Bundesanstalt für Materialforschung und -prüfung (BAM)

Certification Report

Certified Reference Material

BAM-M325

AlSi7MgSr

October 2023

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Summary

This report describes preparation, analysis and certification of the aluminium alloy reference material BAM-M325. The certified reference material (CRM) is available in the form of discs (50 mm diameter and 30 mm height). It is intended for establishing and checking the calibration of optical emission and X-ray spectrometers (excluding micro-analysis) for the analysis of samples of similar matrix composition. It is also suitable for validation and quality control of wet chemical analysis methods.
The following mass fractions and uncertainties have been certified:

Element	Mass fraction [1] in %	Uncertainty [2] in %
Si	6.83	0.14
Fe	0.143	0.005
Cu	0.0197	0.0006
Mn	0.0112	0.0002
Mg	0.504	0.009
Zn	0.0555	0.0008
Ti	0.117	0.004
	in mg/kg	**in mg/kg**
Cr	63.4	1.6
Ni	47.8	1.8
Ca	26	4
Cd	22.0	1.0
Ga	191	5
Li	8.3	1.5
Pb	104	7
Sb	37	4
Sn	183	5
Sr	301	13
V	95.7	1.2
Zr	56.9	1.6

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

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

Additionally, the mass fraction of Na is given for information:

Element	Mass fraction [1)] in mg/kg	Uncertainty [2)] in mg/kg
Na	13.5	2.8

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

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

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

Content

List of abbreviations

(if not explained elsewhere)

CRM	certified reference material
EA	electrothermal atomic absorption spectrometry
FAAS	flame atomic absorption spectrometry
ICP-OES	inductively coupled plasma optical emission spectrometry
ICP-MS	inductively coupled plasma mass spectrometry
SOES	spark optical emission spectrometry
XRF	X-ray fluorescence spectrometry
M	mean value
n	number of accepted data sets
s	standard deviation of an individual data set
s_M	standard deviation of laboratory means
s_{rel}	relative standard deviation
$\bar{s}_i$	square root of mean of variances of data sets under repeatability conditions
M_i	single result
I	ICP-OES (Tables 2 – 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)
FE	flame emission spectrometry (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-M325 is based on the aluminium alloy AlSi7MgSr, which has a lot of technical 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:

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

Statistical evaluation of the data:

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

3. Candidate material

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

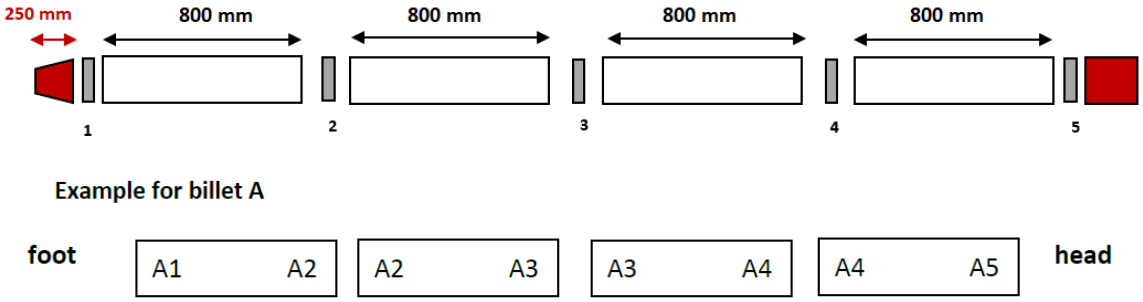


Fig. 1: Preparation of the rods cast (all figures in mm)

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

4. Homogeneity testing

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

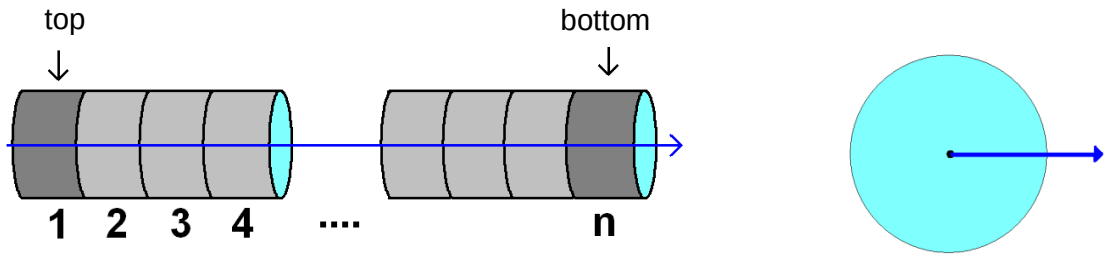


Fig. 2: Axial and radial composition gradient

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

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

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

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

where:

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

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

In addition to the tests performed over the length of the rods three discs were tested for homogeneity over the area (possible segregation from the outer part to the centre) in BAM. To perform this test SOES analysis was carried out in circles (outer circle: 16 sparks, intermediate circle: 12 sparks, inner circle: 6 sparks; centre: 1 spark).

