.77	37.66

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	9.035646	29	0.311574	1.21978	0.226827018	1.562071
Within groups	30.65216	120	0.25543467			
Total	39.68781	149				
within-sd	0.505405					
effective n	4.00					
s_{bb}	0.118469					
u^*_{bb}	0.090797					
u_{bb}	0.118469					
u_{bb}(rel.)	0.313813					

Lead (mass fraction in %):

	1	2	3	4	5
A1	0.0090	0.0090	0.0090	0.0090	0.0090
A2	0.0091	0.0090	0.0091	0.0090	0.0090
A3	0.0091	0.0091	0.0090	0.0090	0.0092
A4	0.0088	0.0089	0.0089	0.0088	0.0090
A5	0.0089	0.0091	0.0089	0.0091	0.0091
B1	0.0090	0.0089	0.0090	0.0089	0.0089
B2	0.0089	0.0088	0.0089	0.0089	0.0088
B3	0.0091	0.0091	0.0090	0.0089	0.0091
B4	0.0089	0.0088	0.0090	0.0090	0.0089
B5	0.0089	0.0089	0.0090	0.0089	0.0090
C1	0.0089	0.0089	0.0088	0.0087	0.0090
C2	0.0090	0.0090	0.0091	0.0091	0.0090
C3	0.0090	0.0089	0.0091	0.0089	0.0090
C4	0.0090	0.0089	0.0089	0.0091	0.0092
C5	0.0090	0.0090	0.0090	0.0090	0.0090
D1	0.0090	0.0091	0.0091	0.0090	0.0090
D2	0.0088	0.0091	0.0091	0.0090	0.0089
D3	0.0088	0.0089	0.0089	0.0090	0.0089
D4	0.0090	0.0090	0.0091	0.0091	0.0090
D5	0.0089	0.0087	0.0089	0.0089	0.0088
E1	0.0089	0.0088	0.0089	0.0089	0.0090
E2	0.0089	0.0088	0.0089	0.0088	0.0089
E3	0.0089	0.0089	0.0090	0.0090	0.0089
E4	0.0090	0.0091	0.0091	0.0091	0.0092
E5	0.0091	0.0091	0.0090	0.0091	0.0092
F1	0.0088	0.0088	0.0089	0.0090	0.0089
F2	0.0090	0.0090	0.0092	0.0092	0.0091
F3	0.0089	0.0091	0.0090	0.0089	0.0091
F4	0.0091	0.0089	0.0090	0.0091	0.0089
F5	0.0090	0.0089	0.0090	0.0090	0.0090

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	8.98E-07	29	3.0952E-08	4.912972	2.57937E-10	1.562071
Within groups	7.56E-07	120	6.3E-09			
Total	1.65E-06	149				
within-sd	7.94E-05					
effective n	4.00					
s_{bb}	7.85E-05					
u^*_{bb}	1.43E-05					
u_{bb}	7.85E-05					
u_{bb}(rel.)	0.874603					

Antimony (mass fraction in %):

