Certification Report

Certified Reference Material

BAM-M313a

AlMg3

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Summary

This report describes preparation, analysis and certification of the aluminium alloy reference material BAM-M313a. The certified reference material (CRM) is available in the form of discs (65 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	0.346	0.012
Fe	0.388	0.010
Cu	0.0932	0.0027
Mn	0.486	0.006
Mg	3.35	0.08
Cr	0.117	0.004
Ni	0.0296	0.0007
Zn	0.1481	0.0026
Ti	0.099	0.006
	in mg/kg	in mg/kg
Be	5.4	0.3
Bi	92	5
Ca	10.4	1.2
Cd	4.7	0.6
Ga	106.7	2.2
Hg	3.7	0.7
Li	11.3	0.4
Mo	4.8	0.8
Na	25	5
Pb	38.0	1.4
Sb	6.1	1.0
Sn	193	6
V	308	8
Zr	355	10

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 about 95%, as defined in the ISO/IEC Guide 98-3:2008 [Uncertainty of measurement -- Part 3: Guide to the Expression of Uncertainty in Measurement (GUM:1995)].

The following mass fractions and uncertainties are given for information:

Element	Mass fraction [1)] in mg/kg	Uncertainty [2)] in mg/kg
As	3.8	1.4
Tl	5.1	0.6

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 eleven laboratories which participated in the certification inter-laboratory comparison.

Content

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List of abbreviations
(if not explained elsewhere)

AFS	atomic fluorescence spectrometry
CRM	certified reference material
CVAAS	cold vapour atomic absorption spectrometry
FAAS	flame atomic absorption spectrometry
ETAAS	Electrothermal 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
CVA	CVAAS (Tables 2 – 26)
I	ICP-OES (Tables 2 – 26)
I(R)	ICP-OES, revised value (Tables 2 – 26)
IMS	ICP-MS (Tables 2 – 26)
A	FAAS (Tables 2 – 26)
EA	ETAAS (Tables 2 – 26)
P	spectrophotometry (Tables 2 – 26)
-s	dissolution in acid (Tables 2 – 26)
-a	dissolution in base (Tables 2 – 26)

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-M313a is based on the aluminium alloy AlMg3, which is used for many applications.

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:

Aleris Rolled Products Germany GmbH, Koblenz, Germany
AMAG Austria Metall AG, Ranshofen, Austria
Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany
Constellium, Centre de Recherches de Voreppe, Voreppe, France
Hydro Aluminium Rolled Products GmbH, R&D, Bonn, Germany
Hydro Aluminium Rolled Products GmbH, Hamburg, Germany
Institute of Non-Ferrous Metals, Gliwice, Poland
Leichtmetall Aluminium Giesserei Hannover GmbH, Hannover, Germany
Otto Fuchs KG, Meinerzhagen, Germany
revierlabor, Essen, Germany
TRIMET Aluminium SE, 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 rods (A – F) with a length of 3775 mm each. 250 mm on both ends of each rod were discarded. The rods were cut into segments of 800 mm length (A1, A2, A3, A4, B1, B2, ..., F3, F4). Between the segments 15-mm discs (AA, AB, AC, AD, AE, BA, BB, ..., FD, FE) were taken for homogeneity testing (see Fig. 1).

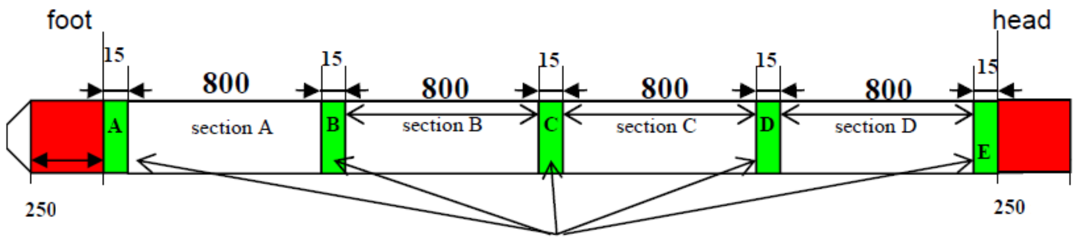


Fig.1: Preparation of the rods cast (all figures in mm)

In total, approx. 500 discs with a diameter of ca. 65 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 Figure 2):

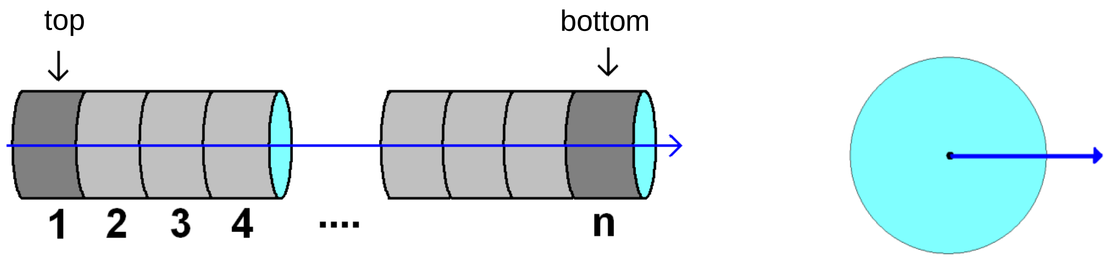


Fig. 2: Axial and radial composition gradient

Therefore, it is necessary to investigate the raw material for both axial and radial inhomogeneities. Radial 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, this corresponds to 6 % of the whole batch. For the elements Zn and Sc XRF was used to investigate homogeneity. This was done in BAM.
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):

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

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

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 $u_{\text{bb}}(1)$. 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). To perform this test SOES analysis was carried out in circles (outer circle: 16 sparks, mean circle: 16 sparks, inner circle: 8 sparks; centre: 1 spark). For some elements data from the accompanying spark emission round robin test was used because BAM-spectrometer was not suitable for these elements (As, Cd, Hg, Tl). Calculation was done in the same way as for the other elements while the number of sparks were different (outer circle: 4 sparks, inner circle: 4 sparks; centre: 1 spark).

The analyte-specific within-disc uncertainty component $u_{\text{bb}}(2)$ 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 requires a minimum of two measurements per factor value. Thus, the value for r_0 should be replaced by a dummy. This dummy is defined as follows:

The two values replacing the one measured have a mean equal to the value measured, and a standard deviation equal to the average within-variation. This resembles the situation where one could take two independent measurements at the same place, with values deviating by the average standard deviation (non-destructive testing method). A first guess for the average standard deviation may be calculated from the data for r_in (inner circle), r_mean (mean circle) and r_out (outer circle). 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. The higher component is used for uncertainty calculation.

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

5. Characterisation study

5.1 Analytical procedures

Eleven 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 procedures 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, Bi, Ga, Zn, Ti, Sc, Sn, V, Zr	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions, matrix matching with pure Al (Merck)
	As, Be, Ca, Cd, Hg, Li, Mo, Na, Pb, Tl	0.5 g	Dissolution with HCl/HNO_3	ICP-OES, commercial mono-element solutions, matrix matching with pure Al
2*	Si, Fe, Cu, Mn, Mg, Cr, Zn, Ti	0.5 g	Dissolution with NaOH	ICP-OES, calibration with pure metals or pure chemicals, matrix matching with pure Al (5N5)
	Ni, Ca, Cd, Li, Na, V, Zr	0.5 g	Dissolution with HNO_3/HF	ICP-OES, calibration with pure metals or chemicals, matrix matching with pure Al (5N5)
	As, Be, Bi, Ga, Mo, Sn	0.5 g	Dissolution with HNO_3/HF	ICP-MS, calibration with pure metals or pure chemicals, matrix matching with pure Al (5N5)
	Hg, Pb, Sb, Tl	0.5 g	Dissolution with aqua regia	ICP-MS, calibration with pure metals or pure chemicals, matrix matching with pure Al (5N5)
3*	Si, Fe, Cu, Mn, Mg, Cr, Zn, Ti, Be, Bi, Cd, Ga, Li, Pb, Sn, V, Zr	0.1 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Roth)
4	Si	0.5 g	Dissolution with NaOH	Spectrophotometry, commercial mono-element solution, matrix matching with pure Al (Merck, Ultrascientific)
	Fe, Cu, Mn, Mg, Cr, Zn, Ti	0.2 g	Dissolution with HNO_3/HCl	ICP-OES, commercial mono-element solutions, matrix matching with pure Al (Merck, Ultrascientific)
	As, Be, Bi, Ca, Cd, Ga, Hg, Li, Mo, Na, Pb, Sb, Sn, Tl, V, Zr	0.5 g	Dissolution with HNO_3/HCl	ICP-OES, commercial mono-element solutions, matrix matching with pure Al (Merck, Ultrascientific)
5*	Si, Cu, Mn, Mg, Cr, Ni, Zn, Bi, Ga, Pb, Zr	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Merck)
5*	Fe, Ti, Be, Sn, V	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Labkings)
6	Si, Fe, Cu, Mn, Mg, Cr, Zn, Ti, Be, Cd, Ga, Mo, Pb, Sn, V, Zr	0.5 g	Dissolution with NaOH	ICP-OES, calibration with pure metals or pure chemicals, matrix matching with pure Al
	As, Bi, Ca, Hg, Li, Na, Sb, Tl	0.5 g	Dissolution with HCl/HNO_3	ICP-OES, calibration with pure metals or pure chemicals, matrix matching with pure Al

*Laboratory accredited acc. to ISO/IEC 17025

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

Lab-No.	Element	Sample mass	Sample pretreatment	Analytical method
7*	Si, Fe, Cu, Mn, Mg, Cr, Ni, Ti, Bi, Ca, Ga, Na, Pb, V, Zr	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-OES, calibration with matrix matched standards, commercial multi-element standard solutions (Merck)
	Fe, Cu, Mn, Mg, Cr, Ni, Ti, Cd, V	0.25 g	Dissolution with HNO_3/HCl/HF	ICP-OES, calibration with matrix matched standards, commercial multi-element standard solutions (Merck)
	Fe, Cr, Zn, Sn, V, Zr, Be, Bi, Cd, Ga, Li, Pb	0.25 g	Dissolution with HNO_3/HCl/HF	ICP-OES, calibration with matrix matched standards, commercial multi-element standard solutions (CHEM-LAB)
	Zn, As, Mo, Pb, Sb, Sn, Tl, Zr	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-OES, calibration with pure metals or compounds
	Sn	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-MS, calibration with matrix matched standards, commercial multi-element standard solutions (LGC)
	Bi	0.25 g	Dissolution with HNO_3/HCl/HF	ICP-OES, calibration with pure metals or compounds
	Zn	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-OES, calibration with matrix matched standards, commercial multi-element standard solutions (Merck)
	Zn, As, Be, Cd, Ga, Hg, Mo, Sb, Tl, V	0.5 g	Dissolution with HNO_3/HF	ICP-MS, with matrix matched standards, commercial mono-element standard solutions (Perkin Elmer)
	Ti, Pb	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-MS, with matrix matched standards, commercial mono-element standard solutions (Perkin Elmer)
	Bi, Na	0.5 g	Dissolution with HNO_3/HF	ICP-MS, calibration with matrix matched standards, commercial multi-element standard solutions (Merck)
	Zr	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-MS, calibration with matrix matched standards, commercial multi-element standard solutions (Merck)
8	Si, Fe, Cu, Mn, Mg, Cr, Zn, Ti	0.5 g	Dissolution with NaOH	ICP-OES with matrix matched standards, commercial mono-element solutions (VWR or Bernd Kraft)
	Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Be, Bi, Ca, Cd, Ga, Mo, Li, Na, Pb, Sb, Sn, Tl, V, Zr	0.5 g	Dissolution with HCl (microwave)	ICP-OES with matrix matched standards, commercial mono-element solutions (VWR or Bernd Kraft)
9*	Si, Zr	0.5 g	Dissolution with NaOH	Spectrophotometry, calibration with commercial mono-element solutions (Merck)
	Fe	0.5 g	Dissolution with HCl/H_2O_2	Spectrophotometry, calibration with commercial mono-element solutions (Merck)
	Mn	1 g	Dissolution with HNO_3,	Spectrophotometry, calibration with commercial mono-element solutions (Merck)

*Laboratory accredited acc. to ISO/IEC 17025

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

	Ti	1 g	Dissolution with HCl/H_2O_2	Spectrophotometry, calibration with commercial mono-element solutions (Merck)
	Fe, Mn, Mg, Cr, Ni, Zn, Ti, Be, Bi, Ca, Cd, Ga, Li, Na, Pb, V	1 g	Dissolution with $HCl/HNO_3/HF$	ICP- OES, calibration with matrix matched standards, commercial mono-element solutions (Merck)
	Si, Fe, Mn, Mg, Ni, Zn, Ti, Be, Cd, Ga, Sn, Zr	0.5 g	Dissolution with NaOH	ICP-OES, calibration with matrix matched standards, commercial mono-element solution (Merck)
	Hg	0.5 g	Dissolution with $HCl/HNO_3/HF$	CVAAS, calibration with commercial mono-element solution (Merck)
	Hg	0.5 g	Dissolution with $HCl/HNO_3/HF$	AFS, calibration with commercial mono-element solution (Merck)
10	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Be, Bi, Cd, Ga, Pb, Sb, Sn, V, Zr	0.25 g	Dissolution with $NaOH/HNO_3$	ICP-OES, calibration with commercial mono-element solutions (Bernd Kraft)
12	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, As, Be, Bi, Cd, Ga, Pb, Sb, Sn, V, Zr	0.5 g	Dissolution with $NaOH/HNO_3$	ICP-OES, calibration with matrix matched standards, commercial mono-element solutions (Merck certipur)

*Laboratory 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 26. 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 ($\overline{s_i}$), 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 discussion with the respective laboratories are highlighted in yellow.

Table 2: Results for Si

Lab./Meth.	3/I-a	9/P	2/I-a	1/I-a	8/I-a	6/I-a	7/I-s(R)	9/I-a	5/I-a	12/I-a(R)	10/I-a	4/P		
M_i [%]	0.290	0.332	0.3368	0.343	0.3385	0.339	0.338	0.340	0.349	0.351	0.3549	0.358		*n*
	0.284	0.335	0.3331	0.341	0.3408	0.337	0.334	0.342	0.349	0.352	0.3591	0.363		11
	0.286	0.334	0.3354	0.341	0.3398	0.346	0.341	0.349	0.352	0.353	0.3602	0.378		
	0.288	0.332	0.3365	0.340	0.3416	0.346	0.343	0.357	0.351	0.351	0.3591	0.375		
	0.290	0.330	0.3356	0.337	0.3416	0.339	0.348	0.341	0.351	0.350	0.3560	0.381		
	0.287	0.331	0.3354	0.337	0.3401	0.340	0.344	0.362	0.349	0.352	0.3560	0.376		
		0.334												
M [%]	0.288	0.332	0.335	0.340	0.3404	0.341	0.341	0.349	0.350	0.352	0.358	0.372		0.346
s [%]	0.0023	0.0017	0.0013	0.0024	0.0012	0.0040	0.0049	0.0092	0.0013	0.0010	0.0022	0.0092	s_M [%]	0.0112
													$\bar{s}_i$ [%]	0.0046
s_{rel}	0.00816	0.00508	0.00391	0.00707	0.00348	0.01184	0.01431	0.02649	0.00380	0.00298	0.00609	0.02461		0.03243

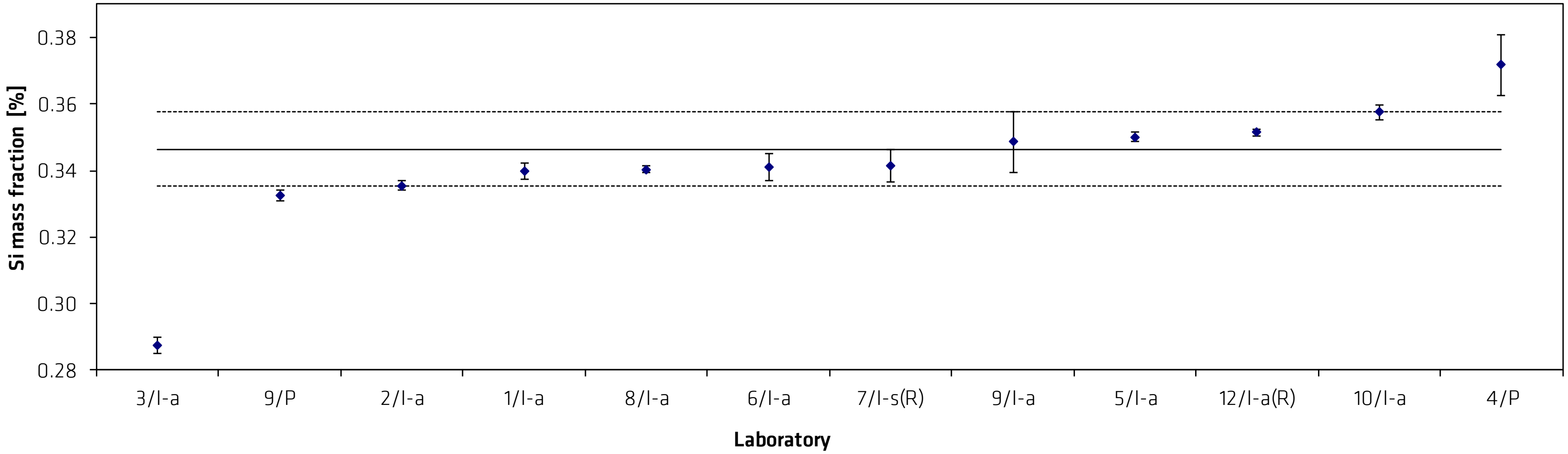


Table 3: Results for Fe

Lab./Meth.	5/I-a(R)	9/P	8/I-s	8/I-a	2/I-a	9/I-a	4/I-s	9/I-s	6/I-a(R)	12/I-a	1/I-a	3/I-a	7/I-s_2	10/I-a	7/I-s_1		
M_i [%]	0.376	0.3821	0.3815	0.3837	0.3859	0.382	0.3860	0.3936	0.3893	0.388	0.386	0.375	0.408	0.395	0.4012		*n*
	0.376	0.3810	0.3821	0.3834	0.3863	0.388	0.3898	0.3837	0.3893	0.389	0.388	0.376	0.406	0.398	0.3990		15
	0.374	0.3796	0.3810	0.3824	0.3854	0.384	0.3828	0.3844	0.3850	0.388	0.390	0.394	0.391	0.393	0.4012		
	0.374	0.3804	0.3804	0.3824	0.3851	0.386	0.3895	0.3858	0.3852	0.389	0.391	0.407	0.389	0.397	0.3984		
	0.374	0.3811	0.3801	0.3841	0.3857	0.386	0.3838	0.3869	0.3876	0.389	0.389	0.407	0.388	0.393	0.3995		
	0.373	0.3810	0.3817	0.3829	0.3836	0.388	0.3828		0.3861	0.390	0.402	0.404	0.388	0.400	0.3987		
			0.3813			0.386											
			0.3832														
M [%]	**0.375**	**0.381**	**0.381**	**0.383**	**0.385**	**0.386**	**0.386**	**0.387**	**0.387**	**0.389**	**0.391**	**0.394**	**0.395**	**0.396**	**0.400**		**0.388**
s [%]	0.0012	0.0008	0.0010	0.0007	0.0009	0.0021	0.0032	0.0039	0.0019	0.0008	0.0057	0.0150	0.0094	0.0028	0.0012	s_M [%]	0.0066
																$\bar{s}_i$ [%]	0.0057
s_{rel}	0.00327	0.00212	0.00256	0.00183	0.00239	0.00554	0.00834	0.01018	0.00503	0.00194	0.01447	0.03805	0.02375	0.00714	0.00311		0.01704

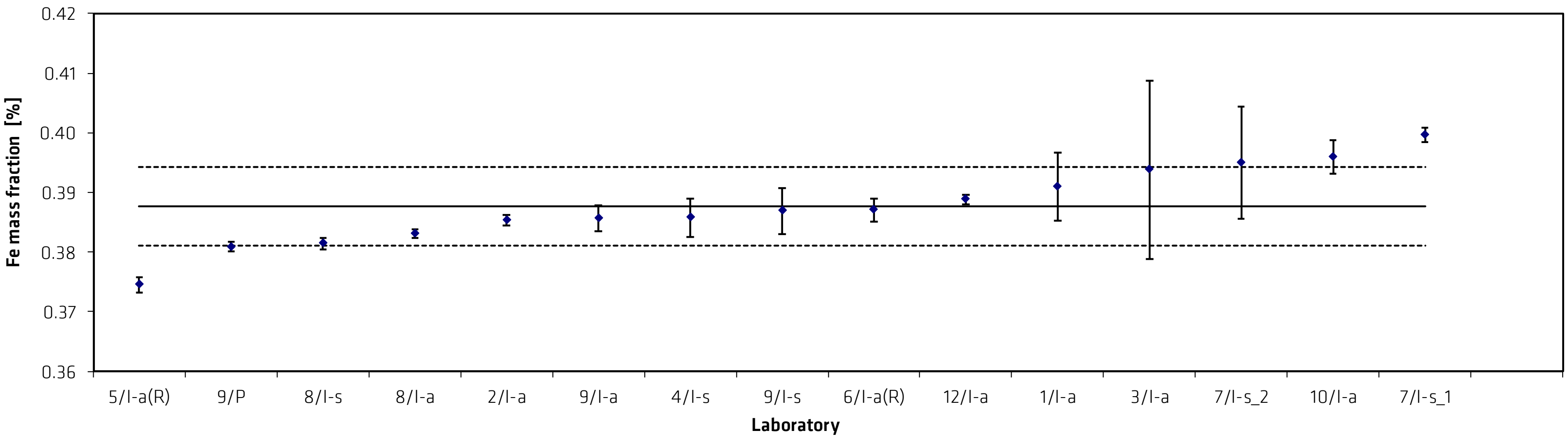


Table 4: Results for Cu

Lab./Meth.	7/I-s_1	7/I-s_2	3/I-a(R)	6/I-a	12/I-a	4/I-s	8/I-s	8/I-a	2/I-a	1/I-a	10/I-a	9/I-s	5/I-a		
M_i [%]	0.0905	0.0900	0.092	0.0942	0.0950	0.0933	0.0942	0.0943	0.0946	0.094	0.0946	0.0968	0.095		*n*
	0.0895	0.0898	0.091	0.0918	0.0940	0.0935	0.0939	0.0936	0.0943	0.094	0.0949	0.0960	0.095		13
	0.0901	0.0901	0.093	0.0928	0.0915	0.0938	0.0935	0.0936	0.0946	0.094	0.0950	0.0942	0.097		
	0.0903	0.0908	0.092	0.0905	0.0905	0.0938	0.0931	0.0936	0.0934	0.094	0.0938	0.0939	0.096		
	0.0907	0.0910	0.091	0.0898	0.0904	0.0931	0.0940	0.0938	0.0937	0.094	0.0952	0.0946	0.096		
	0.0899	0.0899	0.092	0.0938	0.0922	0.0938	0.0938	0.0944	0.0932	0.094	0.0937		0.095		
							0.0933								
							0.0939								
***M* [%]**	**0.0902**	**0.0903**	**0.0918**	**0.0921**	**0.0923**	**0.0936**	**0.0937**	**0.0939**	**0.0940**	**0.0940**	**0.0945**	**0.0951**	**0.0957**		**0.0932**
s [%]	0.0004	0.0005	0.0008	0.0018	0.0019	0.0003	0.0004	0.0004	0.0006	0.0000	0.0006	0.0012	0.0008	s_M [%]	0.0017
														$\bar{s}_i$ [%]	0.0009
s_{rel}	0.00479	0.00559	0.00820	0.01917	0.02038	0.00322	0.00401	0.00395	0.00647	0.00000	0.00675	0.01308	0.00853		0.01837