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

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

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

5. Characterisation study

5.1 Analytical methods

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

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

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

Table 1: Analytical procedures used by the participating laboratories

Lab-No.	Element	Sample mass	Sample pretreatment	Analytical method
1*	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Cd, Ga, Pb, Sb, Sn, Sr, V, Zr	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solution (Merck)
	Ca, Na	0.5 g	Dissolution with HNO_3/HCl/HF	ICP-OES, commercial mono-element solution (Merck)
2*	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Sn, V	0.5 g	Dissolution with NaOH	ICP-OES, calibration with pure metals or pure chemicals, matrix matching with pure Al (5N5)
	Ca, Ga, Li, Na, Sr	0.5 g	Dissolution with HNO_3/HF	ICP-OES, calibration with pure metals or chemicals, matrix matching with pure Al (5N5)
	Cd, Pb, Sb, Zr	0.5 g	Dissolution with HNO_3/HF	ICP-MS, commercial mono-element solution (Merck certipur), matrix matching with pure Al (5N5)
3*	Si, Fe, Cu, Mn, Cr, Zn, Ti, Cd, Ni, Pb, Sb, Sn, Sr, V, Zr	0.1 g	Dissolution with NaOH	ICP-OES, commercial mono-element solution
5*	Si, Fe, Cu, Mn, Cr, Ni, Zn, Cd, Ga, Pb, Sn, Sr, Zr	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Merck)
	V	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Labkings)
	Mg, Ti	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Inorganic Ventures)
7*	Si	0.5 g	Dissolution with NaOH	Gravimetry
	Cu, Mn, Mg, Cr, Ni, Ti, Cd, Ga, Li, Pb, Sb, Sn, Sr, V, Zr	1 g	Dissolution with HNO_3/HF	ICP-MS, with matrix matched standards, commercial mono-element standard solutions (Merck, Perkin Elmer)
	Zn	1 g	Dissolution with HNO_3/HF	FAAS, with matrix matched standards, commercial mono-element standard solutions (VWR)
	Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Ca, Cd, Ga, Li, Na, Pb, Sb, Sn, V, Zr	0.5 g	Dissolution with HCl/HNO_3/HF	ICP-OES, with matrix matched standards, commercial mono-element standard solutions (Merck)
8	Si, Fe, Zn, Ga	0.3 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Merck)
	Cu, Mn, Mg, Cr, Ni, Ti, Pb, Sb, Sr, V, Zr	0.5 g	Dissolution with NaOH	ICP-OES, commercial mono-element solutions (Merck)
	Ca, Cd, Li, Sn	0.5 g	Dissolution with HCl	ICP-OES, commercial mono-element solutions (Merck)

*accredited acc. to ISO IEC 17025

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

9*	Zr	0.5 g	Dissolution with NaOH	Spectrophotometry, calibration with commercial mono-element solutions (Merck)
	Fe, Cu, Mn, Mg, Zn	0.5 g	Dissolution with $HCl/HNO_3/HF$	FAAS, calibration with commercial mono-element solution (Merck)
	Li	0.5 g	Dissolution with $HCl/HNO_3/HF$	Atomic emission spectrometry, calibration with commercial mono-element solution (Merck)
	Cu, Cr, Ni, Ti, Ga, Li, Sr, V, Zr	1 g	Dissolution with $HF/HCl/HNO_3$, Addition of mannite	ICP-OES, calibration with matrix matched standards, commercial mono-element solutions
	Fe, Cu, Cr, Mg, Mn, Ni, Ti, Zn, Cd, Ga, Li, Pb, Sb, Sr, Sn, V, Zr	1 g	Dissolution with HCl/HNO_3, Addition of mannite	ICP-OES, calibration with matrix matched standards, commercial mono-element solutions
	Mn	1 g	Dissolution with HNO_3	Spectrophotometry, calibration with commercial mono-element solutions (Merck)
	Sb	0.5 g	Dissolution with $HCl/HNO_3/HF$	Electrothermal tomic absorption spectrometry, calibration with commercial mono-element solution (Merck)
10*	Si, Fe, Cu, Mn, Mg, Ni, Zn, Ti, Cd, Ga, Li, Sn, Sr, V	0.5 g	Dissolution with NaOH	ICP-OES, calibration with matrix matched standards, commercial mono-element solutions
	Fe, Mn, Mg, Cr, Zn, Ti, Cd, Ga, Sn, V, Zr	1 g	Dissolution with HCl/HNO_3	ICP-OES, calibration with matrix matched standards, commercial mono-element solutions
	Si	0.25 g	Dissolution with NaOH	Spectrophotometry, calibration with commercial mono-element solution
	Fe	0.5 g	Dissolution with HCl/HNO_3	Spectrophotometry, calibration with commercial mono-element solution
	Ti	1 g	Dissolution with HCl/HNO_3	Spectrophotometry, calibration with commercial mono-element solution
	Fe, Cu, Mn, Mg, Cr, Zn, Ti, Cd, Ga, Pb, Sn, V, Zr	1 g	Dissolution with HCl/HNO_3	ICP-MS, calibration with commercial mono-element solutions
11	Si, Fe, Cu, Cr, Ti, Bi, Cd, Ga, Pb, Sn, Sr, Zr	0.25 g	Dissolution with NaOH	ICP-OES, calibration with commercial mono-element solutions (Bernd Kraft)
12	Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Ca, Cd, Ga, Li, Pb, Sn, Sr, V, Zr	0.5 g	Dissolution with NaOH	ICP-OES, calibration with matrix matched standards, commercial mono-element solution (Merck)

*accredited acc. to ISO IEC 17025

5.2 Analytical results and statistical evaluation

The analytical results of the inter-laboratory certification comparison are listed in Tables 2 to 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 ($\bar{s}_i$) where n is the number of accepted data sets. The continuous line marks the certified value (mean of the laboratories' means), the broken lines mark the standard deviation, calculated from the laboratories' means.
In the related figures for each laboratory its mean value and single standard deviation is given. Outliers which have been excluded after consultation with the resp. laboratory are highlighted in yellow.

Table 2: Results for Si

Lab./Meth.	10/I-a	9/I-a	11/I-a	10/P	7/G	2/I-a	1/I-a	5/I-a	3/I-a(R)	8/I-a		
M_i [%]	6.581	6.603	6.690	6.561	6.74	6.84	6.852	6.88	6.97	7.06		*n*
	6.645	6.690	6.810	6.809	6.73	6.79	6.822	6.91	7.04	7.07		10
	6.734	6.736	6.710	6.866	6.84	6.82	6.818	6.89	7.08	7.05		
	6.635	6.625	6.770	6.774	6.74	6.80	6.828	6.90	7.04	7.12		
	6.629	6.781	6.670	6.739	6.81	6.89	6.761	6.87	7.03	7.15		
	6.752		6.770	6.794	6.78	6.83	6.921	6.88	6.80	7.14		
M [%]	**6.663**	**6.687**	**6.737**	**6.757**	**6.773**	**6.829**	**6.834**	**6.889**	**6.993**	**7.100**		**6.826**
s [%]	0.066	0.074	0.055	0.105	0.045	0.034	0.052	0.014	0.101	0.044	s_M [%]	0.137
											$\bar{s}_i$ [%]	0.065
s_{rel}	0.0099	0.0111	0.0081	0.0155	0.0066	0.0049	0.0076	0.0020	0.0145	0.0062		0.0200