	1	2	3	4	5
A1	0.0051	0.0052	0.0055	0.0053	0.0054
A2	0.0054	0.0053	0.0050	0.0054	0.0056
A3	0.0051	0.0057	0.0051	0.0052	0.0057
A4	0.0051	0.0053	0.0053	0.0054	0.0054
A5	0.0055	0.0051	0.0056	0.0055	0.0054
B1	0.0052	0.0054	0.0049	0.0051	0.0057
B2	0.0052	0.0055	0.0052	0.0053	0.0056
B3	0.0054	0.0056	0.0055	0.0055	0.0051
B4	0.0053	0.0052	0.0052	0.0052	0.0056
B5	0.0054	0.0056	0.0053	0.0054	0.0055
C1	0.0053	0.0054	0.0053	0.0054	0.0058
C2	0.0056	0.0054	0.0054	0.0050	0.0054
C3	0.0055	0.0059	0.0056	0.0052	0.0052
C4	0.0052	0.0055	0.0054	0.0055	0.0058
C5	0.0054	0.0057	0.0056	0.0060	0.0058
D1	0.0052	0.0052	0.0052	0.0052	0.0055
D2	0.0054	0.0056	0.0051	0.0065	0.0057
D3	0.0053	0.0055	0.0047	0.0053	0.0056
D4	0.0051	0.0052	0.0054	0.0053	0.0053
D5	0.0055	0.0054	0.0058	0.0055	0.0056
E1	0.0052	0.0054	0.0051	0.0055	0.0054
E2	0.0055	0.0050	0.0052	0.0054	0.0054
E3	0.0049	0.0052	0.0048	0.0050	0.0053
E4	0.0050	0.0050	0.0050	0.0053	0.0052
E5	0.0050	0.0053	0.0055	0.0056	0.0059
F1	0.0056	0.0053	0.0057	0.0053	0.0053
F2	0.0051	0.0051	0.0053	0.0051	0.0053
F3	0.0051	0.0052	0.0057	0.0051	0.0059
F4	0.0054	0.0052	0.0059	0.0058	0.0054
F5	0.0054	0.0051	0.0052	0.0054	0.0058

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.98E-06	29	1.0285E-07	1.767232	0.017591934	1.562071
Within groups	6.98E-06	120	5.82E-08			
Total	9.97E-06	149				
within-sd	0.000241					
effective n	4.00					
s_{bb}	0.000106					
u^*_{bb}	4.33E-05					
u_{bb}	0.000106					
u_{bb}(rel.)	1.967037					

Tin (mass fraction in %):

	1	2	3	4	5
A1	0.0106	0.0106	0.0108	0.0105	0.0106
A2	0.0106	0.0106	0.0106	0.0106	0.0107
A3	0.0106	0.0109	0.0105	0.0106	0.0107
A4	0.0108	0.0108	0.0106	0.0107	0.0108
A5	0.0106	0.0107	0.0106	0.0107	0.0106
B1	0.0108	0.0106	0.0106	0.0105	0.0104
B2	0.0106	0.0107	0.0108	0.0107	0.0107
B3	0.0106	0.0108	0.0106	0.0105	0.0106
B4	0.0106	0.0106	0.0107	0.0107	0.0108
B5	0.0106	0.0106	0.0107	0.0106	0.0107
C1	0.0106	0.0107	0.0107	0.0105	0.0108
C2	0.0108	0.0106	0.0107	0.0108	0.0108
C3	0.0107	0.0107	0.0107	0.0106	0.0108
C4	0.0106	0.0106	0.0106	0.0107	0.0106
C5	0.0107	0.0106	0.0107	0.0108	0.0106
D1	0.0106	0.0107	0.0105	0.0106	0.0107
D2	0.0106	0.0109	0.0107	0.0109	0.0107
D3	0.0107	0.0108	0.0106	0.0107	0.0108
D4	0.0107	0.0106	0.0108	0.0107	0.0106
D5	0.0107	0.0106	0.0108	0.0106	0.0107
E1	0.0106	0.0107	0.0106	0.0106	0.0108
E2	0.0107	0.0106	0.0107	0.0106	0.0106
E3	0.0107	0.0106	0.0107	0.0107	0.0107
E4	0.0105	0.0106	0.0107	0.0106	0.0106
E5	0.0106	0.0107	0.0106	0.0107	0.0108
F1	0.0107	0.0106	0.0105	0.0106	0.0105
F2	0.0107	0.0107	0.0106	0.0108	0.0106
F3	0.0105	0.0106	0.0106	0.0105	0.0105
F4	0.0110	0.0107	0.0107	0.0106	0.0107
F5	0.0104	0.0107	0.0106	0.0107	0.0107

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	4.02E-07	29	1.386E-08	1.599204	0.041639707	1.562071
Within groups	1.04E-06	120	8.6667E-09			
Total	1.44E-06	149				
within-sd	9.31E-05					
effective n	4.00					
s_{bb}	3.6E-05					
u^*_{bb}	1.67E-05					
u_{bb}	3.6E-05					
u_{bb}(rel.)	0.338029					