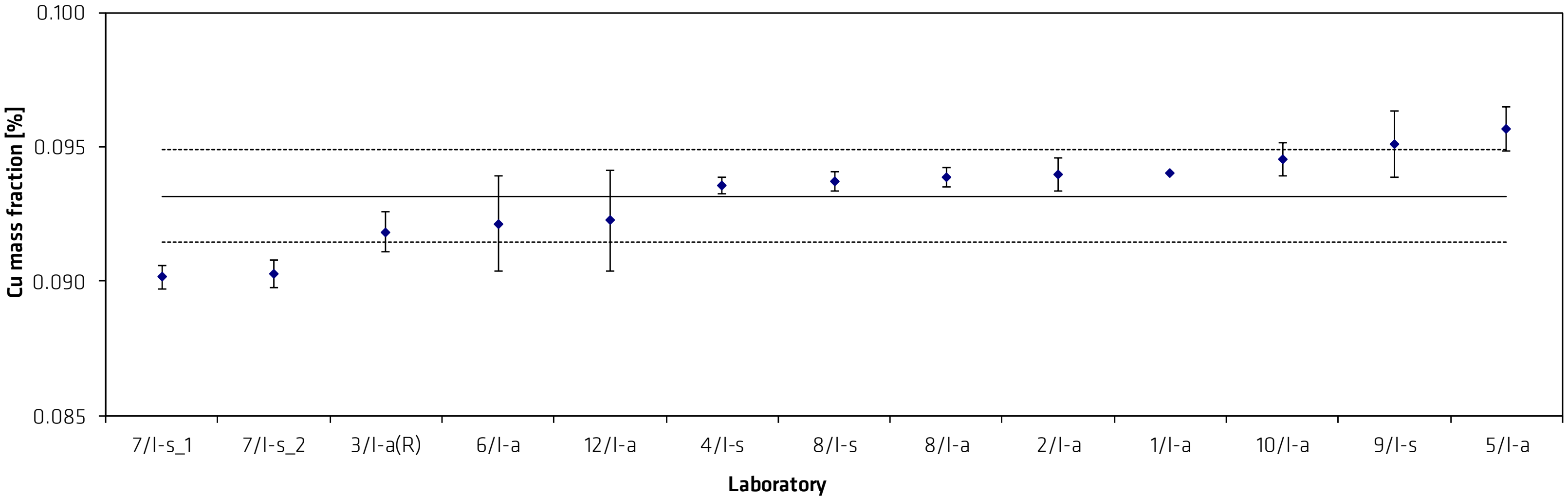


Table 5: Results for Mn

Lab./Meth.	6/I-a	8/I-s	1/I-a	5/I-a	9/P	8/I-a	9/I-a	4/I-s	12/I-a	2/I-a	7/I-s_2	10/I-a	7/I-s_1	9/I-s	3/I-a(R)		
M i [%]	0.4776	0.4755	0.478	0.480	0.4815	0.4796	0.488	0.488	0.4866	0.4846	0.480	0.488	0.4950	0.5052	0.510		*n*
	0.4765	0.4736	0.479	0.480	0.4818	0.4815	0.497	0.481	0.4850	0.4848	0.488	0.490	0.4975	0.5018	0.510		15
	0.4768	0.4781	0.481	0.478	0.4819	0.4819	0.483	0.480	0.4878	0.4845	0.485	0.492	0.4952	0.4977	0.508		
	0.4762	0.4747	0.477	0.479	0.4815	0.4830	0.491	0.485	0.4799	0.4831	0.489	0.490	0.4982	0.4971	0.510		
	0.4753	0.4716	0.478	0.479	0.4798	0.4818	0.483	0.481	0.4821	0.4839	0.486	0.493	0.4973	0.5046	0.513		
	0.4751	0.4790	0.478	0.481	0.4798	0.4811	0.472	0.488	0.4824	0.4838	0.483	0.485	0.4965		0.504		
		0.4764			0.4825		0.460										
		0.4855															
***M* [%]**	**0.476**	**0.477**	**0.479**	**0.480**	**0.481**	**0.481**	**0.482**	**0.484**	**0.484**	**0.484**	**0.485**	**0.490**	**0.497**	**0.501**	**0.509**		**0.486**
s [%]	0.0010	0.0042	0.0014	0.0010	0.0011	0.0011	0.0124	0.0037	0.0030	0.0007	0.0033	0.0029	0.0013	0.0038	0.0030	s_M [%]	0.00944
																$\bar{s}_i$ [%]	0.00405
s_{rel}	0.00200	0.00889	0.00288	0.00219	0.00219	0.00233	0.02580	0.00765	0.00621	0.00135	0.00683	0.00587	0.00261	0.00751	0.00588		0.01942

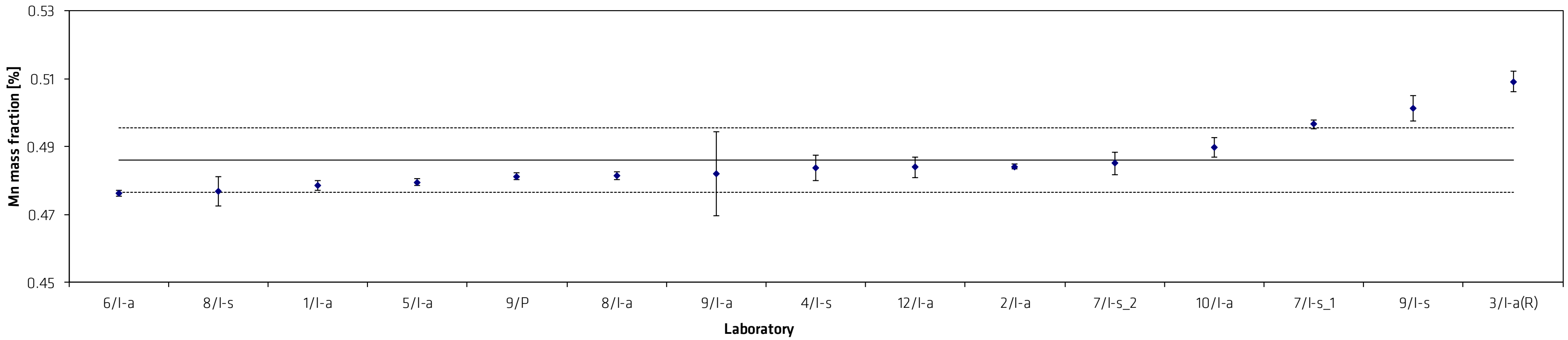


Table 6: Results for Mg

Lab./Meth.	8/I-a	8/I-s	6/I-a	9/I-a	7/I-s_1	7/I-s_2	12/I-a	4/I-s	1/I-a	2/I-a	5/I-a	9/I-s	10/I-a	3/I-a		
M_i [%]	3.251	3.250	3.286	3.293	3.302	3.320	3.338	3.403	3.36	3.377	3.389	3.482	3.40	3.433		*n*
	3.254	3.256	3.327	3.305	3.305	3.350	3.379	3.347	3.36	3.375	3.385	3.445	3.42	3.479		14
	3.256	3.267	3.327	3.294	3.308	3.350	3.350	3.354	3.38	3.384	3.409	3.393	3.44	3.459		
	3.268	3.269	3.312	3.303	3.310	3.280	3.344	3.343	3.34	3.400	3.394	3.367	3.39	3.443		
	3.265	3.260	3.282	3.302	3.302	3.280	3.354	3.337	3.36	3.393	3.403	3.393	3.42	3.452		
	3.267	3.284	3.276	3.319	3.308	3.320	3.349	3.346	3.36	3.400	3.403		3.44	3.470		
		3.282		3.314												
		3.309														
M [%]	**3.26**	**3.27**	**3.30**	**3.30**	**3.31**	**3.32**	**3.35**	**3.36**	**3.36**	**3.39**	**3.40**	**3.42**	**3.42**	**3.46**		**3.35**
s [%]	0.007	0.019	0.023	0.010	0.003	0.031	0.014	0.024	0.013	0.011	0.009	0.046	0.020	0.017	s_M [%]	0.059
															$\bar{s}_i$ [%]	0.021
s_{rel}	0.0022	0.0058	0.0070	0.0029	0.0010	0.0095	0.0042	0.0072	0.0038	0.0032	0.0027	0.0136	0.0060	0.0049		0.0177

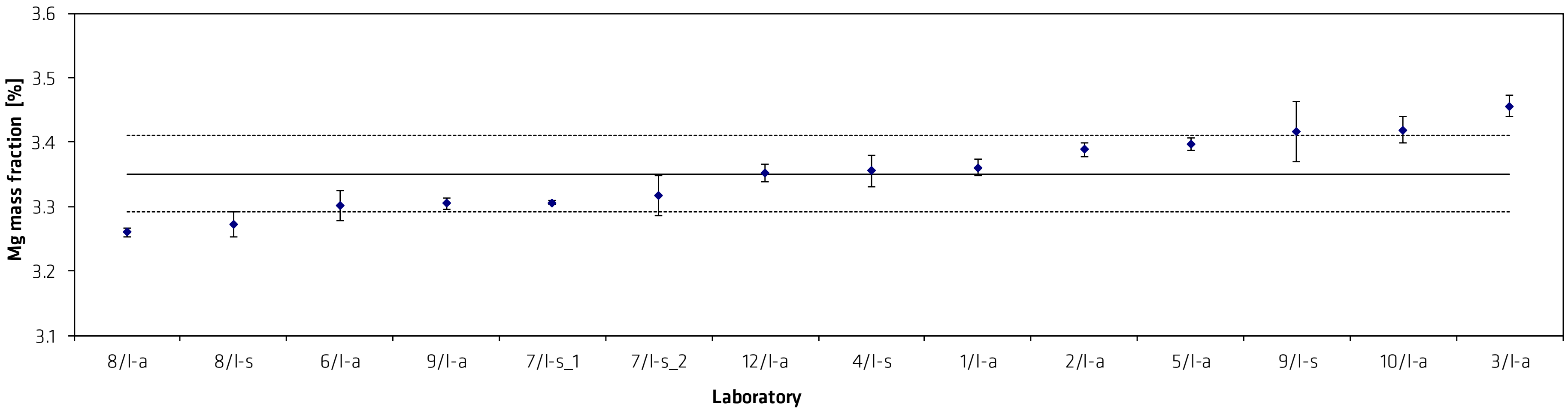


Table 7: Results for Cr

Lab./Meth.	7/I-s_1	3/I-a(R)	9/I-a	7/I-s_2	6/I-a	8/I-a	5/I-a	8/I-s	12/I-a	9/I-s	10/I-a	1/I-a	2/I-a	4/I-s		
M_i [%]	0.1142	0.115	0.1148	0.116	0.1165	0.1169	0.116	0.1176	0.1190	0.1202	0.118	0.118	0.1196	0.1197		*n*
	0.1167	0.115	0.1127	0.118	0.1168	0.1168	0.117	0.1169	0.1190	0.1175	0.119	0.118	0.1193	0.1201		14
	0.1145	0.115	0.1149	0.112	0.1170	0.1171	0.117	0.1173	0.1184	0.1185	0.119	0.118	0.1196	0.1199		
	0.1143	0.116	0.1206	0.116	0.1166	0.1171	0.117	0.1168	0.1170	0.1178	0.118	0.119	0.1188	0.1192		
	0.1150	0.115	0.1143	0.117	0.1164	0.1164	0.117	0.1163	0.1160	0.1182	0.119	0.118	0.1185	0.1193		
	0.1161	0.116		0.115	0.1162	0.1167	0.118	0.1174	0.1180		0.119	0.122	0.1192	0.1195		
								0.1171								
								0.1179								
M [%]	**0.1151**	**0.1153**	**0.1155**	**0.1157**	**0.1166**	**0.1168**	**0.1170**	**0.1172**	**0.1179**	**0.1185**	**0.1187**	**0.1188**	**0.1192**	**0.1196**		**0.1173**
s [%]	0.0010	0.0005	0.0030	0.0021	0.0003	0.0003	0.0006	0.0005	0.0012	0.0010	0.0005	0.0016	0.0005	0.0003	s_M [%]	0.0015
															$\bar{s}_i$ [%]	0.0013
s_{rel}	0.00900	0.00448	0.02603	0.01786	0.00265	0.00228	0.00541	0.00428	0.01011	0.00879	0.00435	0.01348	0.00384	0.00292		0.01302

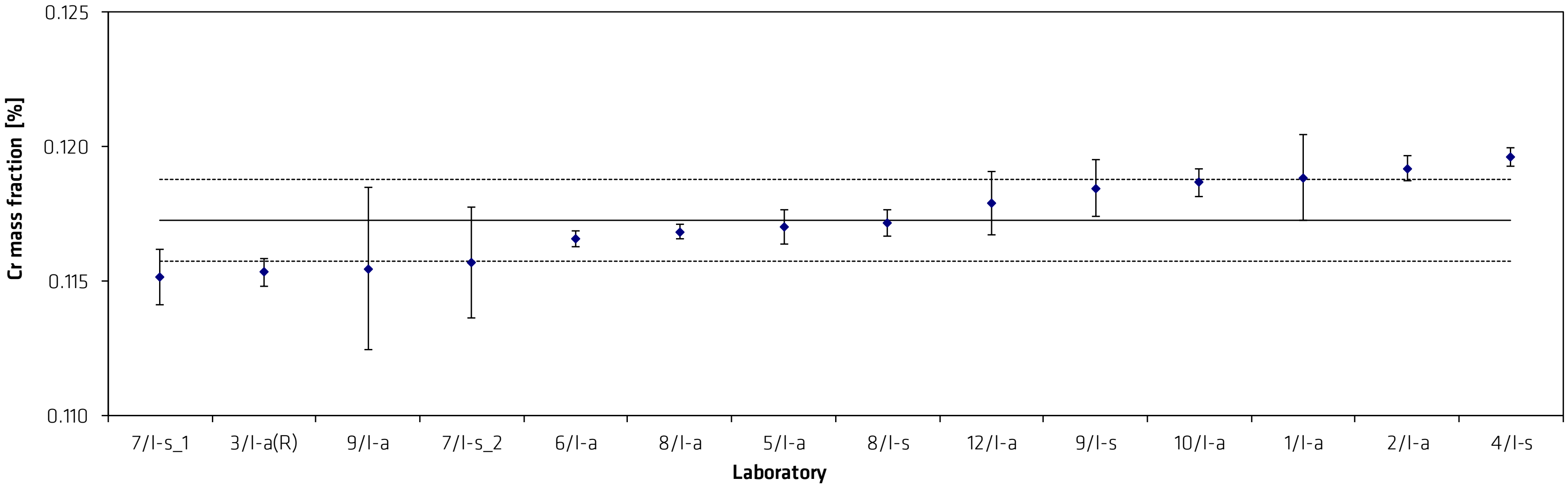


Table 8: Results for Ni

Lab./Meth.	8/I-s	2/I-s	5/I-a	7/I-s_2	12/I-a	10/I-a	1/I-a	4/I-s	6/I-a	7/I-s_1	9/I-s	3/I-a	9/I-a	7/IMS-s		
M_i [%]	0.0279	0.0287	0.029	0.0294	0.0291	0.0293	0.0291	0.0295	0.0293	0.0296	0.0297	0.029	0.0298	0.0310		*n*
	0.0279	0.0288	0.029	0.0288	0.0292	0.0295	0.0294	0.0296	0.0296	0.0297	0.0300	0.029	0.0306	0.0319		14
	0.0278	0.0287	0.029	0.0282	0.0288	0.0292	0.0293	0.0296	0.0299	0.0301	0.0314	0.031	0.0314	0.0332		
	0.0276	0.0289	0.029	0.0286	0.0289	0.0292	0.0293	0.0296	0.0301	0.0303	0.0310	0.031	0.0305	0.0307		
	0.0279	0.0286	0.029	0.0289	0.0292	0.0295	0.0294	0.0295	0.0294	0.0302	0.0286	0.031	0.0303	0.0308		
	0.0279	0.0287	0.029	0.0303	0.0291	0.0293	0.0294	0.0295	0.0292	0.0302		0.031	0.0309	0.0314		
	0.028												0.0303			
	0.028															
M [%]	0.0279	0.0288	0.0290	0.0290	0.0291	0.0293	0.0293	0.0296	0.0296	0.0300	0.0301	0.0303	0.0305	0.0315		0.0296
s [%]	0.0001	0.0001	0.0000	0.0007	0.0002	0.0001	0.0001	0.0001	0.0004	0.0003	0.0011	0.0010	0.0005	0.0009	s_M [%]	0.0009
															s_i [%]	0.0006
s_{rel}	0.00505	0.00361	0.00000	0.02528	0.00566	0.00466	0.00399	0.00185	0.01207	0.00975	0.03709	0.03405	0.01657	0.02992		0.03020

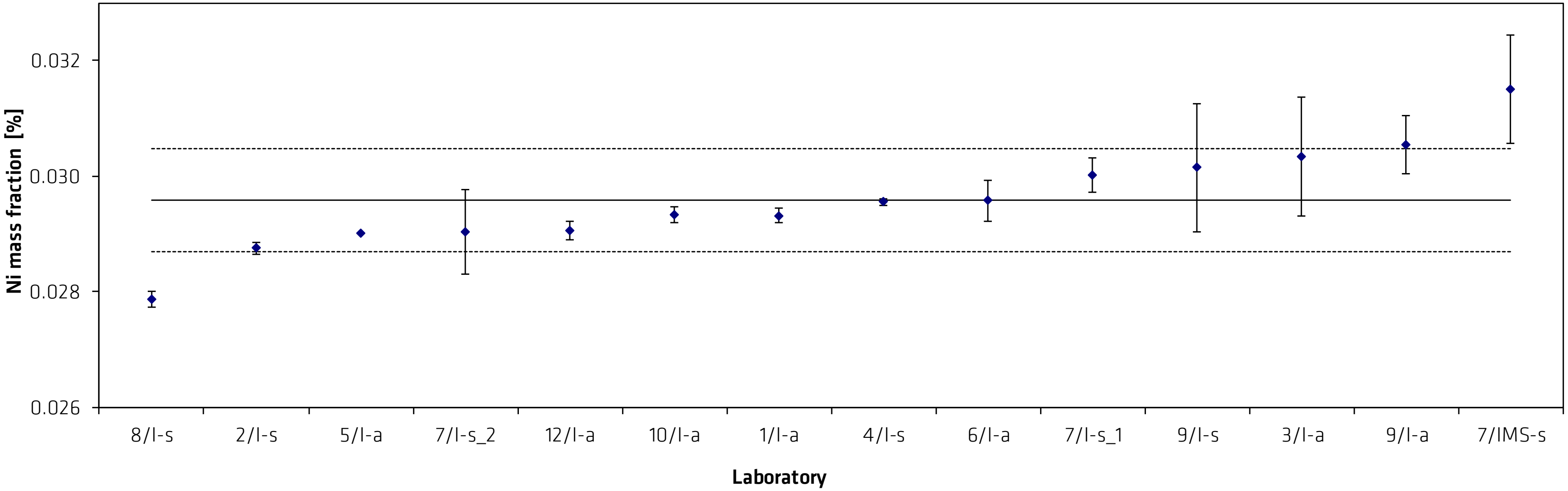


Table 9: Results for Zn

Lab./Meth.	9/I-a	8/I-a	1/I-a	12/I-a	8/I-s	2/I-a	4/I-s	5/I-a	3/I-a	7/IMS-s	10/I-a	9/I-s	7/I-s_1	6/I-a		
M_i [%]	0.145	0.1460	0.145	0.1449	0.1470	0.1473	0.1471	0.149	0.143	0.1470	0.150	0.1535	0.1512	0.1562		*n*
	0.148	0.1456	0.146	0.1473	0.1465	0.1468	0.1467	0.150	0.143	0.1531	0.150	0.1491	0.1509	0.1482		14
	0.142	0.1458	0.146	0.1473	0.1462	0.1466	0.1469	0.148	0.147	0.1511	0.151	0.1494	0.1506	0.1503		
	0.145	0.1462	0.146	0.1469	0.1464	0.1466	0.1467	0.148	0.154	0.1473	0.149	0.1485	0.1509	0.1482		
	0.146	0.1462	0.146	0.1456	0.1462	0.1459	0.1469	0.150	0.155	0.1495	0.150	0.1502	0.1503	0.1476		
	0.143	0.1465	0.149	0.1466	0.1473	0.1472	0.1466	0.149	0.154	0.1502	0.149		0.1505	0.1578		
	0.138				0.1465											
					0.1470											
M [%]	**0.1439**	**0.1461**	**0.1463**	**0.1464**	**0.1466**	**0.1467**	**0.1468**	**0.1490**	**0.1493**	**0.1497**	**0.1498**	**0.1502**	**0.1507**	**0.1514**		**0.1481**
s [%]	0.0032	0.0003	0.0014	0.0010	0.0004	0.0005	0.0002	0.0009	0.0057	0.0023	0.0008	0.0020	0.0003	0.0045	s_M [%]	0.0022
															$\bar{s}_i$ [%]	0.0023
s_{rel}	0.02250	0.00220	0.00934	0.00669	0.00280	0.00349	0.00125	0.00600	0.03804	0.01548	0.00502	0.01321	0.00217	0.02968		0.01493