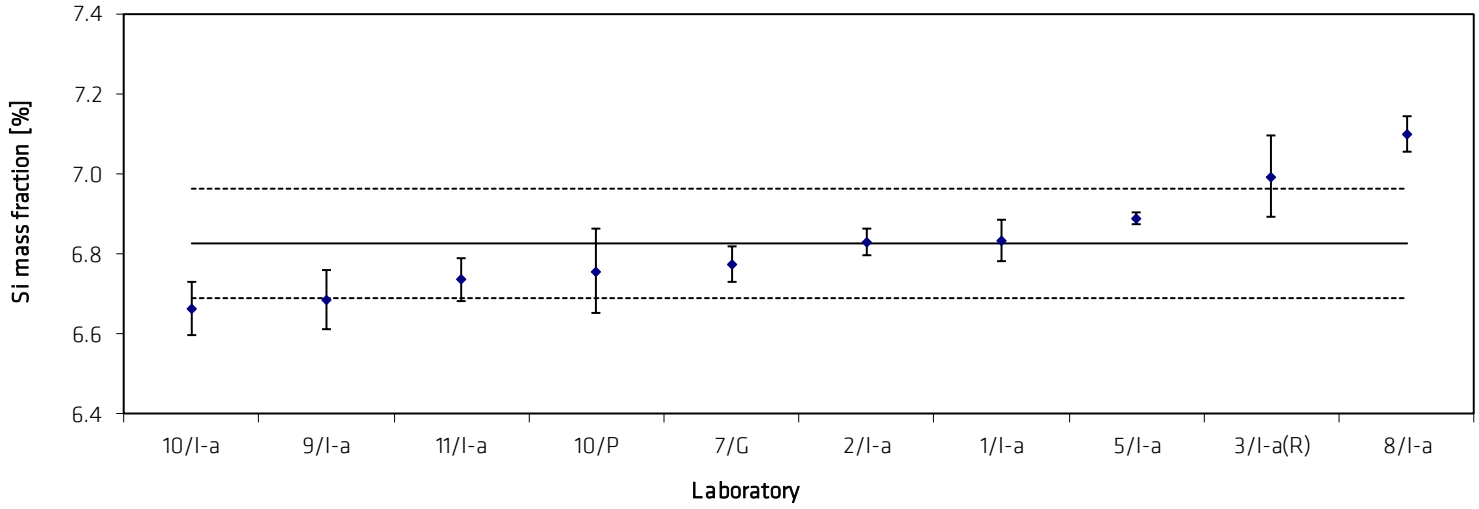


Table 3: Results for Fe

Lab./Meth.	12/I-a	2/I-a	9/I-a	10/IMS-s	10/P	5/I-a	10/I-a	1/I-a	3/I-a(R)	10/I-s	9/A-s	11/I-a	7/I-s_1	8/I-a	7/I-s_2		
M_i [%]	0.1399	0.1383	0.1342	0.139	0.139	0.140	0.141	0.143	0.141	0.143	0.1420	0.144	0.151	0.152	0.153		*n*
	0.1394	0.1368	0.1387	0.140	0.137	0.141	0.139	0.140	0.145	0.147	0.1445	0.147	0.150	0.151	0.154		15
	0.1358	0.1378	0.1389	0.140	0.141	0.140	0.142	0.141	0.150	0.143	0.1462	0.144	0.151	0.151	0.149		
	0.1365	0.1393	0.1424	0.138	0.142	0.141	0.139	0.141	0.146	0.142	0.1481	0.153	0.151	0.153	0.155		
	0.1369	0.1397	0.1392	0.144	0.141	0.140	0.139	0.141	0.142	0.141	0.1463	0.147	0.151	0.154	0.155		
		0.1396	0.1412	0.138	0.141	0.140	0.143	0.141	0.127	0.142	0.1474	0.144	0.151	0.153	0.155		
M [%]	**0.138**	**0.139**	**0.139**	**0.140**	**0.140**	**0.140**	**0.141**	**0.141**	**0.142**	**0.143**	**0.146**	**0.147**	**0.151**	**0.152**	**0.153**		**0.143**
s [%]	0.0018	0.0011	0.0028	0.0022	0.0019	0.0003	0.0016	0.0010	0.0079	0.0022	0.0022	0.0035	0.0004	0.0011	0.0023	s_M [%]	0.0052
																$\bar{s}_i$ [%]	0.0028
s_{rel}	0.01330	0.00823	0.02020	0.01604	0.01340	0.00245	0.01134	0.00727	0.05595	0.01536	0.01499	0.02394	0.00242	0.00707	0.01466		0.03604