Strontium (mass fraction in mg/kg):

	1	2	3	4	5
A1	294.38	295.81	294.74	293.02	297.69
A2	295.06	295.15	293.81	295.05	298.61
A3	295.91	292.67	296.34	297.88	299.28
A4	295.57	294.38	298.23	297.75	297.67
A5	296.73	293.11	295.97	298.48	297.31
B1	296.53	291.11	293.72	295.99	294.50
B2	298.79	295.87	296.70	296.98	298.88
B3	294.76	294.58	293.30	297.15	295.70
B4	296.83	298.62	299.60	295.56	297.25
B5	292.88	295.30	296.80	296.02	298.25
C1	296.34	297.54	295.87	300.82	297.87
C2	296.32	296.20	297.55	295.63	299.07
C3	295.00	296.28	295.73	298.96	297.38
C4	293.61	297.22	292.73	297.48	297.25
C5	297.26	294.96	297.75	295.40	294.71
D1	295.02	294.46	294.23	296.60	293.04
D2	296.03	297.30	297.13	295.22	298.32
D3	295.69	294.87	298.60	300.12	298.90
D4	292.24	294.86	291.77	295.14	295.24
D5	299.69	296.29	300.19	299.08	299.81
E1	290.72	291.82	291.23	288.10	295.77
E2	295.27	295.37	295.27	294.69	296.95
E3	298.62	296.11	296.91	297.09	297.65
E4	292.21	296.07	296.77	297.45	294.50
E5	295.91	293.15	296.56	296.72	299.61
F1	295.62	295.41	290.77	295.24	299.31
F2	291.94	293.55	293.07	291.78	297.55
F3	292.43	296.36	296.79	295.48	296.21
F4	295.78	297.32	299.35	292.91	294.90
F5	293.51	297.10	295.47	293.74	295.94

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	312.1307	29	10.7631271	2.995523	1.49344E-05	1.562071
Within groups	431.1686	120	3.59307133			
Total	743.2992	149				
within-sd	1.89554					
effective n	4.00					
s_{bb}	1.338848					
u^*_{bb}	0.340538					
u_{bb}	1.338848					
u_{bb}(rel.)	0.452465					

Vanadium (mass fraction in mg/kg):

	1	2	3	4	5
A1	100.59	102.68	102.11	101.59	102.84
A2	100.92	101.07	100.75	100.23	100.98
A3	100.91	100.70	101.24	101.27	101.87
A4	100.17	100.43	100.66	100.72	102.12
A5	101.72	100.71	101.77	101.32	100.34
B1	100.47	102.27	101.42	101.43	101.71
B2	99.56	99.96	102.19	100.33	100.15
B3	100.87	101.88	101.58	101.28	100.54
B4	99.33	99.32	99.69	99.61	99.74
B5	100.48	100.49	101.59	100.92	101.56
C1	101.53	100.55	99.32	99.56	99.91
C2	99.42	101.61	101.37	101.17	101.62
C3	101.90	100.40	101.01	100.86	104.65
C4	100.90	101.18	100.16	100.34	101.59
C5	99.95	99.00	101.62	100.90	101.28
D1	100.86	101.63	100.85	101.30	102.09
D2	101.89	101.82	101.25	104.36	102.08
D3	99.39	99.70	99.57	99.79	100.25
D4	100.17	100.71	98.87	101.08	100.47
D5	100.25	100.37	100.72	100.83	101.67
E1	100.82	101.39	100.84	100.26	101.82
E2	101.81	100.66	100.69	100.06	102.26
E3	100.46	100.29	100.14	100.57	100.56
E4	100.77	101.22	101.28	101.23	101.86
E5	100.34	101.21	100.82	101.05	101.61
F1	100.85	100.52	100.88	100.66	100.92
F2	99.83	101.61	100.53	100.49	102.43
F3	101.00	100.60	101.06	101.77	101.05
F4	100.48	100.02	101.50	100.70	100.80
F5	100.60	101.52	100.30	101.52	100.79