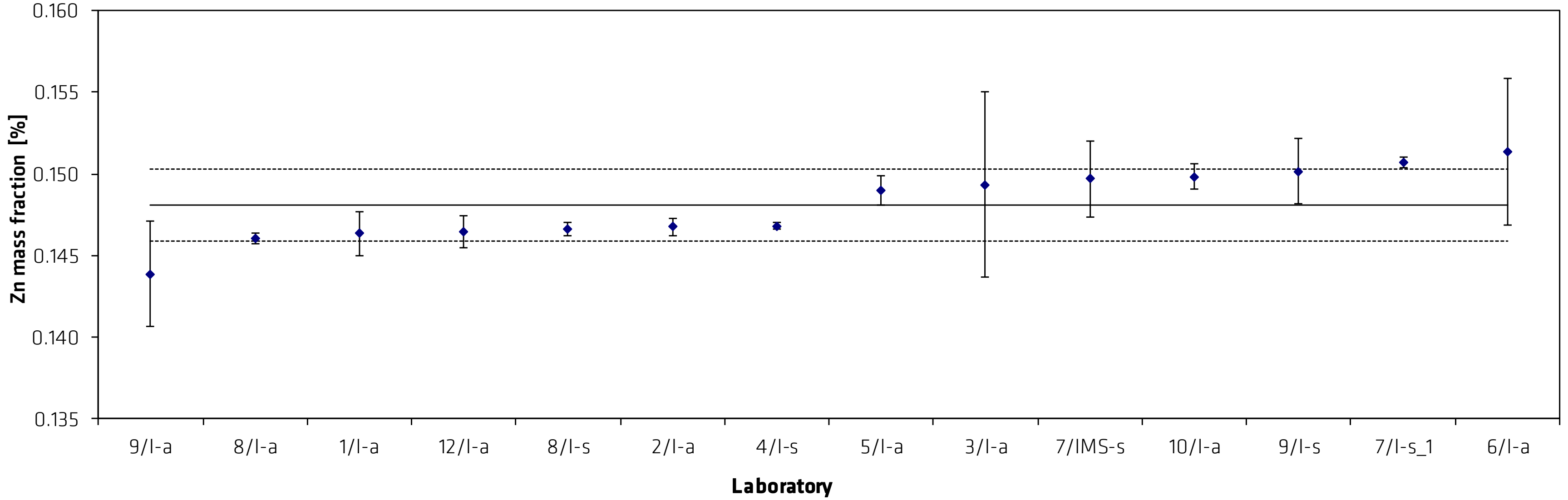


Table 10: Results for Ti

Lab./Meth.	5/I-a	3/I-a	2/I-s	1/I-a	6/I-a	7/I-s_1	8/I-s	7/IMS-s	4/I-s	9/P	10/I-a	7/I-s_2	12/I-a	8/I-a	9/I-a		
M_i [%]	0.0959	0.095	0.0973	0.099	0.0984	0.0992	0.0992	0.0985	0.0990	0.0995	0.0990	0.1001	0.1001	0.1005	0.100		*n*
	0.0961	0.096	0.0973	0.098	0.0995	0.0985	0.0986	0.0970	0.0988	0.0992	0.0993	0.0989	0.0997	0.1005	0.102		15
	0.0956	0.095	0.0973	0.098	0.0991	0.0994	0.0990	0.1037	0.0981	0.0987	0.0996	0.1000	0.0996	0.1003	0.099		
	0.0960	0.097	0.0995	0.099	0.0983	0.0987	0.0984	0.0958	0.0989	0.0991	0.0989	0.1003	0.0996	0.1001	0.102		
	0.0959	0.100	0.0995	0.098	0.0989	0.0993	0.0981	0.0969	0.0994	0.0983	0.1000	0.1008	0.0999	0.0995	0.100		
	0.0972	0.100	0.0988	0.099	0.0984	0.0981	0.0993	0.1020	0.0997	0.0996	0.0986	0.0977	0.0989	0.0994	0.098		
							0.0988			0.0997							
							0.0997										
M [%]	**0.0961**	**0.0972**	**0.0983**	**0.0985**	**0.0988**	**0.0989**	**0.0989**	**0.0990**	**0.0990**	**0.0992**	**0.0992**	**0.0996**	**0.0996**	**0.1001**	**0.1002**		**0.0988**
s [%]	0.00056	0.00232	0.00112	0.00055	0.00050	0.00052	0.00052	0.00316	0.00055	0.00050	0.00051	0.00113	0.00041	0.00049	0.00160	s_M [%]	0.00105
																$\bar{s}_i$ [%]	0.00124
s_{rel}	0.00579	0.02384	0.01141	0.00556	0.00506	0.00522	0.00525	0.03194	0.00555	0.00500	0.00513	0.01138	0.00410	0.00489	0.01599		0.01062

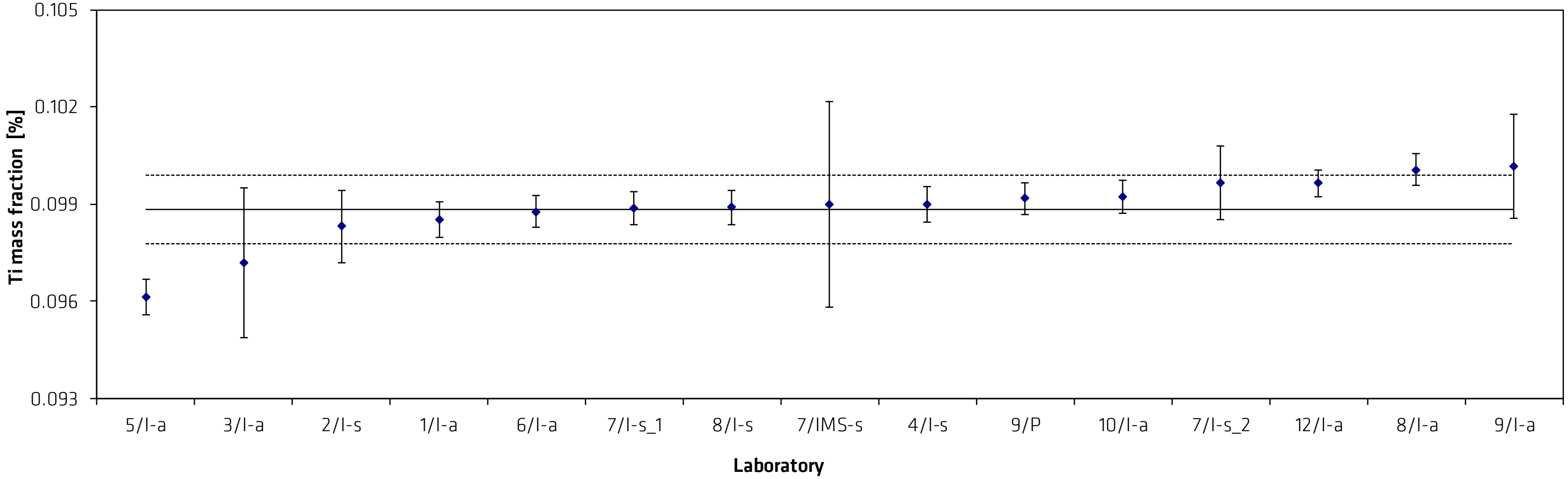


Table 11: Results for As

Lab./Meth.	4/I-s	7/IMS-s	2/IMS-s	12/I-a	1/I-a	6/I-s	7/I-s		
M_i [mg/kg]	2.1	2.2	2.6	3.6	4.3	4.9	6.4		*n*
	2.1	2.3	2.6	3.0	4.5	5.5	6.8		7
	2.1	2.3	2.9	4.2	4.4	5.3	6.2		
	2.2	2.2	2.6	3.7	4.3	5.0	6.8		
	1.9	2.3	2.5	4.0	4.5	5.4	6.7		
	2.3	2.2	2.6	3.7	4.4	5.5	6.5		
M [mg/kg]	**2.12**	**2.25**	**2.64**	**3.70**	**4.40**	**5.27**	**6.57**		**3.85**
s [mg/kg]	0.133	0.055	0.150	0.410	0.089	0.236	0.242	s_M [mg/kg]	1.671
								$\bar{s}_i$ [mg/kg]	0.218
s_{rel}	0.063	0.024	0.057	0.111	0.020	0.045	0.037		0.434

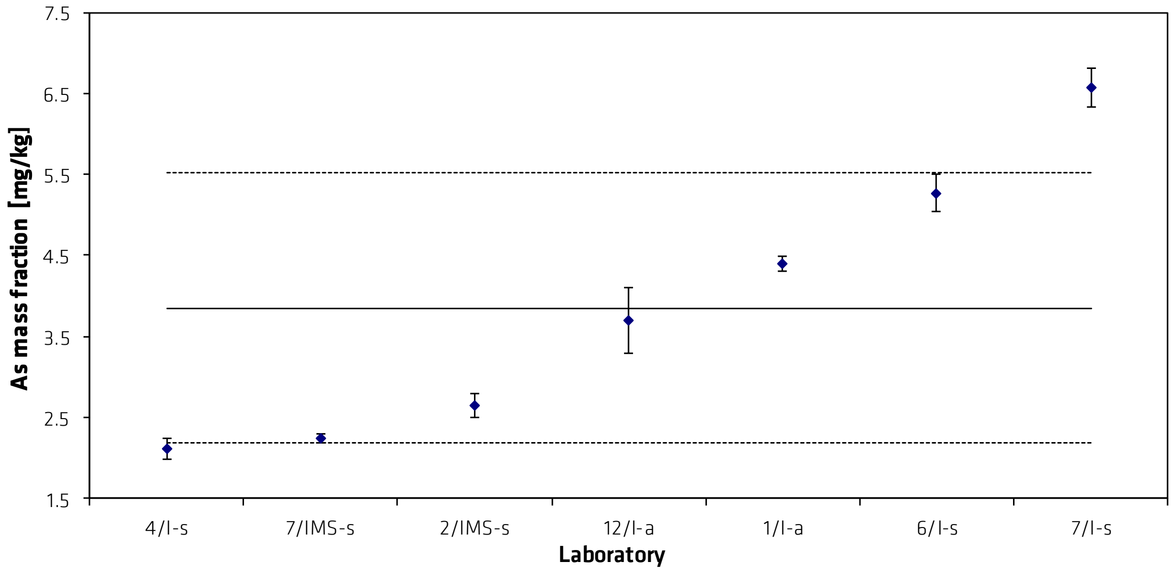


Table 12: Results for Be

Lab./Meth.	3/I-a	1/I-a	9/I-a	4/I-s	9/I-s	2/IMS-s	5/I-a(R)	6/I-a	12/I-a	10/I-a	7/IMS-s	8/I-s		
M_i [mg/kg]	5.0	5.0	5.1	5.2	5.46	5.36	5.4	5.34	5.4	5.4	5.7	6.0		*n*
	5.0	5.0	5.2	5.2	5.39	5.40	5.4	5.36	5.6	5.5	5.8	6.0		12
	5.0	5.0	4.9	5.3	5.30	5.23	5.4	5.43	5.6	5.6	6.3	6.0		
	5.0	5.0	5.1	5.3	5.28	5.23	5.4	5.43	5.2	5.5	5.9	6.0		
	5.0	5.0	5.0	5.1	5.32	5.33	5.4	5.41	5.4	5.5	6.0	6.0		
	5.0	5.0	5.0	5.2	5.09	5.48	5.4	5.40	5.3	5.6	5.7	6.0		
			4.8									6.0		
												6.0		
M [mg/kg]	**5.00**	**5.00**	**5.02**	**5.22**	**5.31**	**5.34**	**5.36**	**5.40**	**5.42**	**5.52**	**5.90**	**6.00**		**5.37**
s [mg/kg]	0.000	0.000	0.132	0.075	0.126	0.099	0.010	0.039	0.160	0.075	0.228	0.000	s_M [mg/kg]	0.320
													$\bar{s}_i$ [mg/kg]	0.106
s_{rel}	0.000	0.000	0.026	0.014	0.024	0.018	0.002	0.007	0.030	0.014	0.039	0.000		0.060

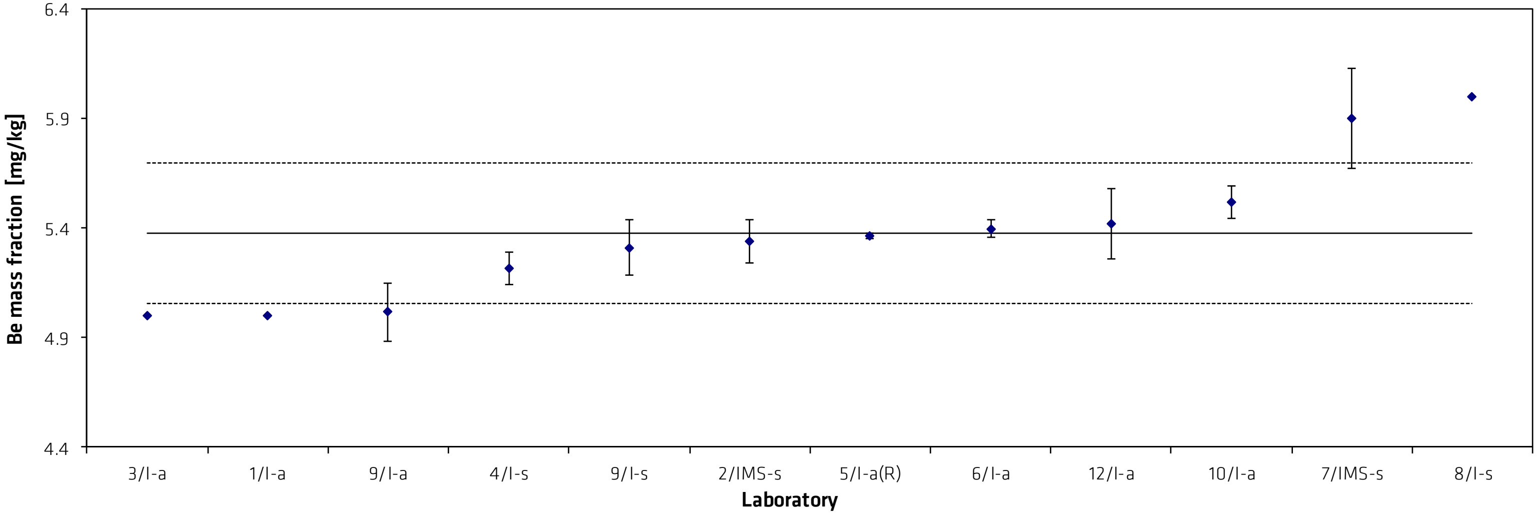


Table 13: Results for Bi

Lab./Meth.	1/I-s	7/I-s_2	7/I-s_1	6/I-s(R)	3/I-a(R)	12/I-a	2/IMS-s	10/I-a	5/I-a	9/I-s	4/I-s	8/I-s	7/IMS-s		
M_i [mg/kg]	85	88.0	86.1	89.6	91.0	91.0	93.1	91.1	92.6	96.0	94.4	95	94.4		n
	85	88.0	91.7	91.2	93.0	91.4	93.9	92.6	92.2	91.6	94.8	101	97.5		13
	84	88.8	88.8	91.6	90.0	92.0	92.6	91.9	93.0	91.2	92.6	96	99.0		
	85	85.2	88.0	89.8	91.0	91.5	90.8	91.6	92.3	91.4	92.6	99	94.1		
	84	90.9	95.0	90.4	90.0	92.1	90.5	91.7	93.2	94.9	95.0	89	95.5		
	84	88.8	88.6	90.6	91.0	91.6	90.5	93.3	92.1		90.5	93	96.5		
												94			
												93			
M [mg/kg]	84.5	88.3	89.7	90.6	91.0	91.6	91.9	92.0	92.6	93.0	93.3	95.0	96.2		91.5
s [mg/kg]	0.55	1.85	3.16	0.77	1.10	0.40	1.49	0.79	0.45	2.26	1.74	3.74	1.88	s_M [mg/kg]	2.96
														$\bar{s}_i$ [mg/kg]	1.85
s_{rel}	0.006	0.021	0.035	0.009	0.012	0.004	0.016	0.009	0.005	0.024	0.019	0.039	0.020		0.032

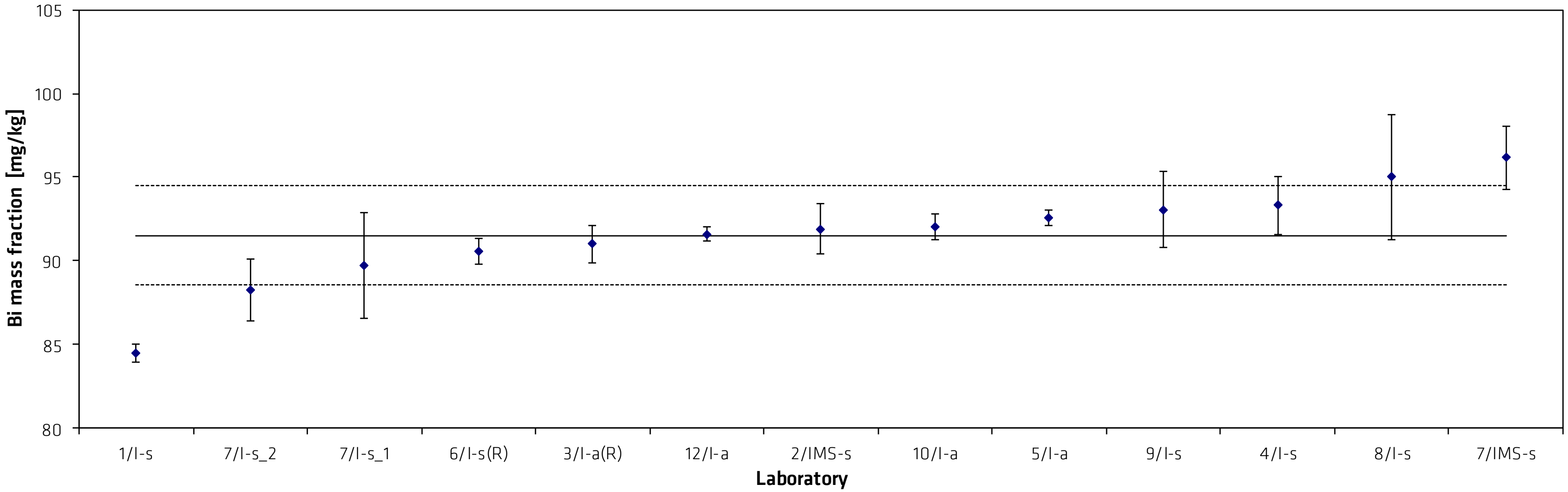


Table 14: Results for Ca

Lab./Meth.	8/I-s(R)	9/I-s	4/I-s	2/I-s	7/I-s	1/I-s	6/I-s	12/I-a		
M_i [mg/kg]	7.0	8.31	10.00	10.0	9.84	12.0	11.41	11.8		*n*
	7.0	11.07	9.70	10.2	9.55	11.0	11.58	13.1		8
	7.0	9.87	10.30	10.6	11.10	11.0	10.27	14.1		
	9.0	7.91	9.60	10.3	10.19	11.0	10.86	12.0		
	9.0	11.16	10.30	10.2	10.92	11.0	12.35	11.8		
	6.0		9.50	10.2	11.09	11.0	12.60	12.4		
	8.0									
M [mg/kg]	**7.6**	**9.7**	**9.9**	**10.2**	**10.4**	**11.2**	**11.5**	**12.5**		**10.4**
s [mg/kg]	1.13	1.51	0.35	0.18	0.68	0.41	0.88	0.91	s_M [mg/kg]	1.47
									$\bar{s}_i$ [mg/kg]	0.86
s_{rel}	0.150	0.157	0.036	0.017	0.065	0.037	0.076	0.073		0.142