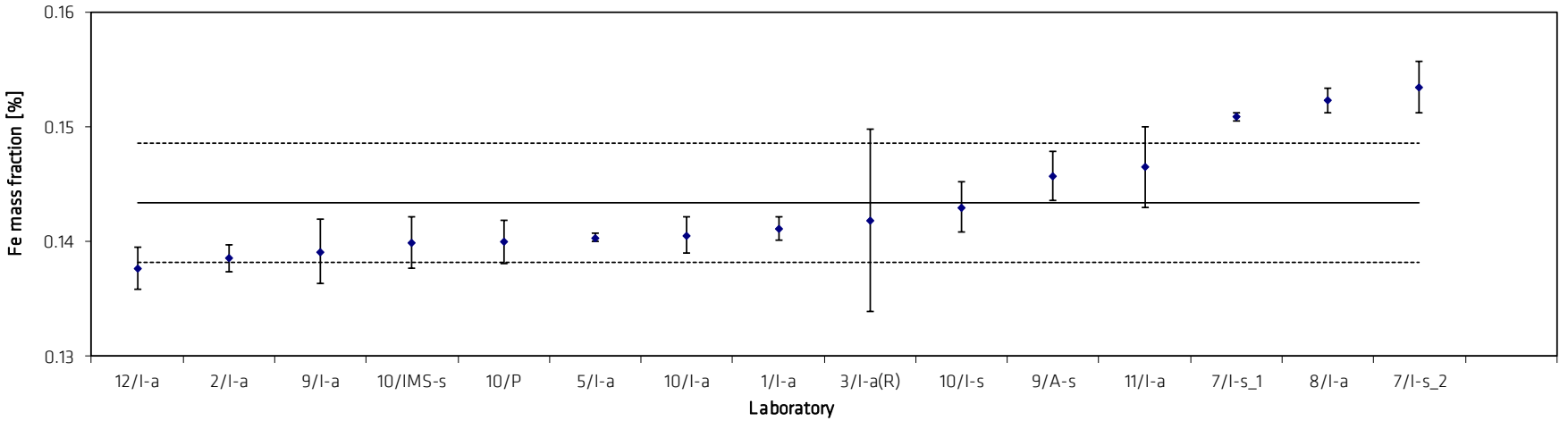


Table 4: Results for Cu

Lab./Meth.	9/I-s(HF)	9/A-s	12/I-a	3/I-a(R)	2/I-a	1/I-a	9/I-s	5/I-a	10/I-a	10/IMS-s	11/I-a	7/IMS-s		
M_i [%]	0.0180	0.0190	0.0194	0.019	0.0198	0.0202	0.0198	0.0198	0.0198	0.0200	0.0207	0.0206		*n*
	0.0184	0.0190	0.0191	0.020	0.0196	0.0196	0.0197	0.0198	0.0195	0.0205	0.0205	0.0204		12
	0.0193	0.0190	0.0192	0.020	0.0197	0.0195	0.0195	0.0198	0.0201	0.0202	0.0198	0.0199		
	0.0185	0.0189	0.0194	0.020	0.0195	0.0195	0.0201	0.0199	0.0198	0.0203	0.0197	0.0213		
	0.0188	0.0190	0.0198	0.020	0.0195	0.0194	0.0201	0.0198	0.0197	0.0198	0.0195	0.0209		
	0.0187	0.0188		0.018	0.0196	0.0195	0.0196	0.0197	0.0199	0.0202	0.0210	0.0211		
	0.0190	0.0189												
M [%]	**0.0187**	**0.0190**	**0.0194**	**0.0195**	**0.0196**	**0.0196**	**0.0198**	**0.0198**	**0.0198**	**0.0202**	**0.0202**	**0.0207**		**0.0197**
s [%]	0.0004	0.0001	0.0003	0.0008	0.0001	0.0003	0.0003	0.0000	0.0002	0.0002	0.0006	0.0005	s_M [%]	0.00055
													$\bar{s}_i$ [%]	0.00039
s_{rel}	0.02237	0.00430	0.01385	0.04291	0.00573	0.01492	0.01309	0.00232	0.00924	0.01181	0.03036	0.02463		0.02771

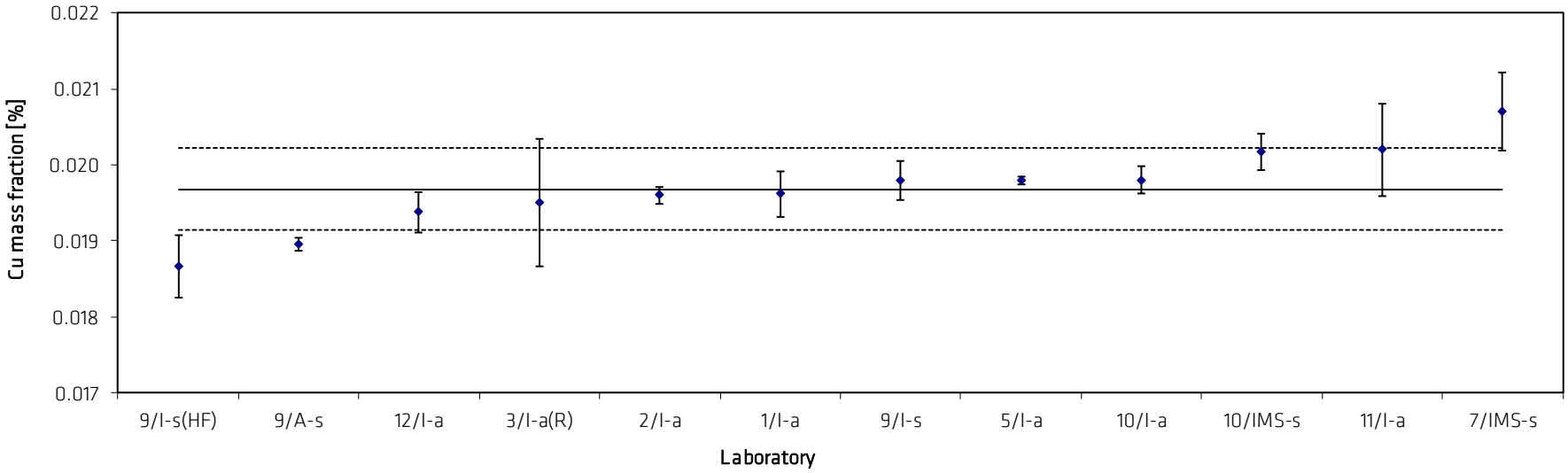


Table 5: Results for Mn

Lab./Meth.	2/I-a	1/I-a	8/I-a	5/I-a	9/A-s	10/I-s	10/IMS-s	10/I-a	9/I-a	12/I-a	3/I-a(R)	9/P	7/IMS-s	7/I-s_2	7/I-s_1		
M_i [%]	0.0109	0.0110	0.0110	0.0110	0.0112	0.0111	0.0112	0.0113	0.0110	0.0114	0.010	0.0110	0.0116	0.0114	0.0120		*n*
	0.0107	0.0109	0.0110	0.0110	0.0109	0.0113	0.0112	0.0112	0.0113	0.0112	0.011	0.0120	0.0115	0.0115	0.0113		15
	0.0106	0.0109	0.0109	0.0109	0.0110	0.0111	0.0110	0.0113	0.0113	0.0112	0.011	0.0119	0.0113	0.0115	0.0113		
	0.0110	0.0109	0.0109	0.0110	0.0111	0.0110	0.0111	0.0111	0.0114	0.0113	0.012	0.0107	0.0114	0.0117	0.0119		
	0.0111	0.0109	0.0109	0.0109	0.0110	0.0110	0.0113	0.0111	0.0113	0.0114	0.012	0.0110	0.0115	0.0116	0.0116		
	0.0110	0.0108	0.0110	0.0110	0.0110	0.0111	0.0112	0.0113	0.0114		0.012	0.0118	0.0118	0.0115	0.0118		
					0.0111							0.0120					
					0.0111							0.0108					
***M* [%]**	**0.0109**	**0.0109**	**0.0109**	**0.0110**	**0.0110**	**0.0111**	**0.0112**	**0.0112**	**0.0113**	**0.0113**	**0.0113**	**0.0114**	**0.0115**	**0.0115**	**0.0117**		**0.0112**
s [%]	0.0002	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0008	0.0005	0.0002	0.0001	0.0003	s_M [%]	0.00025
																$\bar{s}_i$ [%]	0.00028
s_{rel}	0.01817	0.00580	0.00431	0.00243	0.00873	0.00992	0.00859	0.00768	0.01411	0.00885	0.07204	0.04731	0.01496	0.00895	0.02589		0.02202