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	48.23588	29	1.66330621	3.015242	1.32863E-05	1.562071
Within groups	66.19592	120	0.55163267			
Total	114.4318	149				
within-sd	0.74272					
effective n	4.00					
s_{bb}	0.52718					
u^*_{bb}	0.133431					
u_{bb}	0.52718					
u_{bb}(rel.)	0.522363					

Zirconium (mass fraction in mg/kg):

	1	2	3	4	5
A1	29.69	30.12	30.06	30.23	30.15
A2	30.05	30.26	30.09	29.94	30.23
A3	29.99	30.05	29.94	30.20	30.14
A4	30.17	30.05	29.95	29.97	30.31
A5	29.91	30.23	30.08	29.77	30.26
B1	30.10	30.07	30.33	30.08	30.24
B2	30.19	29.96	30.08	30.11	29.88
B3	30.39	30.15	30.11	29.99	30.13
B4	30.35	30.26	30.52	30.09	30.24
B5	30.15	30.10	30.27	30.22	29.90
C1	30.27	29.91	29.92	30.26	30.40
C2	30.13	30.33	29.85	30.23	29.88
C3	30.36	29.96	30.13	30.18	30.07
C4	30.49	30.00	30.05	30.03	30.26
C5	30.14	30.03	29.80	30.20	30.33
D1	30.14	30.42	30.22	30.43	30.02
D2	29.72	30.02	30.18	29.94	30.09
D3	29.82	29.73	30.18	30.24	30.16
D4	30.16	29.90	30.42	30.63	30.15
D5	29.84	30.09	30.08	30.01	29.95
E1	29.90	29.86	30.11	30.52	30.13
E2	29.74	29.64	30.11	29.89	30.28
E3	30.11	29.90	30.32	30.78	29.85
E4	29.86	29.98	30.17	30.01	30.45
E5	30.11	29.94	30.23	30.34	30.15
F1	29.90	29.79	29.86	30.19	30.19
F2	30.19	30.17	30.31	30.11	30.12
F3	29.91	30.01	30.17	30.06	29.94
F4	30.31	29.86	30.06	30.41	30.15
F5	30.38	29.84	30.30	29.86	29.72

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.057206	29	0.03645538	0.92395	0.582094325	1.562071
Within groups	4.73472	120	0.039456			
Total	5.791926	149				
within-sd	0.198635					
effective n	4.00					
s_{bb}	0					
u^*_{bb}	0.035685					
u_{bb}	0.035685					
u_{bb}(rel.)	0.118538					

Annex 2: Calculation of uncertainty contribution of potential inhomogeneity (area)
(u_{bb}(rel.) here means u_{bb} (rel) Area in Table 43)
The number of degrees of freedom (effective n) is calculated using the following equation

$$n = \frac{\sum_{i=1}^{N} g_i - \left(\sum_{i=1}^{N} g_i^2 \Big/ \sum_{i=1}^{N} g_i\right)}{N-1}$$

with
g_i = number of sparks per circle
i = index of circles
N = number of circles (= 4: Centre, Inner, Middle, Outer)

Silicon (mass fraction in %):

Centre	12.1920	12.4246														
Inner	12.4003	12.4105	12.4237	12.3854	12.3374	12.3376										
Middle	12.4145	12.4494	12.4119	12.4572	12.3827	12.4187	12.4775	12.3761								
Outer	12.3176	12.2709	12.3153	12.3693	12.3841	12.3774	12.3835	12.3491	12.3734	12.4213	12.4199	12.3791	12.3803	12.4182	12.3694	12.3674

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.027528356	3	0.009176119	3.845561584	0.020107118	2.946685266
Within groups	0.066812433	28	0.002386158			
Total	0.094340789	31				

within-sd	0.048848
effective n	6.92
s_bb	0.031332
s_bb_min	0.009602
u_bb	0.031332
u_bb(rel.)	0.252962