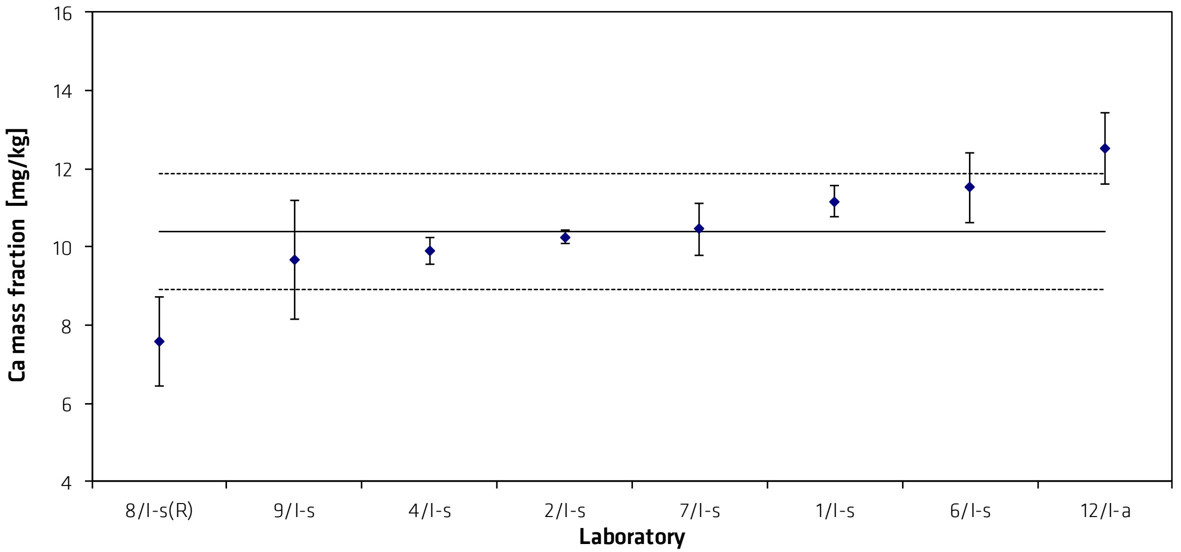


Table 15: Results for Cd

Lab./Meth.	2/I-s	8/I-s	9/I-s	1/I-a	12/I-a	4/I-s	6/I-a	9/I-a	7/IMS-s	7/I-s	3/I-a	10/I-a		
M_i [mg/kg]	4.2	4.0	4.6	4.4	4.6	4.7	4.6	4.6	5.0	5.1	5.0	5.3		*n*
	4.2	4.0	4.4	4.5	4.5	4.7	4.6	4.8	4.9	5.0	5.0	5.2		12
	4.2	4.0	4.3	4.4	4.4	4.6	4.8	4.9	4.9	5.0	6.0	5.2		
	4.1	5.0	4.3	4.4	4.5	4.5	5.1	5.1	4.9	5.0	<5	5.3		
	3.9	5.0	4.5	4.4	4.5	4.6	4.5	4.9	4.8	5.3	5.0	5.3		
	4.0	4.0	4.1	4.4	4.6	4.7	4.7	4.7	4.9	4.9	<5	5.3		
		4.0						4.5						
		4.0												
M [mg/kg]	**4.09**	**4.33**	**4.36**	**4.42**	**4.52**	**4.63**	**4.74**	**4.78**	**4.90**	**5.05**	**5.25**	**5.27**		**4.69**
s [mg/kg]	0.12	0.52	0.15	0.04	0.08	0.08	0.22	0.17	0.06	0.14	0.50	0.05	s_M [mg/kg]	0.37
													$\bar{s}_i$ [mg/kg]	0.24
s_{rel}	0.0295	0.1192	0.0333	0.0092	0.0167	0.0176	0.0459	0.0346	0.0129	0.0273	0.0952	0.0098		0.0796

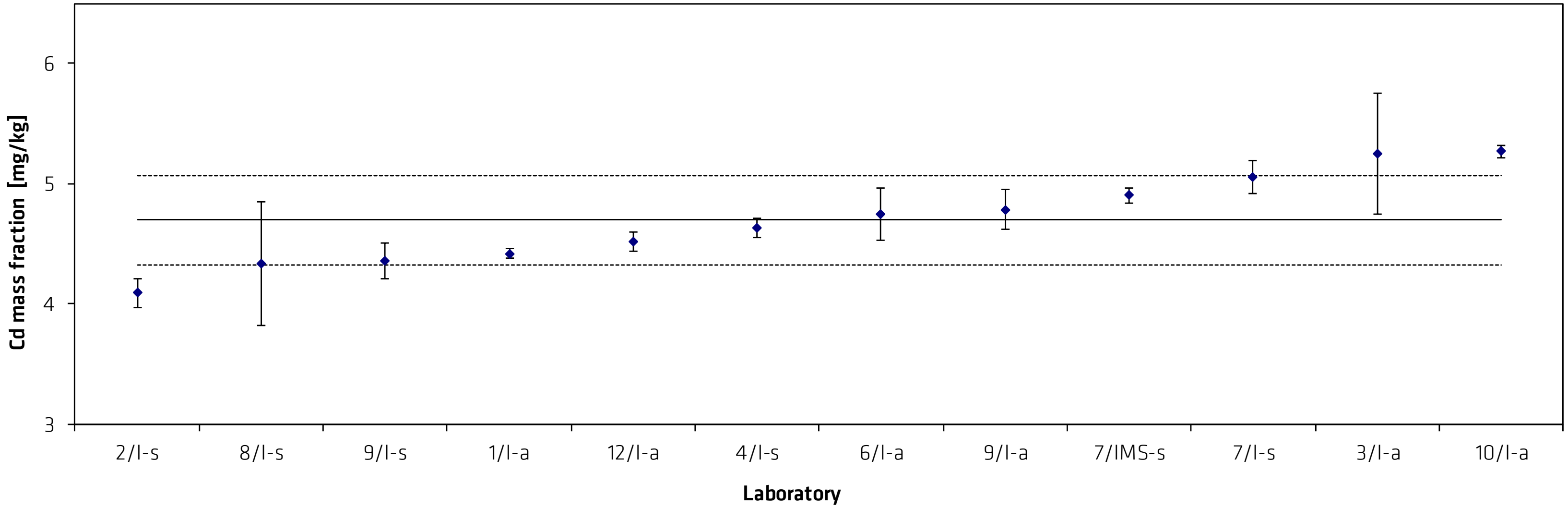


Table 16: Results for Ga

Lab./Meth.	12/I-a	9/I-a	7/I-s_2	2/IMS-s	3/I-a	9/I-s	8/I-s	1/I-a	6/I-a	5/I-a(R)	4/I-s	7/IMS-s	10/I-a(R)		
M_i [mg/kg]	100.0	104.2	109.0	103.9	114	108.0	106	107	108.1	108.4	110	109.3	113.0		*n*
	101.5	106.9	103.0	104.9	98	106.7	106	108	109.2	107.9	111	107.8	113.0		13
	105.0	101.6	101.0	103.1	109	104.8	106	107	108.4	108.5	108	111.2	112.0		
	102.0	104.4	107.0	104.0	105	103.6	107	107	107.7	108.3	110	108.9	114.0		
	105.6	103.9	104.0	103.6	111	105.8	105	107	108.4	108.9	109	109.0	110.0		
	102.0	101.5	98.0	102.7	97		107	107	108.0	109.1	109	111.8	114.0		
		99.6					105								
							107								
M [mg/kg]	102.7	103.2	103.7	103.7	105.7	105.8	106.1	107.2	108.3	108.5	109.5	109.7	112.7		106.7
s [mg/kg]	2.16	2.43	3.98	0.78	6.98	1.69	0.83	0.41	0.51	0.43	1.05	1.52	1.51	s_M [mg/kg]	2.99
														$\bar{s}_i$ [mg/kg]	2.57
s_{rel}	0.021	0.024	0.038	0.008	0.066	0.016	0.008	0.004	0.005	0.004	0.010	0.014	0.013		0.028

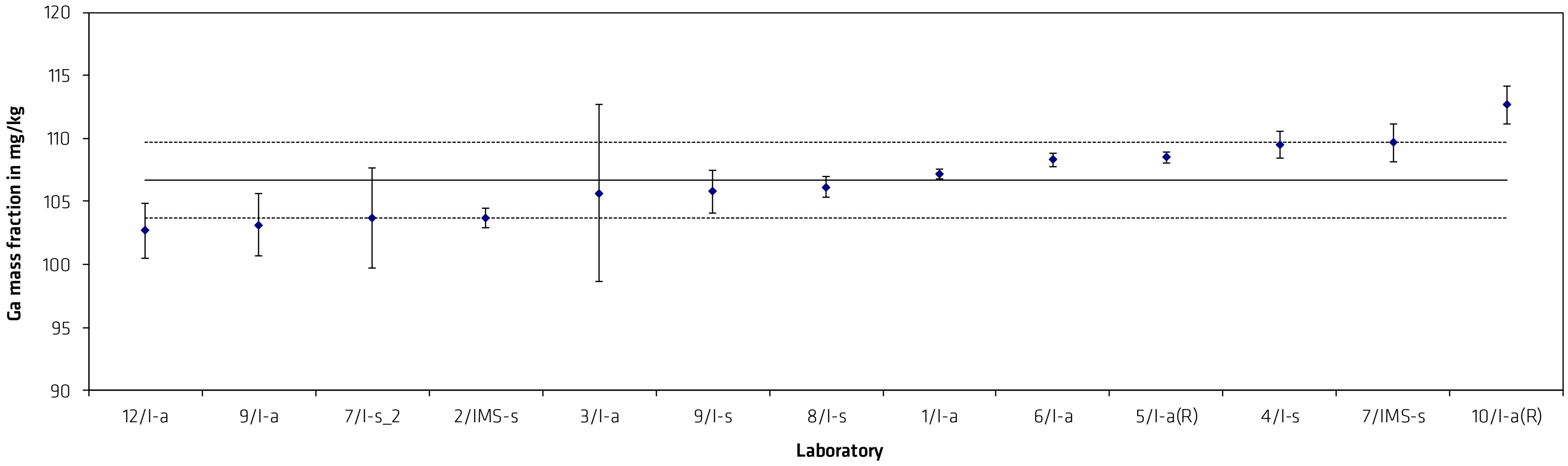


Table 17: Results for Hg

Lab./Meth.	12/I-a	2/IMS-s	1/I-s	6/I-s	9/AFS	7/IMS-s	9/CVA		
M_i [mg/kg]	3.0	4.01	3.4	3.56	3.86	4.3	4.55		*n*
	2.3	4.39	3.4	3.31	3.69	4.3	4.39		7
	2.7	4.20	3.5	2.98	3.83	4.4	4.83		
	3.1	2.63	3.2	3.40	3.85	4.1	4.47		
	2.6	2.57	3.4	4.97	3.79	4.0	4.82		
	2.7	2.50	3.5	4.34	3.61	4.4	5.13		
M [mg/kg]	**2.73**	**3.38**	**3.40**	**3.76**	**3.77**	**4.25**	**4.70**		**3.71**
s [mg/kg]	0.29	0.90	0.11	0.75	0.10	0.16	0.28	s_M [mg/kg]	0.64
								$\overline{s}_i$ [mg/kg]	0.48
s_{rel}	0.105	0.267	0.032	0.199	0.027	0.039	0.059		0.171

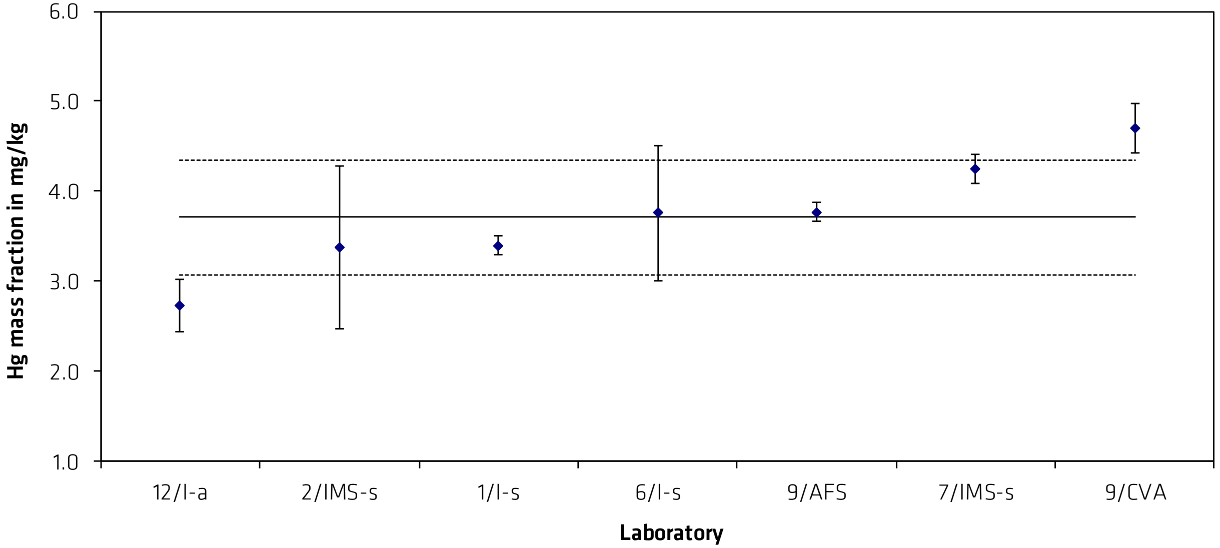


Table 18: Results for Li

Lab./Meth.	6/I-s	8/I-s	3/I-a	4/I-s	9/I-s	12/I-a	2/I-s	1/I-s		
M_i [mg/kg]	10.5	11	12	11.5	11.8	11.3	11.6	12		*n*
	10.4	11	11	11.3	11.6	11.6	11.5	12		8
	10.6	11	10	11.5	11.5	11.7	11.6	12		
	10.5	11	12	11.6	11.4	11.3	12.1	12		
	10.6	11	11	11.4	11.6	11.4	11.8	12		
	10.6	11	10	11.2	11.0	11.6	11.7	12		
		11								
		11								
M [mg/kg]	**10.5**	**11.0**	**11.0**	**11.4**	**11.5**	**11.5**	**11.7**	**12.0**		**11.3**
s [mg/kg]	0.08	0.00	0.89	0.15	0.28	0.17	0.24	0.00	s_M [mg/kg]	0.46
									$\bar{s}_i$ [mg/kg]	0.35
s_{rel}	0.008	0.000	0.081	0.013	0.024	0.015	0.020	0.000		0.041

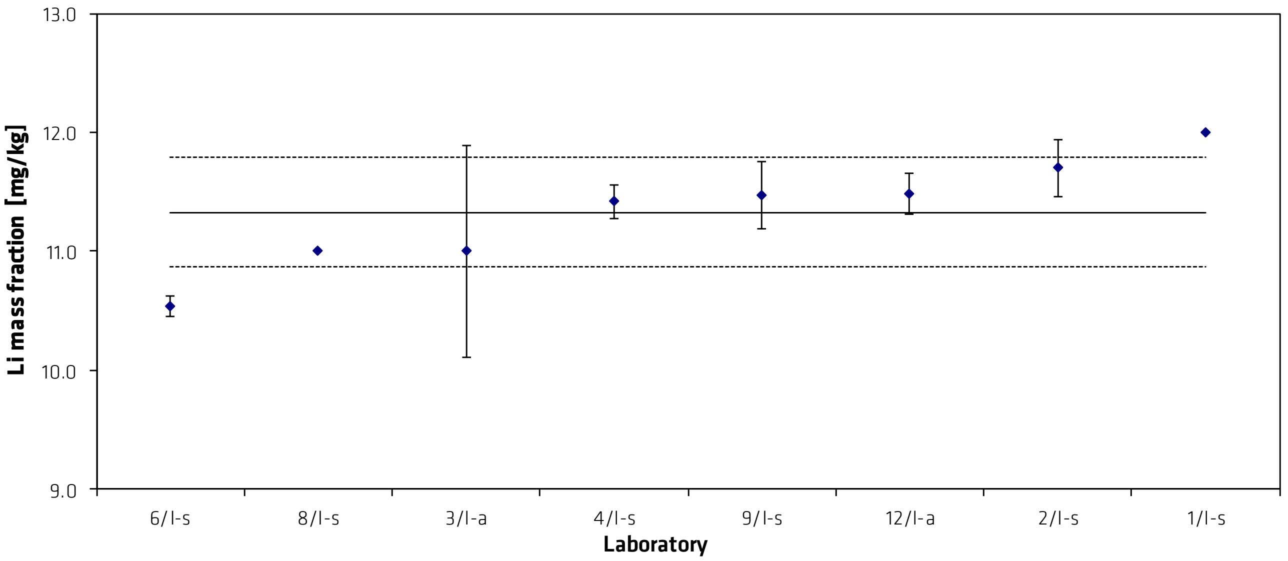


Table 19: Results for Mo

Lab./Meth.	8/I-s	6/I-a	7/I-s	7/IMS-s	1/I-s	2/IMS-s	4/I-s	12/I-a		
M_i [mg/kg]	3.0	3.9	3.4	4.4	4.6	5.7	6.0	6.1		*n*
	3.0	3.6	4.0	4.7	5.0	5.8	5.0	6.4		8
	3.0	3.4	4.3	4.5	4.8	5.7	6.1	6.3		
	3.0	3.4	4.2	4.7	4.6	5.6	6.1	6.1		
	4.0	4.0	4.5	4.5	4.8	5.8	6.1	6.4		
	3.0	4.0	3.9	4.6	4.8	5.7	6.1	6.2		
	3.0									
	3.0									
M [mg/kg]	**3.1**	**3.7**	**4.1**	**4.6**	**4.8**	**5.7**	**5.9**	**6.3**		**4.8**
s [mg/kg]	0.35	0.29	0.38	0.12	0.15	0.06	0.44	0.14	s_M [mg/kg]	1.12
									$\overline{s}_i$ [mg/kg]	0.28
s_{rel}	0.113	0.078	0.095	0.027	0.032	0.010	0.075	0.022		0.234

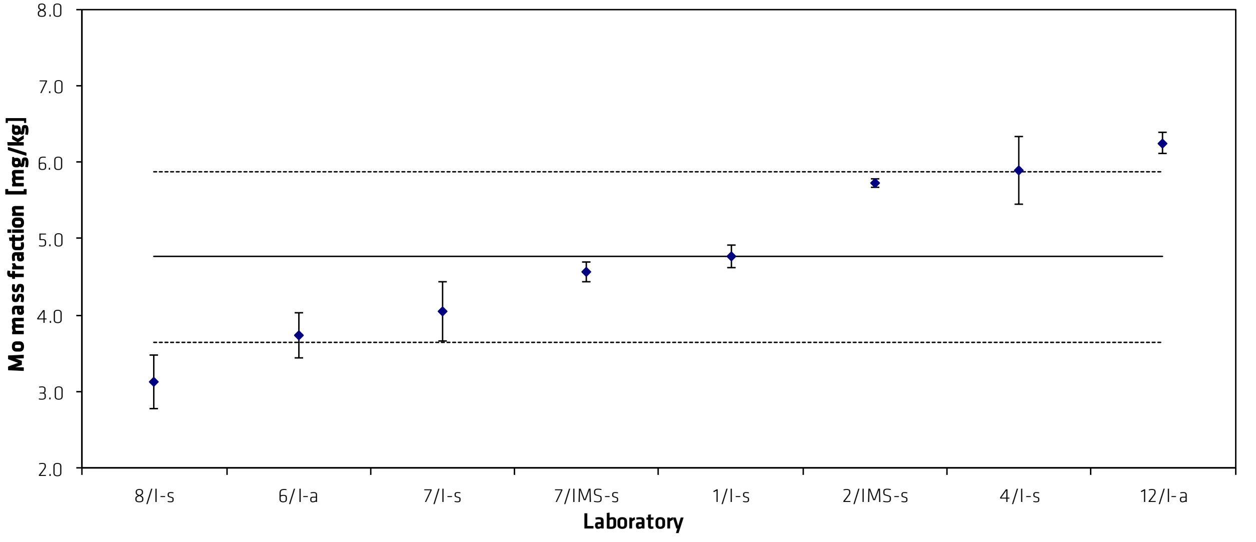


Table 20: Results for Na

Lab./Meth.	2/I-s	6/I-s	4/I-s	1/I-s	9/I-s	7/IMS-s	7/I-s		
M_i [mg/kg]	22.8	23.1	24.2	24	27.5	25.7	29.1		*n*
	22.5	25.9	23.6	25	25.7	27.8	30.2		7
	22.9	22.6	25.1	25	25.1	29.3	30.2		
	23.9	20.6	24.0	24	25.1	28.2	29.5		
	23.2	24.2	24.7	25	24.6	27.3	19.9		
	22.5	24.3	24.9	24		25.5	30.2		
M [mg/kg]	23.0	23.4	24.4	24.5	25.6	27.3	28.2		25.2
s [mg/kg]	0.53	1.82	0.58	0.55	1.11	1.47	4.07	s_M [mg/kg]	1.94
								$\bar{s}_i$ [mg/kg]	1.86
s_{rel}	0.023	0.078	0.024	0.022	0.043	0.054	0.144		0.077

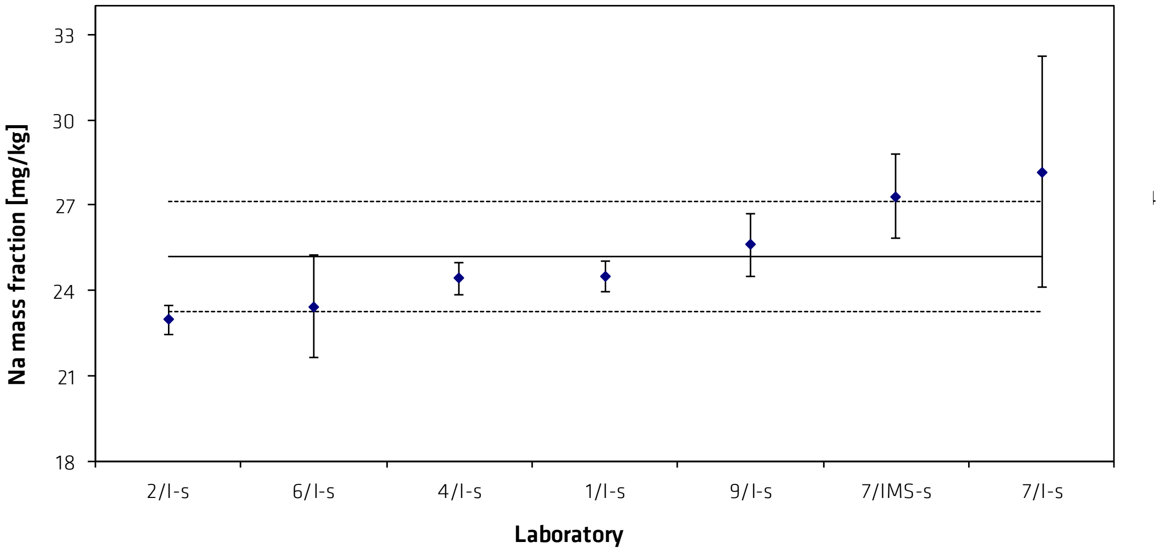


Table 21: Results for Pb

Lab./Meth.	1/I-s	4/I-s	7/IMS-s	5/I-a	2/IMS-s	12/I-a	7/I-s_1	6/I-a	7/I-s_2	9/I-s	8/I-s	10/I-a		
M_i [mg/kg]	36	36.5	37.3	35.0	37.5	37.4	39.3	38.9	40.7	42.0	44	<20		*n*
	36	36.9	36.7	38.4	37.9	35.3	39.5	36.7	39.4	40.4	40	<20		10
	36	36.2	36.8	39.0	37.7	38.5	39.7	40.6	37.7	38.8	42	<20		
	35	37.3	36.7	38.3	38.4	40.4	38.6	40.5	38.8	38.7	47	<20		
	36	36.6	38.0	38.2	38.6	38.7	37.8	37.4	41.2	40.8	43	<20		
	35	37.3	37.0	35.6	37.6	38.4	37.5	38.5	38.7	38.5	45	<20		
											40			
											42			
M [mg/kg]	**35.7**	**36.8**	**37.1**	**37.4**	**37.9**	**38.1**	**38.7**	**38.7**	**39.4**	**39.9**	**43.5**	**<20**		**38.0**
s [mg/kg]	0.52	0.45	0.50	1.67	0.46	1.71	0.93	1.58	1.32	1.41	2.43		s_M [mg/kg]	1.28
													$\bar{s}_i$ [mg/kg]	1.34
s_{rel}	0.0145	0.0122	0.0136	0.0447	0.0121	0.0448	0.0240	0.0408	0.0334	0.0355	0.0558			0.034