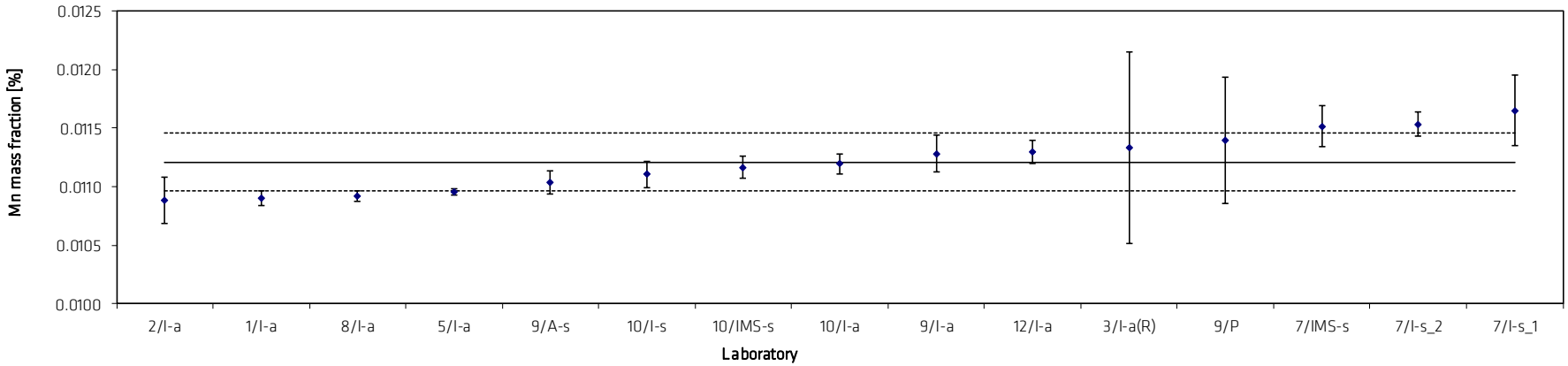


Table 6: Results for Mg

Lab./Meth.	9/I-s	12/I-a(R)	9/A-s	7/IMS-s	7/I-s_2	8/I-a	9/I-s(HF)	7/I-s_1	5/I-a	10/I-a	10/IMS-s	9/I-a	10/I-s	2/I-a	1/I-a		
M_i [%]	0.4846	0.4874	0.497	0.4966	0.5039	0.5092	0.4966	0.5083	0.5127	0.5117	0.5196	0.4997	0.5109	0.5147	0.4996		*n*
	0.4876	0.4855	0.495	0.4845	0.5024	0.5089	0.4900	0.5063	0.5118	0.5093	0.5266	0.5128	0.5272	0.5107	0.5170		15
	0.4734	0.4885	0.491	0.4813	0.4913	0.5045	0.5224	0.5059	0.5105	0.5156	0.5123	0.5141	0.5187	0.5129	0.5190		
	0.4718	0.4887	0.493	0.4925	0.4963	0.5026	0.5169	0.5082	0.5107	0.5056	0.5106	0.5242	0.5150	0.5168	0.5190		
	0.4989	0.4897	0.484	0.4986	0.5009	0.5068	0.4985	0.5072	0.5086	0.5072	0.4959	0.5170	0.5009	0.5176	0.5160		
	0.4772	0.4878	0.483	0.5011	0.4932	0.5070	0.5005	0.5080	0.5107	0.5160	0.5160	0.5193	0.5156	0.5185	0.5220		
			0.490				0.5221										
***M* [%]**	**0.482**	**0.488**	**0.490**	**0.492**	**0.498**	**0.507**	**0.507**	**0.507**	**0.511**	**0.511**	**0.514**	**0.515**	**0.515**	**0.515**	**0.515**		**0.504**
s [%]	0.010	0.001	0.006	0.008	0.005	0.003	0.013	0.001	0.001	0.004	0.010	0.008	0.009	0.003	0.008	s_M [%]	0.0113
																$\bar{s}_i$ [%]	0.0068
s_{rel}	0.0212	0.0030	0.0113	0.0162	0.0104	0.0051	0.0264	0.0020	0.0027	0.0084	0.0201	0.0161	0.0169	0.0058	0.0156		0.02236