Iron (mass fraction in %):

Centre	0.7629	0.7883														
Inner	0.7667	0.7638	0.7677	0.7734	0.7617	0.7657										
Middle	0.7623	0.7725	0.7560	0.7660	0.7719	0.7703	0.7621									
Outer	0.7471	0.7620	0.7639	0.7544	0.7620	0.7671	0.7570	0.7691	0.7541	0.7666	0.7656	0.7591	0.7558	0.7592	0.7716	0.7646

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000455213	3	0.000151738	3.267713098	0.036539711	2.960351318
Within groups	0.001253756	27	4.64354E-05			
Total	0.001708969	30				

within-sd	0.006814
effective n	6.62
s_bb	0.003987
s_bb_min	0.001381
u_bb	0.003987
u_bb(rel.)	0.522281

Copper (mass fraction in %):

Centre	0.0296	0.0306														
Inner	0.0299	0.0297	0.0298	0.0301	0.0296	0.0300										
Middle	0.0299	0.0299	0.0296	0.0302	0.0302	0.0301	0.0298									
Outer	0.0296	0.0299	0.0301	0.0299	0.0300	0.0305	0.0310	0.0310	0.0296	0.0303	0.0301	0.0299	0.0299	0.0300	0.0303	0.0302

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	4.43966E-07	3	1.47989E-07	1.135425063	0.352424562	2.960351318
Within groups	3.51912E-06	27	1.30338E-07			
Total	3.96308E-06	30				

within-sd	0.000361
effective n	6.62
s_bb	0.000052
s_bb_min	0.000073
u_bb	0.000073
u_bb(rel.)	0.243631

Manganese (mass fraction in %):

Centre	0.0087	0.0093														
Inner	0.0089	0.0090	0.0090	0.0090	0.0088	0.0090										
Middle	0.0089	0.0092	0.0089	0.0088	0.0089	0.0089	0.0090	0.0090	0.0089	0.0089	0.0089	0.0089				
Outer	0.0089	0.0089	0.0089	0.0091	0.0089	0.0090	0.0090	0.0088	0.0087	0.0088	0.0088	0.0088	0.0089	0.0088	0.0090	0.0087

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	5.13889E-08	3	1.71296E-08	1.075744861	0.373236945	2.901119584
Within groups	5.09552E-07	32	1.59235E-08			
Total	5.60941E-07	35				

within-sd	0.000126
effective n	7.93
s_{bb}	0.000012
u^*_{bb}	0.000022
u_{bb}	0.000022
u_{bb}(rel.)	0.251561

Magnesium (mass fraction in %):

Centre	0.0353	0.0377														
Inner	0.0365	0.0364	0.0364	0.0371	0.0366	0.0368										
Middle	0.0362	0.0363	0.0368	0.0370	0.0370	0.0369	0.0359	0.0364								
Outer	0.0362	0.0376	0.0368	0.0367	0.0360	0.0359	0.0369	0.0364	0.0359	0.0362	0.0364	0.0366	0.0368	0.0362	0.0362	0.0361

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.12292E-07	3	7.07639E-08	0.267003982	0.848598088	2.946685266
Within groups	7.42082E-06	28	2.65029E-07			
Total	7.63311E-06	31				

within-sd	0.000515
effective n	6.92
s_bb	0.000000
s_bb_min	0.000101
u_bb	0.000101
u_bb(rel.)	0.277201

Chromium (mass fraction in mg/kg):

Centre	39.2799	45.3001														
Inner	42.3500	42.1800	40.2900	44.0300	43.1700	43.4900										
Middle	42.2100	42.6000	43.5500	43.7600	42.8700	42.4900	42.3200	42.6700								
Outer	43.2800	42.4200	44.6200	43.6300	41.8500	42.4100	43.5100	43.5600	42.9500	44.6500	43.8400	42.5800	43.0200	42.5100	43.0700	42.3200