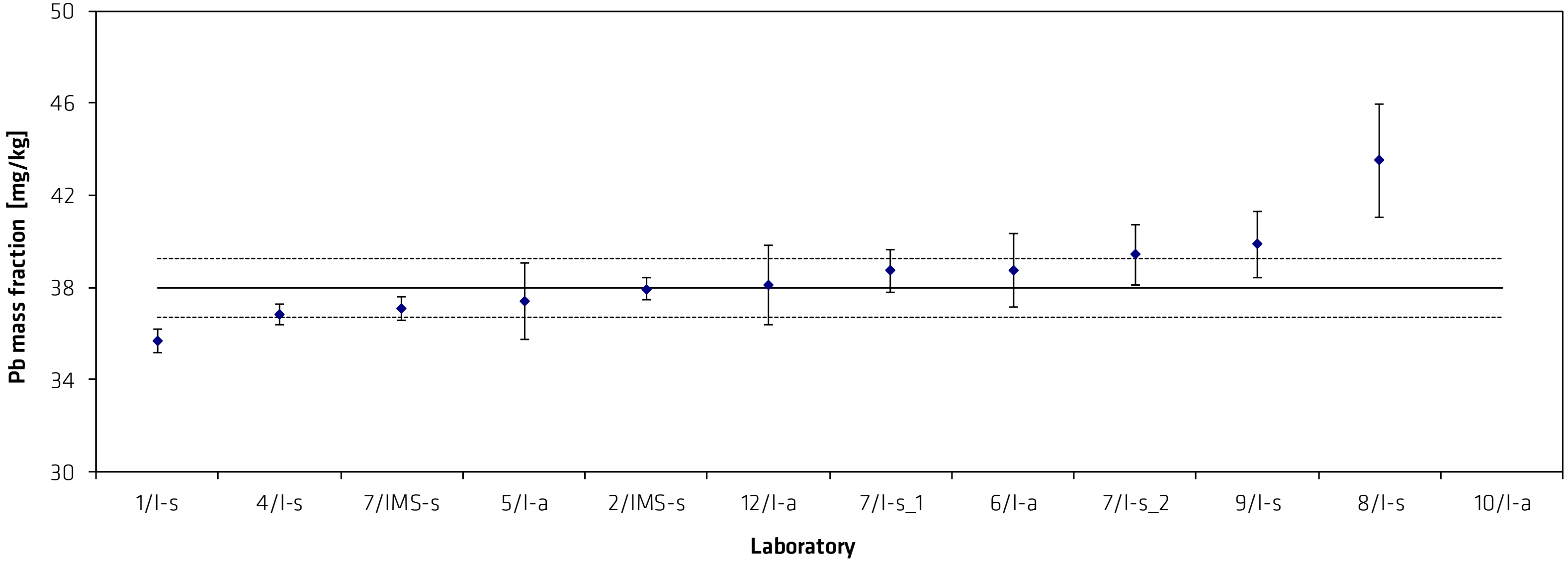


Table 22: Results for Sb

Lab./Meth.	8/I-s	7/IMS-s	6/I-s	2/IMS-s	4/I-s	12/I-a	10/I-a		
M_i [mg/kg]	7.0	4.9	6.1	6.9	7.1	7.8	<8		*n*
	5.0	5.6	5.3	6.8	6.7	7.0	<8		6
	6.0	5.5	4.9	6.8	7.0	6.5	<8		
	5.0	5.4	4.4	6.4	7.2	7.6	<8		
	4.0	5.3	7.3	6.6	6.8	7.4	<8		
	4.0	5.3	5.6	6.5	6.7	6.7	<8		
	4.0								
	6.0								
M [mg/kg]	**5.1**	**5.3**	**5.6**	**6.7**	**6.9**	**7.2**	**<8**		**6.1**
s [mg/kg]	1.13	0.24	0.99	0.21	0.21	0.52		s_M [mg/kg]	0.88
								$\bar{s}_i$ [mg/kg]	0.62
s_{rel}	0.220	0.045	0.177	0.031	0.031	0.072			0.144

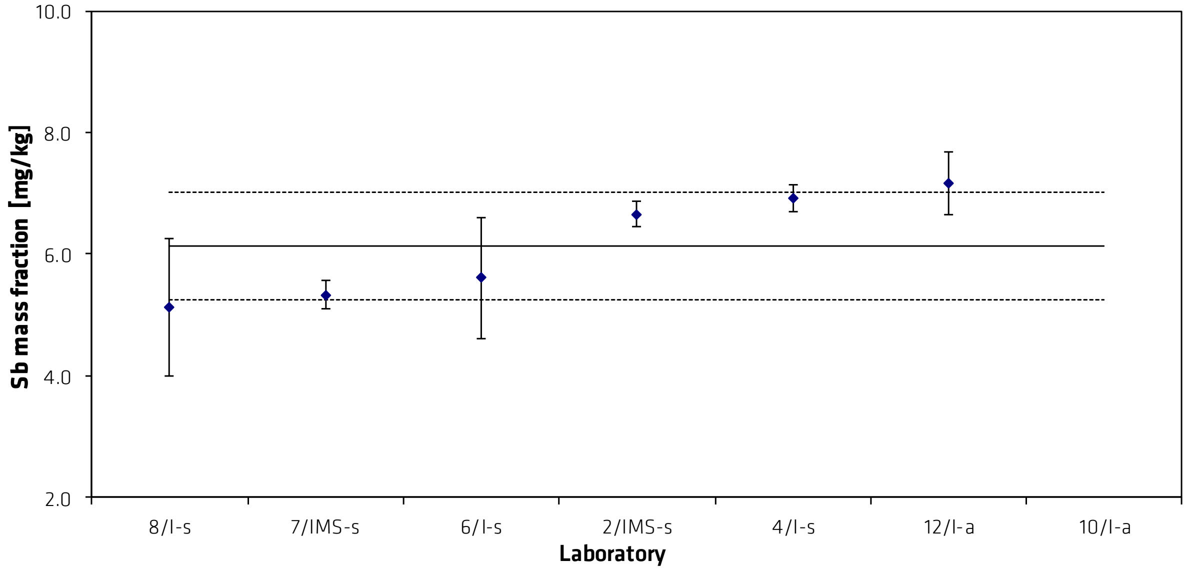


Table 23: Results for Sn

Lab./Meth.	8/I-s	6/I-a	2/IMS-s	9/I-a	12/I-a	10/I-a	7/I-s_2	7/IMS-s	7/I-s_1	4/I-s	1/I-s	5/I-a	3/I-a(R)		
M_i [mg/kg]	184	188.7	191.1	187.6	190.4	189	195	194.8	196.6	199	196	200.3	199		*n*
	179	190.7	191.3	192.0	191.1	190	187	196.0	198.6	194	200	202.4	201		13
	184	193.8	191.8	190.4	190.2	193	188	201.2	193.6	199	197	197.7	204		
	182	188.8	188.8	192.9	191.2	192	195	187.0	194.6	197	198	199.9	199		
	180	186.5	188.2	193.7	190.5	192	193	196.9	193.8	198	198	200.9	202		
	180	183.7	189.0	189.3	191.0	190	189	196.0	195.4	196	198	199.1	199		
	180			185.6											
	185														
M [mg/kg]	181.8	188.7	190.0	190.2	190.7	191.0	191.2	195.3	195.4	197.2	197.8	200.1	200.7		193.1
s [mg/kg]	2.31	3.44	1.53	2.93	0.42	1.55	3.60	4.64	1.90	1.94	1.33	1.60	2.07	s_M [mg/kg]	5.28
														$\bar{s}_i$ [mg/kg]	2.50
s_{rel}	0.013	0.018	0.008	0.015	0.002	0.008	0.019	0.024	0.010	0.010	0.007	0.008	0.010		0.027

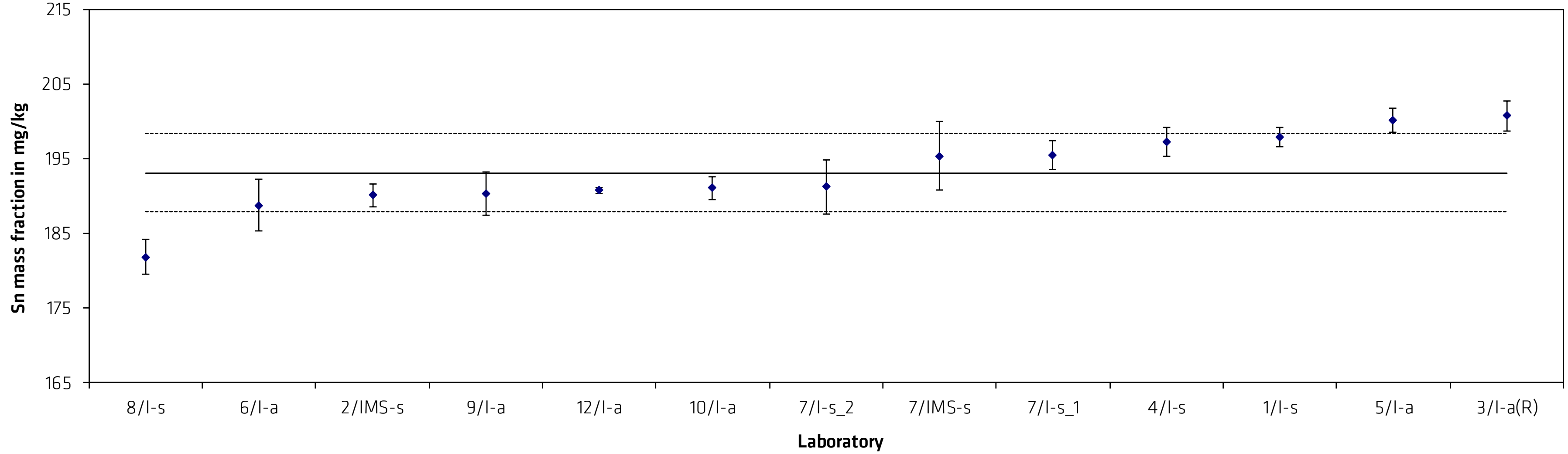


Table 24: Results for Tl

Lab./Meth.	6/I-s	7/I-s	7/IMS-s	2/IMS-s		
M_i [mg/kg]	4.3	5.4	5.4	5.5		*n*
	4.1	4.8	5.5	5.4		4
	4.5	5.8	5.5	5.4		
	4.9	4.7	5.2	5.5		
	4.3	5.2	5.3	5.4		
	4.2	5.4	5.4	5.3		
M [mg/kg]	**4.4**	**5.2**	**5.4**	**5.4**		**5.1**
s [mg/kg]	0.30	0.41	0.12	0.07	s_M [mg/kg]	0.48
					$\bar{s}_i$ [mg/kg]	0.26
s_{rel}	0.069	0.079	0.022	0.012		0.094

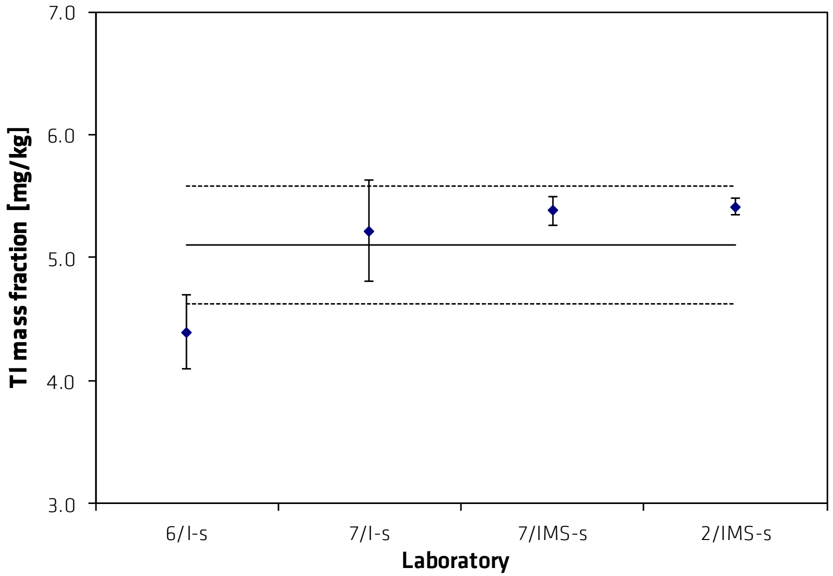


Table 25: Results for V

Lab./Meth.	7/I-s_1	10/I-a	7/I-s_2	6/I-a	2/I-s	1/I-a	8/I-s	9/I-s	12/I-a	5/I-a	4/I-s	9/P	3/I-a		
M_i [mg/kg]	298.4	298	295.0	300.8	307.4	305	309	315.1	311.7	311.1	317.0	316.4	310		*n*
	296.9	300	305.0	303.8	307.3	307	307	309.6	311.8	313.5	312.3	319.8	310		13
	296.8	300	296.0	304.2	308.0	306	307	306.6	314.0	314.3	317.2	316.7	310		
	299.0	300	299.0	301.4	305.2	307	306	307.0	312.0	315.9	307.7	319.8	320		
	298.7	302	307.0	301.9	303.4	308	306	308.5	309.7	316.3	316.3	315.1	330		
	299.4	298	305.0	301.3	303.9	307	308		311.5	317.0	318.3	311.7	330		
							308								
							308								
M [mg/kg]	**298**	**300**	**301**	**302**	**306**	**307**	**307**	**309**	**312**	**315**	**315**	**317**	**318**		**308**
s [mg/kg]	1.1	1.5	5.2	1.4	2.0	1.0	1.1	3.4	1.4	2.2	4.0	3.1	9.8	s_M [mg/kg]	6.7
														$\overline{s}_i$ [mg/kg]	3.7
s_{rel}	0.004	0.005	0.017	0.005	0.006	0.003	0.003	0.011	0.004	0.007	0.013	0.010	0.031		0.022

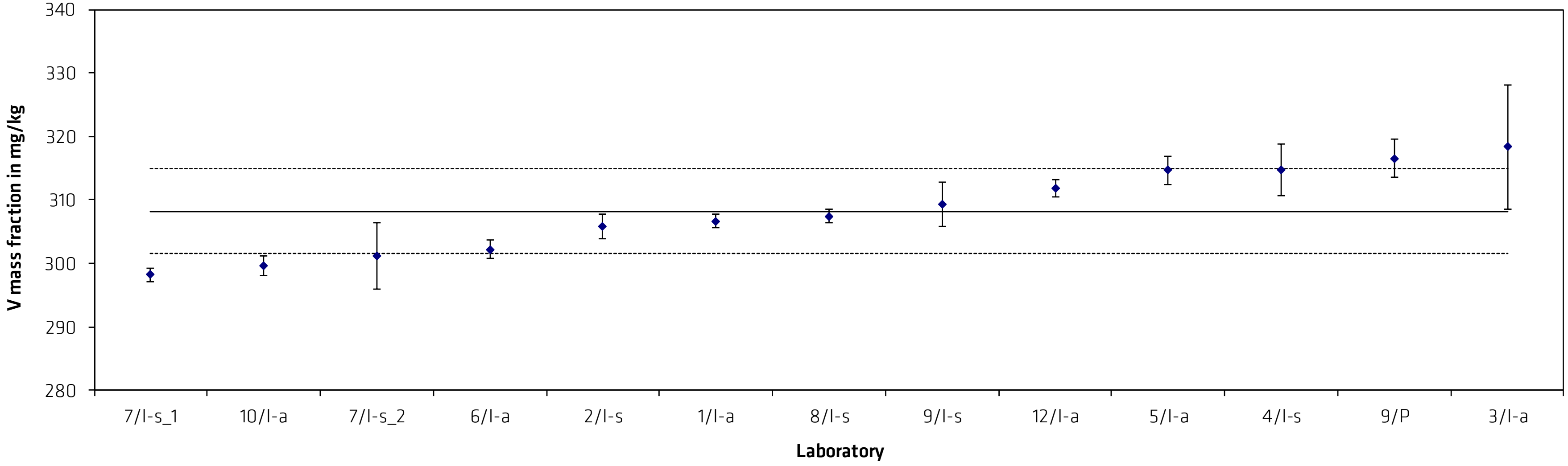
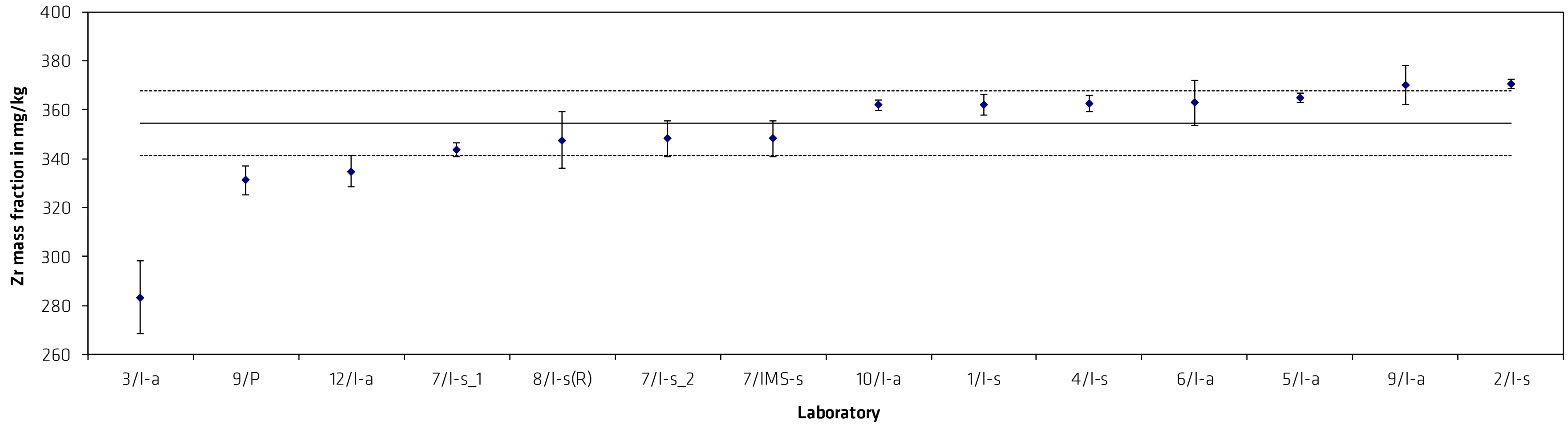


Table 26: Results for Zr

Lab./Meth.	3/I-a	9/P	12/I-a	7/I-s_1	8/I-s(R)	7/I-s_2	7/IMS-s	10/I-a	1/I-s	4/I-s	6/I-a	5/I-a	9/I-a	2/I-s		
M_i [mg/kg]	270	330.6	332	340.6	333	345	345	360.8	357	361	366.9	362.7	370	372.6		*n*
	270	319.5	323	343.2	347	342	342	363.8	367	367	367.8	362.7	380	372.2		13
	270	331.0	339	341.6	344	338	338	362.8	359	359	355.2	366.6	360	372.5		
	290	328.6	336	346.5	348	356	356	360.8	365	361	347.8	364.8	380	369.2		
	300	336.0	340	347.6	358	354	354	364.7	359	361	369.7	365.3	370	368.2		
	300	335.1	338	343.0	360	354	354	358.9	366	366	369.6	367.3	370	368.7		
		336.9			360								360			
					331											
M [mg/kg]	283.3	331.1	334.7	343.8	347.6	348.2	348.2	362.0	362.2	362.5	362.8	364.9	370.0	370.6		354.5
s [mg/kg]	15.06	5.99	6.38	2.75	11.45	7.49	7.49	2.16	4.31	3.21	9.15	1.92	8.16	2.06	s_M [mg/kg]	13.03
															$\bar{s}_i$ [mg/kg]	6.321
s_{rel}	0.053	0.018	0.019	0.008	0.033	0.022	0.022	0.006	0.012	0.009	0.025	0.005	0.022	0.006		0.037



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. 27: Outcome of statistical tests on the results obtained for Si

	1st run	2nd run
Number of data sets	12	11
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 3	---
Dixon (α = 0.01)	---	---
Nalimov (α = 0.05)	Lab. 3	Lab. 4
Nalimov (α = 0.01)	Lab. 3	---
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. 4	Lab. 4
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

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

Tab. 28: Outcome of statistical tests on the results obtained for Fe and Cu

	Fe	Cu
Number of data sets	15	13
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)	---	---
Nalimov (α = 0.05)	Lab. 5	---
Nalimov (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. 3	Lab. 12
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 29: Outcome of statistical tests on the results obtained for Mn and Mg

	Mn	Mg
Number of data sets	15	14
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)	---	---
Nalimov (α = 0.05)	Lab. 3	---
Nalimov (α = 0.01)	Lab. 3	---
Grubbs (α = 0.05)	Lab. 3	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	Labs. 3 and 9/I-s	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 9/I-a	Lab. 9/I-s
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 30: Outcome of statistical tests on the results obtained for Cr and Ni

	Cr	Ni
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)	---	---
Dixon (α = 0.01)	---	---
Nalimov (α = 0.05)	---	Labs. 8/I-s and 7/IMS
Nalimov (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. 7/I-s_2	Lab. 9/I-s
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

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

	Zn	Ti
Number of data sets	14	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. 9/I-a	---
Dixon (α = 0.01)	---	Lab. 5
Nalimov (α = 0.05)	Lab. 9/I-a	Lab. 5
Nalimov (α = 0.01)	Lab. 9/I-a	Lab. 5
Grubbs (α = 0.05)	---	Lab. 5
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 3	Lab. 4
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 32: Outcome of statistical tests on the results obtained for As and Be

	As	Be
Number of data sets	7	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)	---	---
Nalimov (α = 0.05)	---	---
Nalimov (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	---
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 33: Outcome of statistical tests on the results obtained for Bi and Ca

	Bi	Ca
Number of data sets	13	8
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)	---	---
Nalimov (α = 0.05)	Lab. 1	Lab. 8
Nalimov (α = 0.01)	Lab. 1	---
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. 8	---
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 34: Outcome of statistical tests on the results obtained for Cd and Ga

	Cd	Ga
Number of data sets	12	13
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)	---	---
Nalimov (α = 0.05)	---	Lab. 10
Nalimov (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. 3
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 35: Outcome of statistical tests on the results obtained for Hg and Li

	Hg	Li
Number of data sets	7	8
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)	---	---
Nalimov (α = 0.05)	---	---
Nalimov (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. 2	Lab. 3
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 36: Outcome of statistical tests on the results obtained for Mo and Na

	Mo	Na
Number of data sets	8	7
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)	---	---
Nalimov (α = 0.05)	---	---
Nalimov (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. 7
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier was not removed.