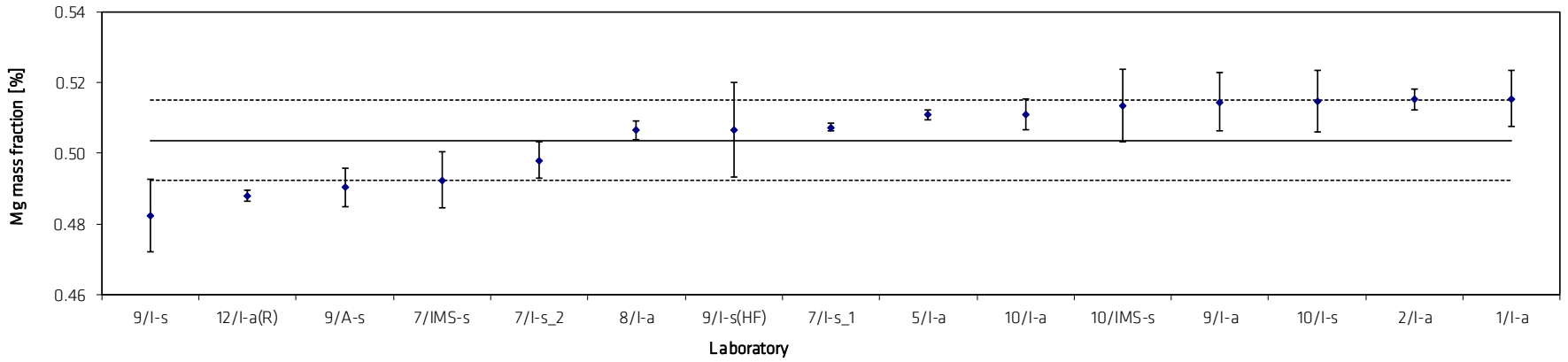


Table 7: Results for Zn

Lab./Meth.	7/I-s_2	2/I-s	5/I-a	9/I-s(HF)	8/I-a	1/I-a	10/I-s	10/IMS-s	9/I-a	12/I-a	10/I-a	9/I-s	7/I-s_1	7/A-s	9/A-s	3/I-a(R)		
M_i [%]	0.0543	0.0543	0.0541	0.0533	0.0545	0.0540	0.0553	0.0551	0.0541	0.0554	0.0559	0.0558	0.0584	0.0575	0.0577	0.057		*n*
	0.0523	0.0538	0.0545	0.0561	0.0547	0.0551	0.0554	0.0549	0.0549	0.0551	0.0551	0.0562	0.0553	0.0557	0.0585	0.060		16
	0.0540	0.0540	0.0541	0.0544	0.0548	0.0551	0.0552	0.0549	0.0552	0.0550	0.0564	0.0556	0.0556	0.0560	0.0581	0.058		
	0.0552	0.0548	0.0545	0.0558	0.0550	0.0551	0.0547	0.0547	0.0558	0.0552	0.0550	0.0540	0.0553	0.0556	0.0576	0.059		
	0.0543	0.0539	0.0543	0.0550	0.0556	0.0551	0.0548	0.0561	0.0554	0.0551	0.0557	0.0563	0.0573	0.0564	0.0578	0.059		
	0.0527	0.0547	0.0542	0.0541	0.0551	0.0552	0.0550	0.0548	0.0554		0.0554	0.0561	0.0566	0.0576	0.0568	0.056		
															0.0572			
															0.0581			
M [%]	**0.0538**	**0.0542**	**0.0543**	**0.0548**	**0.0549**	**0.0549**	**0.0551**	**0.0551**	**0.0551**	**0.0552**	**0.0556**	**0.0557**	**0.0564**	**0.0565**	**0.0577**	**0.0582**		**0.0555**
s [%]	0.0011	0.0004	0.0002	0.0010	0.0004	0.0005	0.0002	0.0005	0.0006	0.0002	0.0005	0.0009	0.0013	0.0009	0.0005	0.0015	s_M [%]	0.00120
																	$\bar{s}_i$ [%]	0.00076
s_{rel}	0.02029	0.00739	0.00362	0.01908	0.00712	0.00836	0.00441	0.00950	0.01040	0.00275	0.00927	0.01560	0.02229	0.01567	0.00908	0.02531		0.02166