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.318175	3	0.772725	0.558160294	0.647029382	2.946685266
Within groups	38.76359575	28	1.384414134			
Total	41.08177075	31				

within-sd	1.176611
effective n	6.92
s_bb	0.000000
s_bb_min	0.231288
u_bb	0.231288
u_bb(rel.)	0.538630

Nickel (mass fraction in %):

Centre	0.0202	0.0210														
Inner	0.0204	0.0204	0.0200	0.0202	0.0204	0.0205										
Middle	0.0204	0.0200	0.0203	0.0202	0.0204	0.0204	0.0201	0.0200								
Outer	0.0205	0.0203	0.0199	0.0199	0.0200	0.0200	0.0200	0.0198	0.0198	0.0199	0.0197	0.0198	0.0204	0.0201	0.0199	0.0199

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.00729E-06	3	3.35764E-07	6.577471712	0.001664112	2.946685266
Within groups	1.42933E-06	28	5.10476E-08			
Total	2.43662E-06	31				

within-sd	0.000226
effective n	6.92
s_bb	0.000203
s_bb_min	0.000044
u_bb	0.000203
u_bb(rel.)	1.008393

Zinc (mass fraction in %):

Centre	0.0499	0.0533														
Inner	0.0509	0.0515	0.0524	0.0526	0.0512	0.0510										
Middle	0.0524	0.0507	0.0518	0.0528	0.0533	0.0526	0.0521									
Outer	0.0526	0.0521	0.0523	0.0526	0.0524	0.0518	0.0520	0.0506	0.0520	0.0522	0.0520	0.0527	0.0529	0.0515	0.0512	0.0525

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.81503E-06	3	6.05012E-07	0.911165009	0.448634408	2.960351318
Within groups	1.79279E-05	27	6.63998E-07			
Total	1.9743E-05	30				

within-sd	0.000815
effective n	6.62
s_bb	0.000000
s_bb_min	0.000165
u_bb	0.000165
u_bb(rel.)	0.317502

Titanium (mass fraction in %):

Centre	0.0348	0.0356														
Inner	0.0353	0.0352	0.0351	0.0351	0.0354	0.0350										
Middle	0.0352	0.0352	0.0354	0.0351	0.0353	0.0353	0.0353	0.0353								
Outer	0.0356	0.0358	0.0355	0.0354	0.0356	0.0355	0.0354	0.0354	0.0353	0.0354	0.0352	0.0354	0.0352	0.0350	0.0351	0.0353

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.18229E-07	3	7.27431E-08	1.92809681	0.147940603	2.946685266
Within groups	1.05638E-06	28	3.77279E-08			
Total	1.27461E-06	31				

within-sd	0.000194
effective n	6.92
s_bb	0.000071
s_bb_min	0.000038
u_bb	0.000071
u_bb(rel.)	0.201503

Silver (mass fraction in mg/kg):

Centre	242.4055	247.9945														
Inner	245.2000	245.2000	243.4000	247.4000	246.6000	247.5000										
Middle	248.7000	247.0000	248.1000	247.4000	251.2000	248.3000	248.2000	247.1000								
Outer	249.6000	249.6000	247.1000	248.4000	246.3000	249.6000	248.1000	245.7000	249.6000	246.3000	248.4000	249.2000	248.9000	248.8000	251.2000	251.2000
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	48.07135417	3	16.02378472	5.590404351	0.003911672	2.946685266										
Within groups	80.25644372	28	2.866301562													
Total	128.3277979	31														
within-sd	1.693016															
effective n	6.92															
s_bb	1.379234															
s_bb_min	0.332798															
u_bb	1.379234															
u_bb(rel.)	0.556195															

Beryllium (mass fraction in mg/kg):