Tab. 37: Outcome of statistical tests on the results obtained for Pb

	1st run	2nd run
Number of data sets	11	10
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 8	---
Dixon (α = 0.01)	---	---
Nalimov (α = 0.05)	Lab. 8	---
Nalimov (α = 0.01)	Lab. 8	---
Grubbs (α = 0.05)	Lab. 8	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	---	---
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier (Lab. 8) was removed.

Tab. 38: Outcome of statistical tests on the results obtained for Sb and Sn

	Sb	Sn
Number of data sets	6	13
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)	---	---
Nalimov (α = 0.05)	---	Lab. 8
Nalimov (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. 6	Lab. 7/IMS
Kolmogorov-Smirnov-Lilliefors Test	Distribution: not normal	Distribution: normal

The outliers were not removed.

Tab. 39: Outcome of statistical tests on the results obtained for Tl and V

	Tl	V
Number of data sets	4	13
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	Lab. 6	---
Dixon (α = 0.01)	---	---
Nalimov (α = 0.05)	Lab. 6	---
Nalimov (α = 0.01)	---	---
Grubbs (α = 0.05)	Lab. 6	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 6	Lab. 3
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 40: Outcome of statistical tests on the results obtained for Zr

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

The outlier was not removed.

The certified mass fractions of all elements were calculated as mean of the accepted data sets. These values are given in Table 41.
The respective combined uncertainties (u_{comb}) 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 3.

$$u_{comb} = \sqrt{u_{ilc}^2 + u_{bb}^2(1) + u_{bb}^2(2)} \qquad (3)$$

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 41: 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}(2) and u_{bb}(2) by multiplication with *M*)

		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	0.3460	11	0.0112	0.0034	0.0029	0.0035	0.0057	0.01136	0.8352		1.0212
Fe	0.3877	15	0.0066	0.0017	0.0030	0.0036	0.0049	0.00987	0.7612		0.9216
Cu	0.0932	13	0.0017	0.0005	0.0001	0.0012	0.0013	0.00265	0.0955		1.3249
Mn	0.4860	15	0.0094	0.0024	0.0009	0.0007	0.0027	0.00539	0.1828		0.1512
Mg	3.3503	14	0.0593	0.0159	0.0258	0.0252	0.0394	0.07871	0.7691		0.7514
Cr	0.1173	14	0.0015	0.0004	0.0009	0.0015	0.0018	0.00368	0.7950		1.3066
Ni	0.0296	14	0.0009	0.0002	0.0000	0.0002	0.0003	0.00061	0.1497		0.6205
Zn	0.1481	14	0.0022	0.0006	0.0005	0.0010	0.0013	0.00252	0.3406		0.6708
Ti	0.0988	15	0.0011	0.0003	0.0005	0.0028	0.0029	0.00571	0.5314		2.8289
	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			
As	3.85	7	1.67	0.6316	0.1800	0.0439	0.6582	1.3164	4.6766		1.1415
Be	5.37	12	0.32	0.0924	0.0081	0.0585	0.1097	0.2193	0.1516		1.0903
Bi	91.50	13	2.96	0.8210	1.6580	1.5177	2.3929	4.7858	1.8120		1.6586
Ca	10.38	8	1.47	0.5208	0.2210	0.1209	0.5785	1.1571	2.1293		1.1652
Cd	4.69	12	0.37	0.1068	0.2148	0.0897	0.2561	0.5123	4.5806		1.9120
Ga	106.70	13	2.99	0.8293	0.3011	0.5706	1.0507	2.1014	0.2822		0.5348
Hg	3.71	7	0.64	0.2408	0.1855	0.1290	0.3302	0.6604	5.0000	*	3.4784
Li	11.33	8	0.46	0.1623	0.0506	0.0511	0.1775	0.3550	0.4462		0.4511
Mo	4.80	8	1.12	0.3960	0.0096	0.0523	0.3995	0.7991	0.2000	*	1.0903
Na	25.20	7	1.94	0.7340	2.1554	0.2333	2.2888	4.5777	8.5530		0.9259
Pb	38.0	10	1.30	0.4111	0.3572	0.4249	0.6907	1.3815	0.9399		1.1182
Sb	6.14	6	0.88	0.3601	0.0614	0.3006	0.4731	0.9461	1.0000	*	4.8958
Sn	193.1	13	5.30	1.4700	1.0341	2.0781	2.7475	5.4950	0.5355		1.0762
Tl	5.1	4	0.48	0.2400	0.0510	0.0914	0.2618	0.5237	1.0000	*	1.7924
V	308.0	13	6.70	1.8584	1.0285	3.1710	3.8167	7.6333	0.3339		1.0296
Zr	354.5	14	12.52	3.3461	0.7451	3.3450	4.7897	9.5793	0.2102		0.9435
									*estimated		

The expanded uncertainties U are calculated by multiplication of u_{comb} with a coverage factor of $k = 2$ using Equation 4.

$$U = k \cdot u_{comb} \qquad (4)$$

The calculated mass fractions and their resp. expanded uncertainties are given on Page 3 of this report. Rounding was done according to DIN 1333 [4].

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. 42 shows the mean values of wet chemical and spark emission results as well as their standard deviations. The agreement between wet chemistry and SOES is given for all elements.

Tab. 42: 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	0.346	0.012	11	0.347	0.010	16
Fe	0.388	0.007	15	0.392	0.012	17
Cu	0.0932	0.0017	13	0.0926	0.0032	16
Mn	0.486	0.010	15	0.477	0.009	15
Mg	3.35	0.06	14	3.38	0.08	17
Cr	0.1174	0.0015	14	0.1184	0.0042	16
Ni	0.0296	0.0009	14	0.0282	0.0019	16
Zn	0.1481	0.0022	14	0.1486	0.0033	15
Ti	0.0988	0.0011	15	0.0976	0.0039	16
	in mg/kg	in mg/kg		in mg/kg	in mg/kg	
As	3.8	1.7	7	6.2	0.4	4
Be	5.4	0.4	12	5.5	0.4	11
Bi	91.5	3.0	13	94.1	4.9	15
Ca	10.4	1.5	8	9.8	1.4	14
Cd	4.7	0.4	12	5.0	0.9	13
Ga	106.7	3.0	13	112.0	11.5	15
Hg	3.7	0.7	7	3.8	1.0	7
Li	11.3	0.5	8	11.1	1.2	15
Mo	4.8	1.2	8	7.1	0.5	3
Na	25.2	2.0	7	23.3	3.0	13
Pb	38.0	1.3	10	37.0	10.0	16
Sb	6.1	0.9	6	6.3	1.5	6
Sn	193.1	5.3	13	186.5	9.4	15
Tl	5.1	0.5	4	5.8	1.5	3
V	308	7	13	308	13	14
Zr	355	13	14	357	13	15

6. Instructions for users and stability

The certified reference material BAM-M313a 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.
The surface of the material should be cleaned by turning or milling before analysis.
An area 8mm in diameter in the centre of the discs should be avoided for spark optical emission spectrometry.
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 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 with stated purity or traceable commercial calibration solutions.

8. Information on and purchase of the CRM

Certified reference material BAM-M313a 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-M313a 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] DIN 1333:1992-02 Zahlenangaben

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

Silicon (measurement results in %):

	1	2	3	4	5
A1	0.340	0.340	0.341	0.336	0.340
A2	0.336	0.339	0.338	0.338	0.336
A3	0.335	0.333	0.331	0.333	0.332
A4	0.334	0.337	0.334	0.334	0.338
A5	0.332	0.330	0.330	0.332	0.331
B1	0.333	0.332	0.331	0.331	0.331
B2	0.337	0.338	0.338	0.340	0.339
B3	0.341	0.339	0.337	0.339	0.338
B4	0.338	0.335	0.339	0.336	0.337
B5	0.333	0.333	0.332	0.336	0.333
C1	0.338	0.336	0.335	0.337	0.335
C2	0.335	0.337	0.337	0.336	0.338
C3	0.334	0.334	0.334	0.334	0.336
C4	0.338	0.340	0.339	0.338	0.339
C5	0.337	0.337	0.339	0.337	0.336
D1	0.333	0.333	0.333	0.333	0.334
D2	0.340	0.339	0.342	0.340	0.340
D3	0.333	0.333	0.332	0.332	0.331
D4	0.336	0.335	0.334	0.338	0.337
D5	0.334	0.333	0.335	0.335	0.334
E1	0.334	0.334	0.337	0.337	0.337
E2	0.337	0.339	0.337	0.334	0.338
E3	0.332	0.332	0.333	0.333	0.330
E4	0.339	0.338	0.336	0.337	0.338
E5	0.332	0.333	0.332	0.329	0.329
F1	0.333	0.332	0.333	0.332	0.332
F2	0.335	0.336	0.335	0.336	0.334
F3	0.339	0.336	0.340	0.339	0.340
F4	0.333	0.335	0.334	0.335	0.334
F5	0.343	0.342	0.341	0.340	0.340

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.0011891	29	4.10025E-05	23.978087	2.84312E-37	1.562071
Within groups	0.0002052	120	0.00000171			
Total	0.0013943	149				
within-sd	0.0013077					
effective n	5					
s_bb	0.0028033					
s_bb_min	0.0002101					
u_bb	0.0028033					
u_bb(rel.)	0.8351945					

Iron (measurement results in %):

	1	2	3	4	5
A1	0.39	0.38	0.39	0.38	0.39
A2	0.38	0.39	0.38	0.38	0.38
A3	0.38	0.38	0.38	0.38	0.38
A4	0.38	0.38	0.38	0.38	0.38
A5	0.38	0.37	0.38	0.38	0.38
B1	0.38	0.38	0.38	0.38	0.38
B2	0.38	0.38	0.38	0.39	0.39
B3	0.39	0.39	0.38	0.39	0.39
B4	0.38	0.38	0.39	0.38	0.38
B5	0.38	0.38	0.38	0.38	0.38
C1	0.38	0.38	0.38	0.38	0.38
C2	0.38	0.38	0.38	0.38	0.38
C3	0.38	0.38	0.38	0.38	0.38
C4	0.38	0.39	0.39	0.38	0.39
C5	0.38	0.38	0.39	0.38	0.38
D1	0.38	0.38	0.38	0.38	0.38
D2	0.39	0.38	0.39	0.38	0.39
D3	0.38	0.38	0.38	0.38	0.38
D4	0.38	0.38	0.38	0.39	0.38
D5	0.38	0.38	0.38	0.38	0.38
E1	0.38	0.38	0.38	0.39	0.39
E2	0.38	0.38	0.38	0.38	0.38
E3	0.38	0.38	0.38	0.38	0.38
E4	0.38	0.38	0.38	0.38	0.38
E5	0.38	0.38	0.38	0.37	0.37
F1	0.38	0.38	0.38	0.38	0.38
F2	0.38	0.38	0.38	0.38	0.38
F3	0.39	0.38	0.39	0.39	0.39
F4	0.38	0.38	0.38	0.38	0.38
F5	0.39	0.39	0.39	0.39	0.39

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.001534	29	5.28966E-05	4.9590517	2.01032E-10	1.562071
Within groups	0.00128	120	1.06667E-05			
Total	0.002814	149				
within-sd	0.003266					
effective n	5					
s_bb	0.0029062					
s_bb_min	0.0005248					
u_bb	0.0029062					
u_bb(rel.)	0.7611829					

Copper (measurement results in %):

	1	2	3	4	5
A1	0.0898	0.0910	0.0892	0.0892	0.0902
A2	0.0904	0.0896	0.0904	0.0894	0.0904
A3	0.0898	0.0898	0.0908	0.0906	0.0894
A4	0.0892	0.0892	0.0892	0.0906	0.0906
A5	0.0902	0.0892	0.0896	0.0908	0.0906
B1	0.0898	0.0900	0.0898	0.0892	0.0896
B2	0.0896	0.0896	0.0908	0.0898	0.0892
B3	0.0892	0.0908	0.0904	0.0894	0.0908
B4	0.0900	0.0894	0.0900	0.0892	0.0904
B5	0.0898	0.0908	0.0908	0.0898	0.0908
C1	0.0900	0.0898	0.0894	0.0902	0.0900
C2	0.0894	0.0908	0.0896	0.0898	0.0904
C3	0.0908	0.0908	0.0904	0.0900	0.0902
C4	0.0894	0.0902	0.0908	0.0892	0.0906
C5	0.0904	0.0896	0.0902	0.0894	0.0894
D1	0.0902	0.0892	0.0902	0.0898	0.0902
D2	0.0896	0.0904	0.0906	0.0900	0.0908
D3	0.0900	0.0908	0.0900	0.0892	0.0900
D4	0.0904	0.0900	0.0898	0.0892	0.0902
D5	0.0894	0.0900	0.0896	0.0900	0.0894
E1	0.0906	0.0898	0.0906	0.0892	0.0896
E2	0.0904	0.0894	0.0900	0.0896	0.0894
E3	0.0900	0.0902	0.0902	0.0902	0.0894
E4	0.0900	0.0900	0.0900	0.0898	0.0894
E5	0.0896	0.0908	0.0904	0.0902	0.0908
F1	0.0898	0.0906	0.0892	0.0902	0.0896
F2	0.0902	0.0898	0.0898	0.0900	0.0902
F3	0.0900	0.0892	0.0906	0.0896	0.0906
F4	0.0906	0.0892	0.0900	0.0906	0.0900
F5	0.0900	0.0898	0.0894	0.0892	0.0908

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	5.65893E-06	29	1.95136E-07	0.682610654	0.8827692	1.562071
Within groups	3.4304E-05	120	2.85867E-07			
Total	3.99629E-05	149				
within-sd	0.000534665					
effective n	5					
s_bb	0					
s_bb_min	8.5913E-05					
u_bb	8.5913E-05					
u_bb(rel.)	0.09548295					

Manganese (measurement results in %):

	1	2	3	4	5
A1	0.478	0.486	0.472	0.472	0.482
A2	0.484	0.484	0.484	0.474	0.484
A3	0.478	0.478	0.488	0.486	0.474
A4	0.472	0.472	0.472	0.486	0.486
A5	0.482	0.472	0.476	0.488	0.486
B1	0.478	0.480	0.478	0.472	0.484
B2	0.484	0.484	0.488	0.478	0.472
B3	0.472	0.480	0.484	0.474	0.488
B4	0.480	0.474	0.478	0.472	0.484
B5	0.478	0.488	0.488	0.478	0.472
C1	0.480	0.478	0.474	0.482	0.488
C2	0.474	0.488	0.484	0.478	0.484
C3	0.488	0.488	0.484	0.480	0.482
C4	0.474	0.482	0.488	0.472	0.486
C5	0.484	0.484	0.482	0.474	0.474
D1	0.482	0.472	0.482	0.478	0.482
D2	0.484	0.484	0.486	0.474	0.488
D3	0.480	0.488	0.480	0.472	0.480
D4	0.484	0.480	0.478	0.472	0.482
D5	0.474	0.480	0.484	0.480	0.474
E1	0.486	0.478	0.486	0.472	0.484
E2	0.484	0.474	0.480	0.484	0.474
E3	0.480	0.482	0.482	0.482	0.474
E4	0.480	0.484	0.480	0.478	0.474
E5	0.484	0.488	0.484	0.482	0.488
F1	0.478	0.486	0.472	0.482	0.484
F2	0.482	0.478	0.478	0.486	0.482
F3	0.474	0.472	0.486	0.484	0.486
F4	0.486	0.472	0.480	0.486	0.480
F5	0.480	0.478	0.474	0.472	0.488

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.0004699	29	1.62032E-05	0.5425185	0.9707305	1.562071
Within groups	0.003584	120	2.98667E-05			
Total	0.0040539	149				
within-sd	0.005465					
effective n	5					
s_bb	0					
s_bb_min	0.0008782					
u_bb	0.0008782					
u_bb(rel.)	0.1828319					

Magnesium (measurement results in %):

	1	2	3	4	5
A1	3.35	3.37	3.37	3.34	3.38
A2	3.32	3.34	3.35	3.36	3.33
A3	3.31	3.30	3.30	3.31	3.32
A4	3.31	3.35	3.33	3.32	3.35
A5	3.27	3.27	3.29	3.31	3.29
B1	3.30	3.30	3.31	3.30	3.31
B2	3.33	3.35	3.36	3.37	3.37
B3	3.37	3.36	3.36	3.37	3.35
B4	3.33	3.32	3.36	3.36	3.35
B5	3.30	3.30	3.31	3.34	3.31
C1	3.33	3.32	3.33	3.35	3.32
C2	3.34	3.33	3.33	3.35	3.36
C3	3.31	3.33	3.32	3.33	3.36
C4	3.34	3.38	3.37	3.36	3.36
C5	3.33	3.34	3.37	3.34	3.34
D1	3.29	3.30	3.32	3.32	3.31
D2	3.37	3.36	3.39	3.38	3.38
D3	3.30	3.31	3.30	3.30	3.30
D4	3.31	3.32	3.32	3.34	3.34
D5	3.31	3.33	3.35	3.34	3.33
E1	3.33	3.33	3.35	3.35	3.35
E2	3.33	3.35	3.33	3.33	3.34
E3	3.29	3.30	3.30	3.31	3.29
E4	3.33	3.36	3.35	3.36	3.37
E5	3.30	3.31	3.30	3.30	3.31
F1	3.30	3.28	3.32	3.30	3.31
F2	3.33	3.33	3.32	3.32	3.32
F3	3.35	3.35	3.36	3.37	3.39
F4	3.30	3.32	3.31	3.31	3.32
F5	3.40	3.40	3.39	3.40	3.39

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.10027	29	0.0034576	20.063363	1.57786E-33	1.562071
Within groups	0.02068	120	0.0001723			
Total	0.12095	149				
within-sd	0.0131276					
effective n	5					
s_bb	0.025633					
s_bb_min	0.0021094					
u_bb	0.025633					
u_bb(rel.)	0.7690668					

Chromium (measurement results in %):

	1	2	3	4	5
A1	0.118	0.118	0.119	0.118	0.120
A2	0.117	0.118	0.118	0.119	0.118
A3	0.117	0.116	0.116	0.117	0.117
A4	0.117	0.118	0.118	0.117	0.119
A5	0.115	0.116	0.117	0.117	0.117
B1	0.116	0.116	0.116	0.116	0.116
B2	0.118	0.118	0.118	0.119	0.119
B3	0.119	0.119	0.119	0.118	0.119
B4	0.118	0.117	0.119	0.118	0.119
B5	0.116	0.117	0.117	0.118	0.117
C1	0.118	0.118	0.118	0.119	0.117
C2	0.117	0.118	0.117	0.118	0.119
C3	0.117	0.118	0.117	0.117	0.119
C4	0.118	0.119	0.118	0.118	0.119
C5	0.119	0.119	0.120	0.119	0.119
D1	0.116	0.115	0.117	0.117	0.116
D2	0.118	0.118	0.120	0.119	0.119
D3	0.116	0.117	0.117	0.116	0.117
D4	0.118	0.117	0.117	0.118	0.118
D5	0.117	0.118	0.118	0.118	0.118
E1	0.118	0.117	0.119	0.119	0.119
E2	0.118	0.118	0.117	0.118	0.117
E3	0.116	0.116	0.116	0.117	0.116
E4	0.118	0.118	0.118	0.119	0.119
E5	0.116	0.117	0.116	0.116	0.116
F1	0.116	0.116	0.116	0.116	0.117
F2	0.119	0.118	0.118	0.118	0.118
F3	0.118	0.118	0.119	0.119	0.119
F4	0.118	0.118	0.117	0.117	0.117
F5	0.119	0.120	0.119	0.119	0.119

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000139	29	4.79287E-06	11.50289655	7.69319E-23	1.562071
Within groups	5E-05	120	4.16667E-07			
Total	0.000189	149				
within-sd	0.0006455					
effective n	5					
s_bb	0.0009355					
s_bb_min	0.0001037					
u_bb	0.0009355					
u_bb(rel.)	0.7950343					

Nickel (measurement results in %):