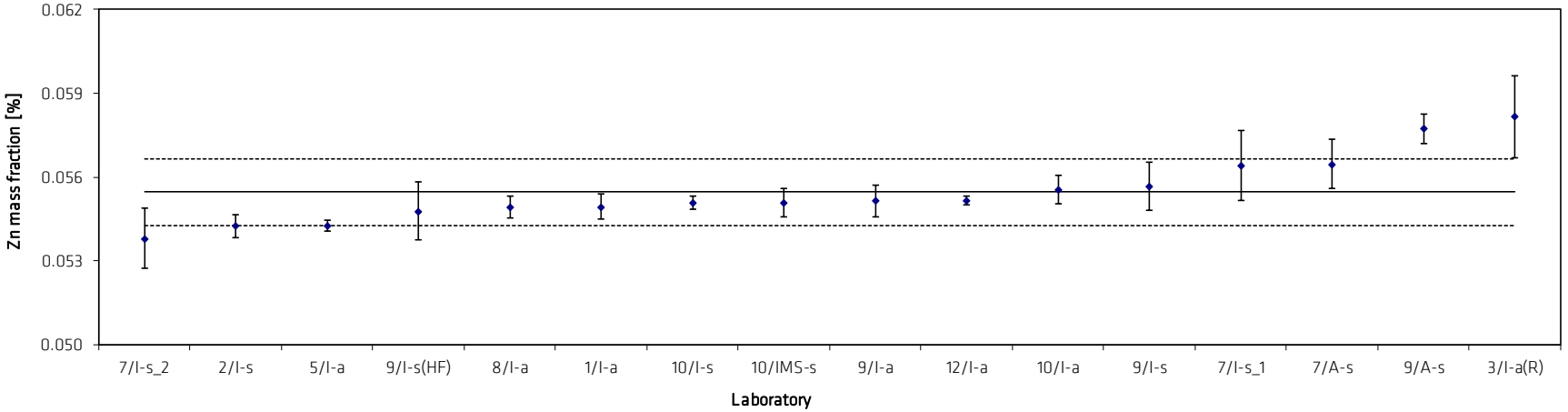


Table 8: Results for Ti

Lab./Meth.	7/IMS-s	3/I-a(R)	11/I-a	9/I-s	7/I-s_1	10/IMS-s	1/I-a	8/I-a	10/I-s	2/I-a	7/I-s_2	10/I-a	5/I-a	9/I-a	10/P	12/I-a	9/I-s(HF)		
M_i [%]	0.1097	0.110	0.1100	0.1120	0.1141	0.1177	0.1160	0.1166	0.1184	0.1175	0.1195	0.1203	0.1201	0.1227	0.1193	0.121	0.1259		*n*
	0.1069	0.110	0.1120	0.1146	0.1099	0.1133	0.1153	0.1164	0.1164	0.1182	0.1176	0.1197	0.1193	0.1201	0.1165	0.120	0.1200		17
	0.1057	0.100	0.1110	0.1146	0.1134	0.1152	0.1162	0.1141	0.1182	0.1180	0.1185	0.1209	0.1197	0.1196	0.1202	0.119	0.1202		
	0.1068	0.100	0.1110	0.1094	0.1138	0.1151	0.1160	0.1146	0.1169	0.1176	0.1195	0.1171	0.1183	0.1184	0.1191	0.120	0.1222		
	0.1077	0.110	0.1100	0.1113	0.1140	0.1153	0.1154	0.1160	0.1175	0.1194	0.1185	0.1188	0.1190	0.1197	0.1183	0.121	0.1193		
	0.1078	0.120	0.1110	0.1149	0.1137	0.1159	0.1153	0.1167	0.1178	0.1166	0.1169	0.1180	0.1203	0.1179	0.1257		0.1217		
																	0.1176		
***M* [%]**	**0.1074**	**0.1083**	**0.1108**	**0.1128**	**0.1132**	**0.1154**	**0.1157**	**0.1157**	**0.1175**	**0.1179**	**0.1184**	**0.1191**	**0.1194**	**0.1197**	**0.1199**	**0.1200**	**0.1210**		**0.1171**
s [%]	0.00134	0.00753	0.00075	0.00225	0.00161	0.00142	0.00041	0.00112	0.00077	0.00093	0.00103	0.00144	0.00075	0.00168	0.00313	0.00065	0.00264	s_M [%]	0.00305
																		$\bar{s}_i$ [%]	0.00157
s_{rel}	0.01251	0.06949	0.00679	0.01996	0.01424	0.01231	0.00354	0.00967	0.00654	0.00786	0.00872	0.01207	0.00632	0.01403	0.02608	0.00545	0.02183		0.02606

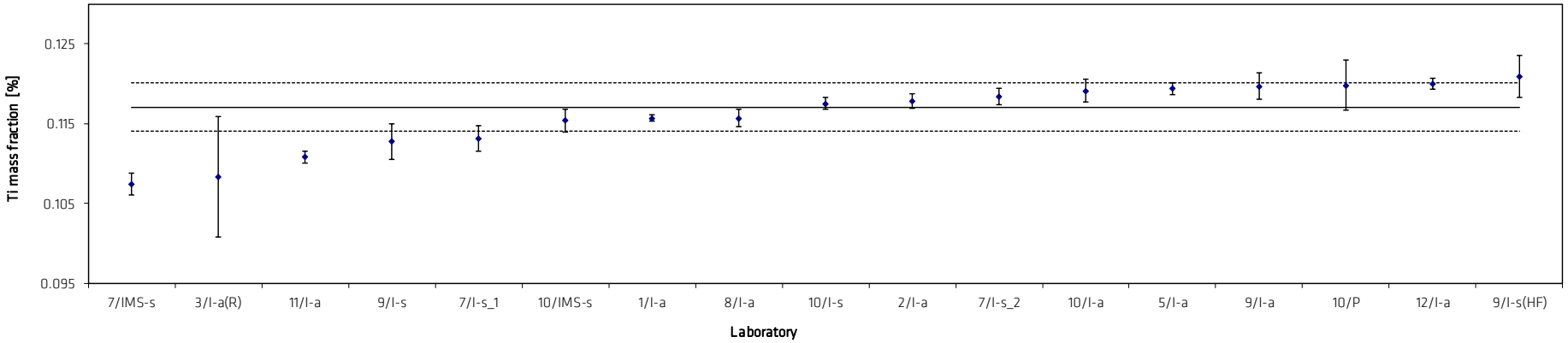


Table 9: Results for Cr

Lab./Meth.	7/I-s_2	3/I-a	9/I-s(HF)	9/A-s	9/I-s	5/I-a	2/I-s	8/I-a	9/I-a	1/I-a	7/I-s_1	10/IMS-s	10/I-s	12/I-a	7/IMS-s	11/I-a		
M_i [mg/kg]	59	59	58.6	60.5	61.3	63.0	63.5	63.9	62.3	62	64	65.5	65	67	68	67.9		*n*
	57	55	58.9	62.1	63.3	63.1	63.2	63.5	63.6	63	66	65.3	65	66	67	68.8		16
	60	63	60.4	59.5	60.9	63.1	62.9	63.0	63.9	65	65	64.6	66	65	66	67.4		
	59	61	60.2	58.7	59.8	62.8	62.8	62.4	63.4	64	68	64.6	65	66	67	69.8		
	59	58	60.6	62.8	62.0	62.9	63.5	62.9	63.7	64	61	63.9	66	66	67	70.1		
	59	62	59.7	62.2	61.3	63.0	62.6	63.2	64.1	64	63	64.7	65.3		70	68.2		
			60.7	59.1														
***M* [mg/kg]**	**58.8**	**59.7**	**59.9**	**60.7**	**61.5**	**63.0**	**63.1**	**63.2**	**63.5**	**63.7**	**64.5**	**64.8**	**65.3**	**66.0**	**67.5**	**68.7**		**63.4**
s [mg/kg]	0.98	2.94	0.85	1.67	1.16	0.12	0.36	0.52	0.61	1.03	2.43	0.56	0.42	0.71	1.38	1.07	s_M [mg/kg]	2.79
																	$\bar{s}_i$ [mg/kg]	1.28
s_{rel}	0.017	0.049	0.014	0.027	0.019	0.002	0.006	0.008	0.010	0.016	0.038	0.009	0.006	0.011	0.020	0.016		0.044