Centre	5.5442	14.0558														
Inner	9.7400	13.3900	9.6300	13.5300	13.6800	13.7000										
Middle	9.5500	13.6300	9.4900	13.5900	9.5100	9.5300	9.5600	13.2300								
Outer	13.2500	9.4900	13.8700	9.5000	13.3000	13.1200	9.5100	13.8400	9.4500	9.4200	9.4100	13.0900	13.1100	13.4900	13.6200	9.4500
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	11.85627917	3	3.952093056	0.747368257	0.533020046	2.946685266										
Within groups	148.0643639	28	5.288012996													
Total	159.9206431	31														
within-sd	2.299568															
effective n	6.92															
s_bb	0.000000															
s_bb_min	0.452029															
u_bb	0.452029															
u_bb(rel.)	3.889198															

Bismuth (mass fraction in mg/kg):

Centre	115.9476	133.4524														
Inner	120.6000	121.8000	127.2000	130.6000	122.4000	121.5000										
Middle	126.5000	119.1000	125.3000	129.9000	132.6000	127.2000	129.3000									
Outer	127.2000	124.4000	127.3000	128.0000	126.8000	122.4000	125.6000	117.2000	126.2000	126.7000	126.5000	128.7000	130.4000	122.8000	121.6000	129.0000

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	33.09576805	3	11.03192268	0.586363928	0.629163973	2.960351318
Within groups	507.981303	27	18.81412233			
Total	541.0770711	30				

within-sd	4.337525
effective n	6.62
s_bb	0.000000
s_bb_min	0.879244
u_bb	0.879244
u_bb(rel.)	0.699574

Calcium (mass fraction in mg/kg):

Centre	21.4698	22.2902														
Inner	21.9600	22.1100	21.8800	22.0200	22.0400	22.0600										
Middle	22.1800	22.0400	22.1500	22.1800	22.3300	22.1100	22.6500	22.0200								
Outer	22.2200	22.2900	22.0000	22.0700	22.0200	22.2100	22.0000	22.2700	22.2100	22.0700	22.0400	22.1500	22.2600	22.5100	22.2200	22.2600

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.288938542	3	0.096312847	2.870905428	0.054104704	2.946685266
Within groups	0.93934119	28	0.0335479			
Total	1.228279732	31				

within-sd	0.183161
effective n	6.92
s_bb	0.095260
s_bb_min	0.036004
u_bb	0.095260
u_bb(rel.)	0.430048

Cadmium (mass fraction in mg/kg):

Centre	47.0751	64.1249														
Inner	52.4000	51.9000	50.8000	54.8000	56.0000	57.6000										
Middle	54.5000	51.2000	52.7000	60.5000	60.9000	59.1000	61.3000	53.3000								
Outer	54.6000	59.4000	59.4000	57.0000	60.3000	57.9000	52.4000	59.9000	56.2000	57.4000	49.4900	55.7000	54.3000	56.7000	59.3000	62.5000

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	44.77804479	3	14.92601493	0.904390251	0.451412744	2.946685266
Within groups	462.1107068	28	16.50395381			
Total	506.8887516	31				
within-sd	4.062506					
effective n	6.92					
s_bb	0.000000					
s_bb_min	0.798571					
u_bb	0.798571					
u_bb(rel.)	1.418010					

Gallium (mass fraction in mg/kg):

Centre	89.4045	91.3955														
Inner	90.0000	91.2000	91.0000	91.2000	91.2000	90.5000										
Middle	90.8000	90.0000	90.3000	90.7000	90.8000	91.2000	91.4000									
Outer	90.3000	89.9000	89.5000	89.6000	90.4000	90.3000	89.7000	89.5000	90.2000	89.7000	90.4000	90.9000	91.0000	90.2000	90.2000	90.7000

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.94203053	3	0.980676843	3.312414516	0.034926623	2.960351318
Within groups	7.993647727	27	0.296061027			
Total	10.93567826	30				
within-sd	0.544115					
effective n	6.62					
s_bb	0.321495					
s_bb_min	0.110296					
u_bb	0.321495					
u_bb(rel.)	0.355474					

Lead (mass fraction in mg/kg):