	1	2	3	4	5
A1	0.0289	0.0293	0.0286	0.0286	0.0291
A2	0.0292	0.0288	0.0292	0.0287	0.0292
A3	0.0289	0.0289	0.0294	0.0293	0.0287
A4	0.0286	0.0286	0.0286	0.0293	0.0293
A5	0.0291	0.0286	0.0288	0.0294	0.0293
B1	0.0289	0.0290	0.0289	0.0286	0.0288
B2	0.0288	0.0288	0.0294	0.0289	0.0286
B3	0.0286	0.0294	0.0292	0.0287	0.0294
B4	0.0288	0.0287	0.0289	0.0286	0.0292
B5	0.0289	0.0294	0.0294	0.0289	0.0286
C1	0.0290	0.0289	0.0287	0.0291	0.0294
C2	0.0287	0.0294	0.0288	0.0289	0.0292
C3	0.0294	0.0294	0.0292	0.0290	0.0291
C4	0.0287	0.0291	0.0290	0.0286	0.0293
C5	0.0292	0.0288	0.0291	0.0287	0.0287
D1	0.0291	0.0286	0.0291	0.0289	0.0291
D2	0.0288	0.0292	0.0293	0.0287	0.0294
D3	0.0290	0.0294	0.0290	0.0286	0.0290
D4	0.0292	0.0290	0.0289	0.0286	0.0290
D5	0.0287	0.0290	0.0288	0.0290	0.0287
E1	0.0293	0.0289	0.0293	0.0286	0.0288
E2	0.0292	0.0287	0.0290	0.0288	0.0287
E3	0.0290	0.0291	0.0291	0.0291	0.0287
E4	0.0290	0.0292	0.0290	0.0290	0.0287
E5	0.0288	0.0294	0.0292	0.0291	0.0294
F1	0.0289	0.0293	0.0290	0.0291	0.0288
F2	0.0291	0.0289	0.0289	0.0293	0.0291
F3	0.0287	0.0286	0.0293	0.0288	0.0293
F4	0.0293	0.0286	0.0290	0.0293	0.0290
F5	0.0290	0.0289	0.0287	0.0286	0.0294

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.2374E-06	29	4.2669E-08	0.585575922	0.9517421	1.562071
Within groups	8.744E-06	120	7.28667E-08			
Total	9.9814E-06	149				
within-sd	0.000269938					
effective n	5					
s_bb	0					
s_bb_min	4.33752E-05					
u_bb	4.33752E-05					
u_bb(rel.)	0.1496626					

Zinc (measurement results in %):

	1	2	3	4	5
A1	0.146	0.148	0.147	0.145	0.148
A2	0.146	0.147	0.147	0.147	0.145
A3	0.146	0.146	0.145	0.146	0.147
A4	0.145	0.147	0.146	0.145	0.147
A5	0.144	0.144	0.145	0.146	0.145
B1	0.146	0.146	0.147	0.146	0.146
B2	0.146	0.147	0.147	0.147	0.147
B3	0.146	0.146	0.146	0.146	0.145
B4	0.145	0.145	0.147	0.148	0.146
B5	0.146	0.146	0.146	0.148	0.146
C1	0.147	0.147	0.146	0.147	0.146
C2	0.146	0.146	0.145	0.147	0.148
C3	0.146	0.147	0.146	0.147	0.148
C4	0.145	0.147	0.147	0.145	0.146
C5	0.146	0.147	0.148	0.147	0.147
D1	0.146	0.147	0.147	0.146	0.147
D2	0.147	0.145	0.147	0.147	0.147
D3	0.145	0.146	0.145	0.145	0.145
D4	0.145	0.146	0.146	0.147	0.147
D5	0.145	0.146	0.147	0.146	0.145
E1	0.147	0.148	0.149	0.149	0.148
E2	0.146	0.147	0.146	0.147	0.147
E3	0.145	0.145	0.145	0.146	0.146
E4	0.145	0.146	0.147	0.146	0.148
E5	0.146	0.147	0.146	0.145	0.147
F1	0.146	0.145	0.147	0.146	0.147
F2	0.146	0.146	0.147	0.146	0.147
F3	0.146	0.146	0.147	0.146	0.147
F4	0.145	0.147	0.147	0.146	0.147
F5	0.148	0.148	0.146	0.147	0.147

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	5.57333E-05	29	1.92184E-06	2.8262339	4.07614E-05	1.562071
Within groups	8.16E-05	120	6.8E-07			
Total	0.000137333	149				
within-sd	0.000824621					
effective n	5					
s_bb	0.000498365					
s_bb_min	0.000132505					
u_bb	0.000498365					
u_bb(rel.)	0.340568435					

Titanium (measurement results in %):

	1	2	3	4	5
A1	0.099	0.100	0.099	0.099	0.100
A2	0.099	0.099	0.099	0.099	0.099
A3	0.099	0.099	0.098	0.098	0.098
A4	0.099	0.099	0.099	0.099	0.099
A5	0.099	0.099	0.098	0.098	0.099
B1	0.098	0.098	0.098	0.098	0.098
B2	0.100	0.099	0.099	0.099	0.100
B3	0.100	0.100	0.099	0.099	0.099
B4	0.099	0.099	0.099	0.098	0.099
B5	0.099	0.099	0.098	0.099	0.098
C1	0.099	0.099	0.098	0.099	0.099
C2	0.099	0.099	0.098	0.099	0.099
C3	0.098	0.099	0.098	0.098	0.099
C4	0.100	0.100	0.099	0.099	0.099
C5	0.099	0.099	0.100	0.099	0.099
D1	0.099	0.097	0.098	0.098	0.098
D2	0.100	0.099	0.099	0.100	0.100
D3	0.098	0.098	0.098	0.098	0.098
D4	0.099	0.099	0.099	0.099	0.099
D5	0.099	0.099	0.098	0.099	0.098
E1	0.099	0.098	0.098	0.099	0.098
E2	0.100	0.099	0.098	0.099	0.099
E3	0.098	0.098	0.098	0.098	0.098
E4	0.100	0.099	0.099	0.099	0.100
E5	0.099	0.098	0.099	0.098	0.098
F1	0.098	0.098	0.098	0.098	0.098
F2	0.099	0.098	0.099	0.098	0.098
F3	0.099	0.099	0.099	0.099	0.099
F4	0.098	0.099	0.098	0.098	0.098
F5	0.100	0.101	0.100	0.100	0.100

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	4.614E-05	29	1.59103E-06	7.4579741	8.27383E-16	1.562071
Within groups	0.0000256	120	2.13333E-07			
Total	7.174E-05	149				
within-sd	0.00046188					
effective n	5					
s_bb	0.000524919					
s_bb_min	7.42175E-05					
u_bb	0.000524919					
u_bb(rel.)	0.531402369					

Arsenic (measurement results in mg/kg):

	1	2	3	4	5
A1	5.6	5.4	4.5	4.4	5.7
A2	4.3	4.8	5.4	6.4	6.3
A3	5.7	6.3	4.7	6.5	6.4
A4	5.7	4.9	5.6	4.4	5.7
A5	5.0	7.3	6.1	5.8	5.8
B1	5.2	5.6	5.1	5.3	6.7
B2	5.3	5.7	4.9	5.9	5.4
B3	6.2	6.0	5.6	6.1	5.5
B4	5.9	5.7	5.7	6.0	6.4
B5	6.4	6.8	5.8	5.1	5.7
C1	5.0	5.9	5.1	4.8	5.6
C2	5.5	5.7	6.2	5.8	5.8
C3	7.5	6.8	6.0	6.7	6.5
C4	5.3	5.2	6.4	5.4	6.1
C5	5.8	5.6	4.9	5.1	6.0
D1	5.5	6.1	5.2	4.9	5.2
D2	6.0	5.8	5.0	5.2	5.7
D3	5.4	5.7	5.2	6.4	4.5
D4	5.3	4.8	6.8	5.6	3.7
D5	5.6	5.2	5.5	6.3	6.2
E1	5.5	7.2	6.3	5.6	5.3
E2	5.7	7.4	6.0	5.6	5.7
E3	6.2	6.7	5.1	5.5	6.2
E4	5.6	5.6	6.5	5.6	5.3
E5	5.9	7.5	4.6	5.9	7.3
F1	5.9	6.3	6.7	6.0	6.4
F2	6.0	5.7	5.6	6.5	7.4
F3	5.8	5.9	5.9	6.2	5.3
F4	6.0	5.8	7.3	6.5	5.9
F5	4.8	5.3	4.8	5.1	5.7

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	22.0304	29	0.759669	1.9093556	0.0081947	1.562071
Within groups	47.744	120	0.3978667			
Total	69.7744	149				
within-sd	0.6307667					
effective n	5					
s_bb	0.268999					
s_bb_min	0.1013552					
u_bb	0.268999					
u_bb(rel.)	4.6766168					

Beryllium:

	1	2	3	4	5
A1	5.36	5.53	5.50	5.37	5.41
A2	5.42	5.39	5.42	5.38	5.42
A3	5.36	5.36	5.44	5.53	5.38
A4	5.37	5.50	5.37	5.53	5.53
A5	5.41	5.40	5.39	5.44	5.53
B1	5.36	5.40	5.36	5.37	5.39
B2	5.39	5.50	5.44	5.36	5.37
B3	5.37	5.44	5.42	5.38	5.50
B4	5.39	5.38	5.36	5.37	5.42
B5	5.36	5.44	5.44	5.36	5.37
C1	5.40	5.36	5.38	5.41	5.44
C2	5.38	5.44	5.39	5.36	5.42
C3	5.44	5.44	5.42	5.40	5.41
C4	5.38	5.50	5.44	5.37	5.53
C5	5.42	5.39	5.41	5.38	5.38
D1	5.41	5.37	5.41	5.36	5.41
D2	5.39	5.40	5.53	5.38	5.44
D3	5.40	5.44	5.40	5.50	5.40
D4	5.42	5.40	5.36	5.37	5.41
D5	5.38	5.40	5.39	5.40	5.38
E1	5.53	5.36	5.53	5.37	5.39
E2	5.42	5.38	5.50	5.39	5.38
E3	5.40	5.41	5.41	5.41	5.38
E4	5.40	5.42	5.40	5.36	5.38
E5	5.39	5.44	5.42	5.41	5.44
F1	5.36	5.53	5.37	5.41	5.39
F2	5.41	5.36	5.36	5.53	5.41
F3	5.38	5.37	5.53	5.39	5.53
F4	5.43	5.37	5.50	5.53	5.40
F5	5.40	5.36	5.38	5.37	5.44

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.06463	29	0.0022286	0.8546417	0.679465	1.562071
Within groups	0.31292	120	0.0026077			
Total	0.37755	149				
within-sd	0.0510653					
effective n	5					
s_bb	0					
s_bb_min	0.0082055					
u_bb	0.0082055					
u_bb(rel.)	0.1515881					

Bismuth:

	1	2	3	4	5
A1	87	89	92	92	91
A2	84	89	90	90	87
A3	95	96	95	96	94
A4	94	92	92	91	95
A5	91	91	95	93	92
B1	86	87	93	91	87
B2	97	96	96	98	89
B3	92	93	94	96	93
B4	92	93	96	94	95
B5	95	94	92	93	92
C1	93	97	90	88	95
C2	91	92	90	95	98
C3	91	93	96	94	98
C4	93	94	92	93	91
C5	94	96	97	95	94
D1	93	89	91	95	85
D2	92	94	90	96	91
D3	95	98	92	94	92
D4	95	96	95	97	99
D5	91	93	98	94	93
E1	97	91	92	88	86
E2	96	92	91	96	93
E3	95	95	95	93	96
E4	96	96	96	92	96
E5	94	94	95	93	91
F1	92	95	90	84	90
F2	94	89	93	91	91
F3	93	90	95	96	93
F4	97	95	93	95	95
F5	93	95	92	93	93

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	580.59333	29	20.02046	3.4399415	1.08159E-06	1.562071
Within groups	698.4	120	5.82			
Total	1278.9933	149				
within-sd	2.4124676					
effective n	5					
s_bb	1.6852572					
s_bb_min	0.387649					
u_bb	1.6852572					
u_bb(rel.)	1.8119747					

Calcium:

	1	2	3	4	5
A1	10.0	10.0	10.0	10.0	11.0
A2	10.0	10.0	10.0	10.0	10.0
A3	10.0	10.0	10.0	10.0	10.0
A4	10.0	10.0	10.0	10.0	10.0
A5	10.0	9.9	10.0	10.0	10.0
B1	10.0	10.0	10.0	10.0	10.0
B2	10.0	10.0	10.0	10.0	10.0
B3	10.0	10.0	10.0	10.0	10.0
B4	10.0	10.0	10.0	10.0	10.0
B5	10.0	10.0	10.0	10.0	10.0
C1	10.0	10.0	10.0	10.0	10.0
C2	10.0	10.0	10.0	10.0	10.0
C3	9.9	10.0	10.0	10.0	10.0
C4	10.0	10.0	10.0	10.0	10.0
C5	10.0	10.0	10.0	11.0	11.0
D1	10.0	10.0	10.0	10.0	10.0
D2	10.0	10.0	10.0	10.0	10.0
D3	10.0	10.0	10.0	10.0	10.0
D4	10.0	10.0	9.9	10.0	10.0
D5	10.0	10.0	10.0	9.9	10.0
E1	11.0	11.0	12.0	12.0	10.0
E2	10.0	10.0	10.0	10.0	10.0
E3	10.0	10.0	10.0	9.9	10.0
E4	10.0	10.0	10.0	10.0	10.0
E5	10.0	10.0	10.0	10.0	10.0
F1	10.0	10.0	10.0	11.0	11.0
F2	10.0	10.0	10.0	10.0	10.0
F3	10.0	10.0	10.0	10.0	10.0
F4	10.0	10.0	10.0	10.0	11.0
F5	10.0	10.0	10.0	10.0	10.0

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	8.3283333	29	0.2871839	5.0383142	1.31171E-10	1.562071
Within groups	6.84	120	0.057			
Total	15.168333	149				
within-sd	0.2387467					
effective n	5					
s_bb	0.2145618					
s_bb_min	0.0383632					
u_bb	0.2145618					
u_bb(rel.)	2.1292938					

Cadmium

	1	2	3	4	5
A1	5.4	5.5	5.7	5.4	5.7
A2	5.3	5.1	5.4	5.1	5.1
A3	5.2	5.2	5.0	5.1	5.1
A4	5.1	5.1	5.1	5.2	5.1
A5	5.0	4.9	5.0	5.2	4.9
B1	5.5	5.4	5.6	5.4	5.6
B2	5.0	5.2	5.2	5.1	5.3
B3	5.2	5.1	5.2	5.1	5.0
B4	4.9	4.9	5.0	5.0	5.1
B5	5.0	4.9	4.9	5.2	5.0
C1	5.7	5.7	5.6	5.7	5.5
C2	5.4	5.2	5.2	5.2	5.1
C3	5.2	5.3	5.2	5.2	5.3
C4	5.0	5.0	5.1	5.0	5.0
C5	4.9	5.0	4.8	5.0	4.9
D1	5.5	5.6	5.8	5.7	5.7
D2	5.2	5.1	5.2	5.2	5.1
D3	5.1	5.1	5.1	5.2	5.3
D4	5.1	5.0	5.1	5.2	5.2
D5	4.9	4.9	5.1	5.1	5.0
E1	5.8	5.7	5.7	5.7	5.7
E2	5.1	5.2	5.2	5.2	5.2
E3	5.0	5.0	5.0	5.2	5.1
E4	4.9	5.0	5.0	5.1	5.0
E5	4.8	4.8	4.8	4.9	4.9
F1	5.4	5.4	5.5	5.6	5.8
F2	5.2	5.3	5.1	5.2	5.2
F3	5.2	5.1	5.1	5.1	5.0
F4	5.1	5.1	5.1	5.1	5.1
F5	4.8	4.7	4.7	4.9	4.8

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	8.412	29	0.290069	33.860191	7.20646E-45	1.562071
Within groups	1.028	120	0.0085667			
Total	9.44	149				
within-sd	0.0925563					
effective n	5					
s_bb	0.2372772					
s_bb_min	0.0148725					
u_bb	0.2372772					
u_bb(rel.)	4.5806405					

Gallium:

	1	2	3	4	5
A1	110	112	111	110	112
A2	111	111	111	112	111
A3	112	111	111	111	111
A4	110	112	111	111	113
A5	110	109	111	112	111
B1	110	111	110	111	112
B2	110	111	112	112	112
B3	111	111	111	111	111
B4	111	111	112	112	112
B5	112	112	111	113	112
C1	112	111	111	112	111
C2	111	111	111	112	112
C3	111	112	111	111	113
C4	110	110	111	111	111
C5	112	112	113	112	113
D1	111	111	111	112	111
D2	110	110	112	111	112
D3	112	111	112	111	112
D4	111	111	111	112	112
D5	111	111	112	111	112
E1	112	111	113	113	113
E2	111	112	111	111	111
E3	111	111	111	111	111
E4	110	111	111	111	112
E5	110	112	111	111	111
F1	111	111	111	111	112
F2	112	112	111	111	112
F3	110	111	112	111	112
F4	112	113	112	111	112
F5	111	112	111	111	111

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	28.133333	29	0.9701149	2.0352062	0.0040815	1.562071
Within groups	57.2	120	0.4766667			
Total	85.333333	149				
within-sd	0.6904105					
effective n	5					
s_bb	0.3141491					
s_bb_min	0.1109391					
u_bb	0.3141491					
u_bb(rel.)	0.2821698					

Lithium:

	1	2	3	4	5
A1	11.0	11.3	10.7	10.7	11.1
A2	11.2	10.9	11.2	10.8	11.2
A3	10.6	10.6	11.4	11.3	10.8
A4	10.7	10.7	10.7	11.3	11.3
A5	11.1	10.0	11.1	11.4	11.3
B1	10.6	11.0	10.6	10.7	10.9
B2	10.9	10.9	11.4	10.6	10.7
B3	10.7	11.4	11.2	10.8	11.4
B4	10.9	10.8	10.6	10.7	11.2
B5	10.0	11.4	11.4	10.6	10.7
C1	11.0	10.6	10.8	11.1	11.4
C2	10.8	11.4	10.9	10.6	11.2
C3	11.4	11.4	11.2	11.0	11.1
C4	10.8	11.1	11.4	10.7	11.3
C5	11.2	10.9	11.1	10.8	10.8
D1	11.1	10.7	11.1	10.6	11.1
D2	10.9	11.2	11.3	10.8	11.4
D3	11.0	11.4	11.0	10.7	11.0
D4	11.2	11.0	10.6	10.7	11.1
D5	10.8	11.0	10.9	11.0	10.8
E1	11.3	10.6	11.3	10.7	10.9
E2	11.2	10.8	11.0	10.9	10.8
E3	11.0	11.1	10.0	11.1	10.8
E4	11.0	11.2	11.0	10.6	10.8
E5	10.9	11.4	11.0	11.1	11.4
F1	10.6	11.3	11.2	11.1	10.9
F2	11.1	11.0	10.6	11.3	11.1
F3	10.8	10.7	11.3	10.9	11.3
F4	11.3	10.7	11.0	11.3	11.0
F5	11.0	10.6	10.8	10.7	11.4

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.5424	29	0.0531862	0.5729214	0.9580132	1.562071
Within groups	11.14	120	0.0928333			
Total	12.6824	149				
within-sd	0.3046856					
effective n	5					
s_bb	0					
s_bb_min	0.0489586					
u_bb	0.0489586					
u_bb(rel.)	0.4462142					

Sodium:

	1	2	3	4	5
A1	30	30	30	30	32
A2	27	28	28	29	27
A3	27	26	26	27	27
A4	26	25	25	25	26
A5	23	22	24	23	23
B1	30	29	30	30	30
B2	29	29	29	29	28
B3	26	26	27	27	26
B4	25	25	27	26	26
B5	23	23	23	24	23
C1	31	30	29	30	30
C2	28	28	27	28	29
C3	26	27	27	27	28
C4	25	26	25	25	25
C5	24	24	24	24	24
D1	30	29	30	32	29
D2	28	28	28	29	28
D3	27	28	26	27	26
D4	25	26	25	27	27
D5	23	24	25	24	23
E1	32	30	31	31	30
E2	28	28	28	28	28
E3	27	26	26	26	27
E4	26	26	26	25	26
E5	24	23	23	23	23
F1	30	30	31	29	30
F2	28	28	29	28	28
F3	27	26	27	27	27
F4	26	26	26	25	26
F5	24	24	23	24	24

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	776.03333	29	26.75977	63.212055	1.74532E-59	1.562071
Within groups	50.8	120	0.4233333			
Total	826.83333	149				
within-sd	0.6506407					
effective n	5					
s_bb	2.2950572					
s_bb_min	0.1045486					
u_bb	2.2950572					
u_bb(rel.)	8.553008					

Lead:

	1	2	3	4	5
A1	39	40	39	39	41
A2	39	40	41	42	41
A3	41	41	39	41	41
A4	39	41	42	39	42
A5	40	40	39	41	42
B1	41	40	40	37	40
B2	40	40	41	41	41
B3	40	39	40	39	40
B4	41	39	42	41	42
B5	42	41	40	43	41
C1	40	39	41	41	39
C2	39	41	41	41	41
C3	41	42	40	40	42
C4	40	39	40	40	41
C5	41	42	43	42	41
D1	38	40	40	39	41
D2	39	39	41	40	42
D3	41	39	41	40	40
D4	41	40	40	41	41
D5	39	40	41	39	41
E1	41	40	42	44	42
E2	40	41	40	42	41
E3	40	41	39	40	41
E4	38	40	42	40	42
E5	40	42	40	39	40
F1	39	41	40	40	41
F2	40	41	41	40	41
F3	39	40	42	40	40
F4	40	41	42	41	44
F5	41	41	39	39	40

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	54.133333	29	1.8666667	1.6326531	0.0352248	1.562071
Within groups	137.2	120	1.1433333			
Total	191.33333	149				
within-sd	1.0692677					
effective n	5					
s_bb	0.3803507					
s_bb_min	0.171816					
u_bb	0.3803507					
u_bb(rel.)	0.9399112					

Tin:

	1	2	3	4	5
A1	188	191	189	186	191
A2	187	190	190	189	189
A3	191	190	187	188	189
A4	188	189	187	188	192
A5	188	187	187	190	191
B1	188	189	187	188	190
B2	188	189	190	190	191
B3	188	187	187	188	188
B4	189	189	193	191	191
B5	190	191	189	193	191
C1	191	188	190	192	190
C2	188	189	188	190	191
C3	189	190	191	190	193
C4	185	187	188	188	189
C5	193	192	193	193	192
D1	188	188	190	189	192
D2	189	188	192	189	190
D3	189	191	189	189	191
D4	191	189	190	193	191
D5	186	188	190	189	190
E1	190	190	194	193	192
E2	189	192	190	188	190
E3	187	190	188	190	188
E4	187	189	190	189	190
E5	187	188	188	186	188
F1	186	189	189	189	188
F2	189	191	190	191	189
F3	190	188	191	189	190
F4	189	190	190	190	192
F5	189	192	189	189	189

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	207.26	29	7.1468966	3.5734483	4.94778E-07	1.562071
Within groups	240	120	2			
Total	447.26	149				
within-sd	1.4142136					
effective n	5					
s_bb	1.0145833					
s_bb_min	0.2272439					
u_bb	1.0145833					
u_bb(rel.)	0.5355132					

Vanadium:

	1	2	3	4	5
A1	294	297	298	294	299
A2	296	298	298	298	296
A3	299	298	296	299	299
A4	296	299	296	294	300
A5	294	296	296	298	299
B1	295	296	295	296	297
B2	296	296	299	299	301
B3	299	297	297	295	297
B4	297	295	302	298	299
B5	297	299	296	301	298
C1	297	295	297	300	296
C2	295	297	295	297	301
C3	297	299	297	295	303
C4	297	298	298	297	298
C5	301	302	304	300	300
D1	298	293	298	299	296
D2	298	296	301	299	300
D3	296	297	297	295	300
D4	299	297	297	299	299
D5	296	298	298	298	298
E1	299	296	301	304	302
E2	298	297	295	298	296
E3	296	295	294	298	297
E4	296	298	297	299	301
E5	296	297	296	296	297
F1	296	296	294	295	299
F2	299	298	299	297	298
F3	296	296	300	299	300
F4	297	301	295	297	299
F5	300	302	299	301	299

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	245.07333	29	8.4508046	2.4076366	0.0004814	1.562071
Within groups	421.2	120	3.51			
Total	666.27333	149				
within-sd	1.8734994					
effective n	5					
s_bb	0.9940628					
s_bb_min	0.3010445					
u_bb	0.9940628					
u_bb(rel.)	0.3339292					

Zirconium:

	1	2	3	4	5
A1	355	354	353	353	352
A2	353	353	353	354	351
A3	355	354	351	351	351
A4	354	353	351	351	354
A5	352	352	351	352	352
B1	352	352	350	351	349
B2	354	351	352	352	353
B3	355	354	352	351	353
B4	354	352	354	351	353
B5	354	353	351	353	350
C1	353	353	351	352	352
C2	352	353	351	352	352
C3	352	353	352	350	353
C4	354	353	352	351	353
C5	354	354	355	354	353
D1	354	349	352	351	351
D2	355	352	352	353	353
D3	352	351	351	350	351
D4	354	353	352	353	354
D5	353	351	353	352	350
E1	352	351	352	353	351
E2	354	352	351	353	352
E3	352	350	350	352	350
E4	355	352	351	353	355
E5	354	352	353	351	350
F1	352	351	350	351	352
F2	353	351	352	351	352
F3	353	353	354	353	354
F4	351	352	351	351	351
F5	356	357	354	353	353

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	122.99333	29	4.2411494	2.827433	4.04726E-05	1.562071
Within groups	180	120	1.5			
Total	302.99333	149				
within-sd	1.2247449					
effective n	5					
s_bb	0.7404255					
s_bb_min	0.196799					
u_bb	0.7404255					
u_bb(rel.)	0.2101531					

Annex 2: Calculation of uncertainty contribution of potential inhomogeneity (area)

Silicon:

r_0	0.3240	0.3346														
r_in	0.3305	0.3304	0.3305	0.3333	0.3317	0.3294	0.3273	0.3306								
r_middle	0.3376	0.3354	0.3332	0.3373	0.3354	0.3363	0.3326	0.3331	0.3325	0.3329	0.3320	0.3327	0.3345	0.3337	0.3324	0.3315
r_out	0.3274	0.3282	0.3276	0.3297	0.3278	0.3260	0.3281	0.3271	0.3256	0.3279	0.3261	0.3286	0.3287	0.3278	0.3243	0.3294

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000334322	3	0.000111441	26.10117396	2.44993E-09	2.851741336
Within groups	0.000162243	38	4.26956E-06			
Total	0.000496565	41				

within-sd	0.002066291
effective n	9.40
s_bb	0.003377132
s_bb_min	0.000322859
u_bb	0.003377132
u_bb(rel.)	1.021243323

Iron:

r_0	0.3628	0.3808														
r_in	0.3786	0.3794	0.3775	0.3764	0.3762	0.3819	0.3729	0.3749								
r_middle	0.3834	0.3825	0.3804	0.3784	0.3803	0.3785	0.3804	0.3800	0.3779	0.3771	0.3798	0.3787	0.3791	0.3772	0.3790	0.3807
r_out	0.3771	0.3733	0.3768	0.3758	0.3730	0.3693	0.3699	0.3718	0.3713	0.3725	0.3708	0.3761	0.3757	0.3732	0.3745	0.3712

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000367134	3	0.000122378	13.13223349	4.94213E-06	2.851741336
Within groups	0.000354119	38	9.31891E-06			
Total	0.000721253	41				

within-sd	0.003052689
effective n	9.40
s_bb	0.003468665
s_bb_min	0.000476984
u_bb	0.003468665
u_bb(rel.)	0.921616161

Copper:

r_0	0.0859	0.0923														
r_in	0.0916	0.0929	0.0908	0.0912	0.0912	0.0916	0.0912	0.0915								
r_middle	0.0925	0.0935	0.0930	0.0946	0.0931	0.0931	0.0937	0.0923	0.0925	0.0927	0.0947	0.0930	0.0949	0.0933	0.0930	0.0931
r_out	0.0926	0.0930	0.0928	0.0925	0.0939	0.0922	0.0915	0.0940	0.0919	0.0924	0.0928	0.0940	0.0944	0.0926	0.0955	0.0937

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	4.61612E-05	3	1.53871E-05	11.87504211	1.24789E-05	2.851741336
Within groups	4.92384E-05	38	1.29575E-06			
Total	9.53996E-05	41				

within-sd	0.001138309
effective n	9.40
s_bb	0.001224574
s_bb_min	0.000177861
u_bb	0.001224574
u_bb(rel.)	1.324917448

Manganese:

r_0	0.4691	0.4807														
r_in	0.4774	0.4774	0.4748	0.4740	0.4752	0.4761	0.4737	0.4738								
r_middle	0.4792	0.4780	0.4765	0.4773	0.4763	0.4773	0.4761	0.4756	0.4769	0.4771	0.4756	0.4758	0.4764	0.4743	0.4764	0.4755
r_out	0.4804	0.4795	0.4790	0.4783	0.4772	0.4772	0.4768	0.4773	0.4774	0.4777	0.4791	0.4759	0.4750	0.4768	0.4747	0.4742

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.64113E-05	3	8.80375E-06	2.243907951	0.098874105	2.851741336
Within groups	0.000149089	38	3.9234E-06			
Total	0.0001755	41				

within-sd	0.001980758
effective n	9.40
s_bb	0.000720667
s_bb_min	0.000309494
u_bb	0.000720667
u_bb(rel.)	0.151160672

Magnesium:

r_0	3.284	3.451														
r_in	3.391	3.424	3.406	3.433	3.413	3.442	3.425	3.403								
r_middle	3.471	3.443	3.441	3.427	3.444	3.444	3.449	3.436	3.442	3.464	3.461	3.463	3.461	3.434	3.454	3.410
r_out	3.353	3.389	3.379	3.353	3.419	3.396	3.456	3.402	3.415	3.406	3.424	3.426	3.426	3.410	3.389	3.415

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.021023312	3	0.00700771	8.71849802	0.000158081	2.851741336
Within groups	0.030543712	38	0.000803782			
Total	0.051567024	41				

within-sd	0.028351047
effective n	9.40
s_bb	0.025694781
s_bb_min	0.004429861
u_bb	0.025694781
u_bb(rel.)	0.751353335

Chromium:

r_0	0.1172	0.1204														
r_in	0.1163	0.1165	0.1164	0.1169	0.1154	0.1165	0.1164	0.1164								
r_middle	0.1174	0.1177	0.1169	0.1165	0.1163	0.1166	0.1163	0.1162	0.1158	0.1159	0.1163	0.1161	0.1156	0.1157	0.1161	0.1160
r_out	0.1201	0.1189	0.1196	0.1193	0.1193	0.1188	0.1185	0.1187	0.1189	0.1188	0.1183	0.1189	0.1188	0.1192	0.1183	0.1183

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	6.76393E-05	3	2.25464E-05	55.96400833	5.18951E-14	2.851741336
Within groups	1.53092E-05	38	4.02874E-07			
Total	8.29485E-05	41				

within-sd	0.000634723
effective n	9.40
s_bb	0.001535088
s_bb_min	9.91758E-05
u_bb	0.001535088
u_bb(rel.)	1.306621137

Nickel:

r_0	0.0271	0.0295														
r_in	0.0285	0.0291	0.0285	0.0280	0.0283	0.0288	0.0281	0.0286								
r_middle	0.0292	0.0286	0.0284	0.0286	0.0286	0.0287	0.0283	0.0288	0.0290	0.0287	0.0290	0.0284	0.0285	0.0281	0.0288	0.0282
r_out	0.0281	0.0277	0.0279	0.0278	0.0278	0.0279	0.0288	0.0284	0.0288	0.0286	0.0284	0.0281	0.0283	0.0283	0.0283	0.0281

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.42821E-06	3	4.76071E-07	2.596105551	0.066506733	2.851741336
Within groups	6.9684E-06	38	1.83379E-07			
Total	8.39662E-06	41				

within-sd	0.000428228
effective n	9.40
s_bb	0.000176488
s_bb_min	6.69108E-05
u_bb	0.000176488
u_bb(rel.)	0.620472653

Zinc:

r_0	0.1442	0.1550														
r_in	0.1491	0.1463	0.1514	0.1527	0.1524	0.1512	0.1499	0.1511								
r_middle	0.1514	0.1505	0.1521	0.1518	0.1508	0.1517	0.1516	0.1499	0.1489	0.1497	0.1503	0.1494	0.1490	0.1524	0.1478	0.1509
r_out	0.1481	0.1474	0.1481	0.1475	0.1476	0.1480	0.1498	0.1467	0.1468	0.1499	0.1504	0.1495	0.1479	0.1507	0.1485	0.1489

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	3.9386E-05	3	1.31287E-05	3.599975145	0.022022664	2.851741336
Within groups	0.000138581	38	3.64688E-06			
Total	0.000177967	41				

within-sd	0.00190968
effective n	9.40
s_bb	0.001004511
s_bb_min	0.000298388
u_bb	0.001004511
u_bb(rel.)	0.670831433

Titanium:

r_0	0.0945	0.0991														
r_in	0.0956	0.0967	0.0953	0.0967	0.0964	0.0954	0.0964	0.0965								
r_middle	0.0961	0.0963	0.0965	0.0965	0.0967	0.0968	0.0968	0.0974	0.0961	0.0962	0.0962	0.0963	0.0962	0.0967	0.0962	0.0966
r_out	0.1010	0.1022	0.1022	0.1022	0.1016	0.1015	0.1007	0.1006	0.1009	0.1011	0.1003	0.1005	0.1002	0.1004	0.1008	0.1011

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000218781	3	7.29271E-05	130.2541312	4.84091E-20	2.851741336
Within groups	2.12756E-05	38	5.59883E-07			
Total	0.000240057	41				
within-sd	0.000748254					
effective n	9.40					
s_bb	0.002775111					
s_bb_min	0.000116915					
u_bb	0.002775111					
u_bb(rel.)	2.828944381					

Arsenic (data taken from spark emission round robin):

r_0	6.452	6.948		
r_in	6.755	6.775	6.463	6.853
r_out	6.850	6.652	6.766	6.608

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000489399	2	0.000244699	0.006961888	0.993069156	4.737414128
Within groups	0.246038868	7	0.03514841			
Total	0.246528267	9				
within-sd	0.187479091					
effective n	3.20					
s_bb	0					
s_bb_min	0.076623298					
u_bb	0.076623298					
u_bb(rel.)	1.141549828					

Beryllium:

r_0	4.965	5.175														
r_in	5.160	5.190	5.160	5.210	5.140	5.200	5.120	5.160								
r_middle	5.250	5.270	5.250	5.260	5.240	5.200	5.250	5.220	5.220	5.210	5.240	5.220	5.260	5.210	5.200	5.240
r_out	5.320	5.280	5.320	5.290	5.250	5.240	5.230	5.250	5.230	5.230	5.260	5.240	5.260	5.250	5.280	5.230

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.095208333	3	0.031736111	24.25655172	6.11617E-09	2.851741336
Within groups	0.049717381	38	0.001308352			
Total	0.144925714	41				

within-sd	0.036171151
effective n	9.40
s_bb	0.056904211
s_bb_min	0.005651755
u_bb	0.056904211
u_bb(rel.)	1.09030328

Bismuth:

r_0	85.3	124.7														
r_in	107.3	98.5	107.3	112.2	119.0	107.0	108.4	118.6								
r_middle	112.3	105.0	110.2	107.7	106.6	109.7	110.0	103.0	109.1	99.3	109.9	102.9	98.2	107.0	103.5	100.2
r_out	100.3	97.8	104.0	98.1	102.5	97.5	104.9	104.8	98.2	104.8	107.2	103.9	107.1	116.0	97.5	108.5

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	225.8141369	3	75.27137897	1.624985319	0.19965183	2.851741336
Within groups	1760.208149	38	46.32126707			
Total	1986.022286	41				

within-sd	6.805972897
effective n	9.40
s_bb	1.755232067
s_bb_min	1.063435702
u_bb	1.755232067
u_bb(rel.)	1.658640642

Calcium:

r_0	8.98	11.90															
r_in	10.58	10.49	10.53	10.65	10.60	10.91	10.45	10.78									
r_middle	10.67	10.54	10.55	10.67	10.57	10.70	10.69	10.78	10.98	10.70	10.72	10.66	10.69	10.71	11.00	10.77	
r_out	10.21	9.95	9.91	10.04	10.14	10.28	12.15	10.25	10.48	10.36	10.25	10.46	10.36	10.32	10.21	10.31	

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.098076786	3	0.366025595	1.633174705	0.19780223	2.851741336
Within groups	8.516524643	38	0.22411907			
Total	9.614601429	41				
within-sd	0.473412156					
effective n	9.40					
s_bb	0.122888319					
s_bb_min	0.073970819					
u_bb	0.122888319					
u_bb(rel.)	1.165208004					

Cadmium (data taken from spark emission round robin):

r_0	6.074	6.449				
r_in	6.545	6.395	6.715	6.580		
r_out	6.478	6.600	6.550	6.558		

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.135820417	2	0.067910208	3.657686985	0.081758647	4.737414128
Within groups	0.129965046	7	0.018566435			
Total	0.265785463	9				
within-sd	0.136258707					
effective n	3.20					
s_bb	0.124177007					
s_bb_min	0.055689365					
u_bb	0.124177007					
u_bb(rel.)	1.912033369					

Mercury (data taken from spark emission round robin):

r_0	4.14	4.86				
r_in	3.84	3.97	4.12	4.38		
r_out	4.46	4.76	4.26	4.15		

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.323855972	2	0.161927986	1.788129814	0.235874384	4.737414128
Within groups	0.633900231	7	0.090557176			
Total	0.957756204	9				

within-sd	0.300927194
effective n	3.20
s_bb	0.149343156
s_bb_min	0.122989896
u_bb	0.149343156
u_bb(rel.)	3.478354624

Gallium:

r_0	109.4	113.2															
r_in	111.5	111.7	111.9	113.6	112.7	112.6	111.7	111.6									
r_middle	113.1	113.3	113.4	113.0	113.1	113.2	113.1	113.0	113.5	113.2	113.4	113.3	113.4	114.2	113.2	112.8
r_out	112.9	112.5	112.9	113.3	112.3	112.4	113.4	112.8	112.4	113.4	113.0	113.1	113.4	113.2	113.6	112.5

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	11.44342262	3	3.814474206	9.563626262	7.75289E-05	2.851741336
Within groups	15.1563869	38	0.398852287			
Total	26.59980952	41				

within-sd	0.631547533
effective n	9.40
s_bb	0.602898658
s_bb_min	0.098679528
u_bb	0.602898658
u_bb(rel.)	0.534805353

Lithium:

r_0	11.40	12.36														
r_in	11.84	11.57	12.08	11.97	11.91	11.92	11.94	11.99								
r_middle	11.86	11.84	11.95	11.98	11.88	12.16	12.22	12.20	12.27	11.97	12.01	12.16	11.93	12.17	12.30	12.08
r_out	12.03	11.76	11.91	12.00	11.86	12.12	12.13	11.75	11.92	12.07	11.87	12.10	11.97	12.15	11.79	11.92

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.179945536	3	0.059981845	1.841085077	0.156157182	2.851741336
Within groups	1.238025417	38	0.032579616			
Total	1.417970952	41				

within-sd	0.180498244
effective n	9.40
s_bb	0.05400107
s_bb_min	0.028202915
u_bb	0.05400107
u_bb(rel.)	0.451114592

Sodium:

r_0	28.65	30.27														
r_in	30.31	30.11	30.00	30.39	30.43	30.79	29.91	30.34								
r_middle	30.58	30.37	30.86	30.55	30.36	30.16	30.55	30.59	30.58	30.47	30.61	30.58	30.57	30.34	30.84	30.60
r_out	30.01	30.04	30.13	30.05	30.08	30.05	30.22	30.15	30.05	30.44	30.58	30.51	30.36	30.52	29.94	30.19

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.450468155	3	0.816822718	10.50256951	3.61637E-05	2.851741336
Within groups	2.955397083	38	0.077773607			
Total	5.405865238	41				

within-sd	0.278879199
effective n	9.40
s_bb	0.280443947
s_bb_min	0.043574975
u_bb	0.280443947
u_bb(rel.)	0.925944065

Lead:

r_0	31.19	37.85														
r_in	35.01	37.04	35.10	36.14	34.17	36.59	35.80	35.09								
r_middle	36.11	36.54	36.10	35.39	34.67	36.07	35.78	34.60	35.87	35.54	35.78	35.52	35.88	35.37	36.55	34.82
r_out	37.84	34.80	36.85	34.34	36.48	36.41	37.19	37.67	36.78	37.20	36.13	36.08	35.87	36.59	35.37	35.76

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	8.298846726	3	2.766282242	2.205538265	0.103260252	2.851741336
Within groups	47.66125661	38	1.254243595			
Total	55.96010333	41				

within-sd	1.119930174
effective n	9.40
s_bb	0.401135287
s_bb_min	0.174989491
u_bb	0.401135287
u_bb(rel.)	1.118174642

Antimony (data taken from spark emission round robin):

r_0	5.05	6.35		
r_in	6.40	6.70	6.00	6.20
r_out	6.10	7.00	8.00	5.80

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.409	2	0.7045	1.213783202	0.352731739	4.737414128
Within groups	4.062916667	7	0.580416667			
Total	5.471916667	9				

within-sd	0.761850817
effective n	3.20
s_bb	0.196916332
s_bb_min	0.311370839
u_bb	0.311370839
u_bb(rel.)	4.895767911

Tin:

r_0	188.9	207.7														
r_in	194.4	198.7	198.6	195.8	194.5	198.7	194.9	194.9								
r_middle	196.5	196.5	191.8	190.3	191.3	191.0	191.4	195.9	199.4	194.2	195.8	193.8	197.9	196.2	197.1	194.5
r_out	192.1	187.5	191.9	187.0	186.3	188.0	194.1	194.1	193.2	193.6	196.6	193.5	192.5	193.3	192.4	193.7

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	158.4749405	3	52.82498016	4.438224638	0.009054379	2.851741336
Within groups	452.2865357	38	11.90227726			
Total	610.7614762	41				
within-sd	3.449967718					
effective n	9.40					
s_bb	2.086851648					
s_bb_min	0.539058691					
u_bb	2.086851648					
u_bb(rel.)	1.076202522					

Thallium (data taken from spark emission round robin):

r_0	6.495 €	7.138 €				
r_in	6.770 €	6.895 €	7.113 €	7.192 €		
r_out	7.048 €	6.802 €	6.710 €	7.455 €		

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.052936528	2	0.026468264	0.283942413	0.76108356	4.737414128
Within groups	0.652519097	7	0.093217014			
Total	0.705455625	9				
within-sd	0.305314615					
effective n	3.20					
s_bb	0					
s_bb_min	0.124783049					
u_bb	0.124783049					
u_bb(rel.)	1.792387766					

Vanadium:

r_0	299.8	325.6														
r_in	303.3	303.0	299.5	314.8	296.3	302.9	304.2	302.8								
r_middle	300.6	306.3	301.7	303.9	300.8	301.1	301.0	298.1	298.1	299.8	301.1	299.6	301.1	299.1	300.7	300.8
r_out	307.2	303.8	309.1	302.4	308.6	309.1	300.9	306.1	306.3	305.3	304.9	301.5	302.7	306.7	305.5	304.1

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	330.2211905	3	110.0737302	6.068478175	0.001764871	2.851741336
Within groups	689.267	38	18.13860526			
Total	1019.48819	41				

within-sd	4.258944149
effective n	9.40
s_bb	3.127880529
s_bb_min	0.665461548
u_bb	3.127880529
u_bb(rel.)	1.029555525

Zirconium:

r_0	355.9	370.3														
r_in	353.9	357.2	352.9	348.7	349.1	353.6	353.2	352.5								
r_middle	354.9	357.6	355.7	354.1	351.3	354.4	353.1	351.3	350.1	351.5	353.5	352.0	351.6	350.4	352.1	350.1
r_out	359.9	355.5	359.1	356.0	357.7	358.2	354.6	358.3	357.2	357.5	354.6	355.3	358.3	359.2	356.7	357.5

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	337.1616369	3	112.3872123	16.16331562	6.25776E-07	2.851741336
Within groups	264.2226488	38	6.9532276			
Total	601.3842857	41				

within-sd	2.636897344
effective n	9.40
s_bb	3.349652321
s_bb_min	0.412016154
u_bb	3.349652321
u_bb(rel.)	0.943509315