Centre	101.5717	108.8283														
Inner	106.6000	106.3000	105.8000	105.0000	105.3000	104.0000										
Middle	107.6000	104.5000	105.9000	105.0000	109.7000	105.6000	106.1000									
Outer	111.0000	108.8000	108.3000	109.8000	108.0000	108.4000	106.6000	107.4000	106.2000	106.5000	107.9000	107.1000	108.0000	105.9000	108.3000	107.4000
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	34.14479263	3	11.38159754	4.047354717	0.01691027	2.960351318										
Within groups	75.92690909	27	2.812107744													
Total	110.0717017	30														
within-sd	1.676934															
effective n	6.62															
s_bb	1.137440															
s_bb_min	0.339925															
u_bb	1.137440															
u_bb(rel.)	1.063028															

Tin (mass fraction in mg/kg):

Centre	95.0276	104.1724														
Inner	96.4000	98.3000	95.6000	93.6000	95.2000	94.7000										
Middle	99.2000	93.8000	98.7000	94.9000	93.6000	96.1000	93.5000	94.7000								
Outer	97.7000	95.7000	95.4000	96.7000	97.3000	96.8000	96.7000	94.4000	93.9000	97.6000	95.0000	96.7000	96.1000	96.1000	94.2000	95.8000
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*										
Between groups	28.17854167	3	9.392847222	2.36009636	0.09282528	2.946685266										
Within groups	111.4360103	28	3.97985751													
Total	139.6145519	31														
within-sd	1.994958															
effective n	6.92															
s_bb	0.884647															
s_bb_min	0.392151															
u_bb	0.884647															
u_bb(rel.)	0.923303															

Strontium (mass fraction in mg/kg):

Centre	122.2379	127.1621														
Inner	126.4000	126.8000	125.2000	126.5000	127.4000	127.2000										
Middle	128.6000	127.2000	128.1000	127.7000	130.1000	128.2000	129.4000	126.4000								
Outer	129.5000	128.5000	126.7000	127.3000	126.9000	129.1000	128.7000	126.4000	129.3000	125.3000	128.1000	128.2000	129.4000	128.6000	131.3000	129.9000

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	33.77166667	3	11.25722222	5.325189639	0.004963253	2.946685266
Within groups	59.19079762	28	2.113957058			
Total	92.96246429	31				

within-sd	1.453945
effective n	6.92
s_bb	1.149747
s_bb_min	0.285804
u_bb	1.149747
u_bb(rel.)	0.898614

Vanadium (mass fraction in mg/kg):

Centre	142.9670	160.6330														
Inner	154.1000	154.3000	149.1000	158.8000	155.0000	157.1000										
Middle	150.8000	150.8000	156.4000	157.5000	154.2000	153.7000	153.0000	153.8000								
Outer	151.9000	154.0000	156.7000	154.6000	151.2000	155.6000	155.4000	153.8000	152.9000	157.0000	154.2000	152.4000	153.0000	152.2000	154.6000	151.4000

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	13.16197917	3	4.387326389	0.412423752	0.745354327	2.946685266
Within groups	297.8614553	28	10.63790912			
Total	311.0234345	31				

within-sd	3.261581
effective n	6.92
s_bb	0.000000
s_bb_min	0.641132
u_bb	0.641132
u_bb(rel.)	0.416365

Zirconium (mass fraction in mg/kg):

Centre	21.8449	25.5751														
Inner	25.2200	22.3500	22.9900	23.1100	23.5100	22.1500										
Middle	24.3600	23.5300	21.9000	23.5200	23.5900	23.2100	21.9800									
Outer	22.8600	23.9000	22.7000	22.3000	22.1200	24.5000	21.8100	23.9100	22.2400	22.9100	24.0700	22.9100	21.8200	22.6600	22.4700	23.1700

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.488188585	3	0.496062862	0.479263374	0.699393091	2.960351318
Within groups	27.9464236	27	1.035052726			
Total	29.43461218	30				

within-sd	1.017375
effective n	6.62
s_bb	0.000000
s_bb_min	0.206229
u_bb	0.206229
u_bb(rel.)	0.895612