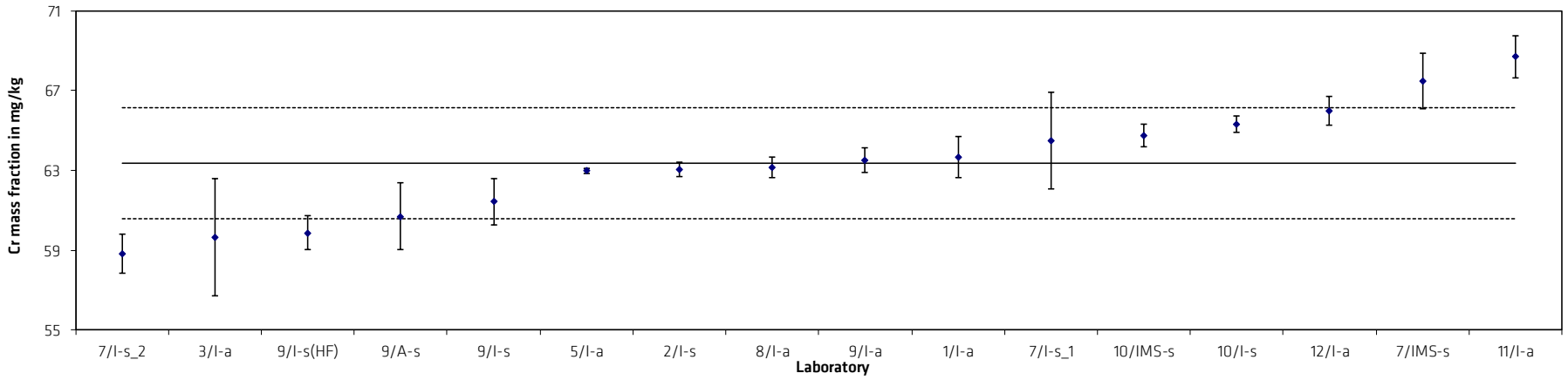


Table 10: Results for Ni

Lab./Meth.	7/I-s_2	9/I-s(HF)	8/I-a	2/I-s	9/I-a	5/I-a	10/I-a	12/I-a	1/I-a	7/IMS-s	7/I-s_1	3/I-a		
M_i [mg/kg]	42	43.3	47.6	47.9	45.2	48.0	48.2	49	46	50	49	53		*n*
	42	45.7	45.9	47.0	46.9	48.3	47.5	49	49	50	51	52		12
	41	43.9	45.0	47.7	46.9	47.8	48.6	48	50	49	51	57		
	42	43.9	45.2	46.0	48.7	48.0	48.0	48	49	49	52	57		
	43	45.7	45.2	46.2	47.7	47.7	47.9	48	49	50	49	47		
	42	48.3	47.6	47.4	47.1	47.9	48.5		49	52	49	50		
		46.0												
M [mg/kg]	**42.0**	**45.3**	**46.1**	**47.1**	**47.1**	**48.0**	**48.1**	**48.4**	**48.7**	**50.0**	**50.2**	**52.7**		**47.8**
s [mg/kg]	0.63	1.70	1.21	0.77	1.15	0.21	0.40	0.55	1.37	1.10	1.33	3.93	s_M [mg/kg]	2.69
													$\bar{s}_i$ [mg/kg]	1.51
s_{rel}	0.015	0.038	0.026	0.016	0.024	0.004	0.008	0.011	0.028	0.022	0.026	0.075		0.056

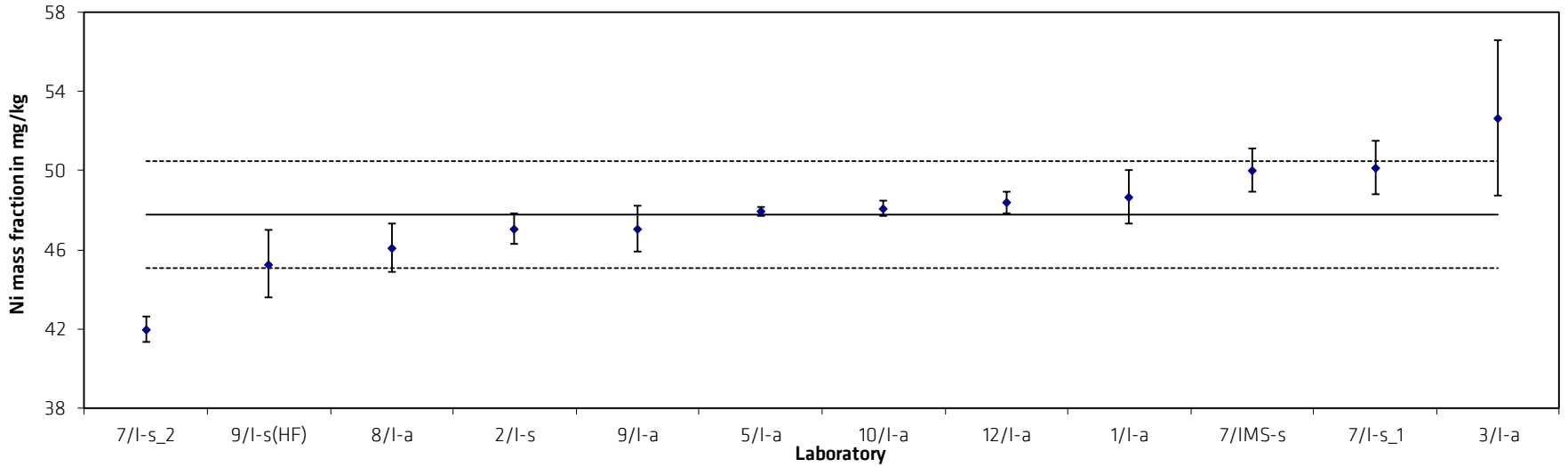


Table 11: Results for Ca

Lab./Meth.	8/I-s	7/I-s_1	7/I-s_2	12/I-a	2/I-s	1/I-s		
M_i [mg/kg]	21.5	21	24.7	22	27.5	30.2		*n*
	19.7	22	28.3	28	27.5	29.9		6
	19.0	27	26.3	28	27.4	30.1		
	19.9	28	28.3	25	28.7	30.4		
	18.9	21	26.4	33	27.9	30.2		
	19.5	21	27.2		27.4	30.4		
M [mg/kg]	**19.8**	**23.3**	**26.9**	**27.2**	**27.7**	**30.2**		**25.8**
s [mg/kg]	0.94	3.27	1.39	4.09	0.53	0.19	s_M [mg/kg]	3.71
							$\bar{s}_i$ [mg/kg]	2.25
s_{rel}	0.048	0.140	0.052	0.150	0.019	0.006		0.144

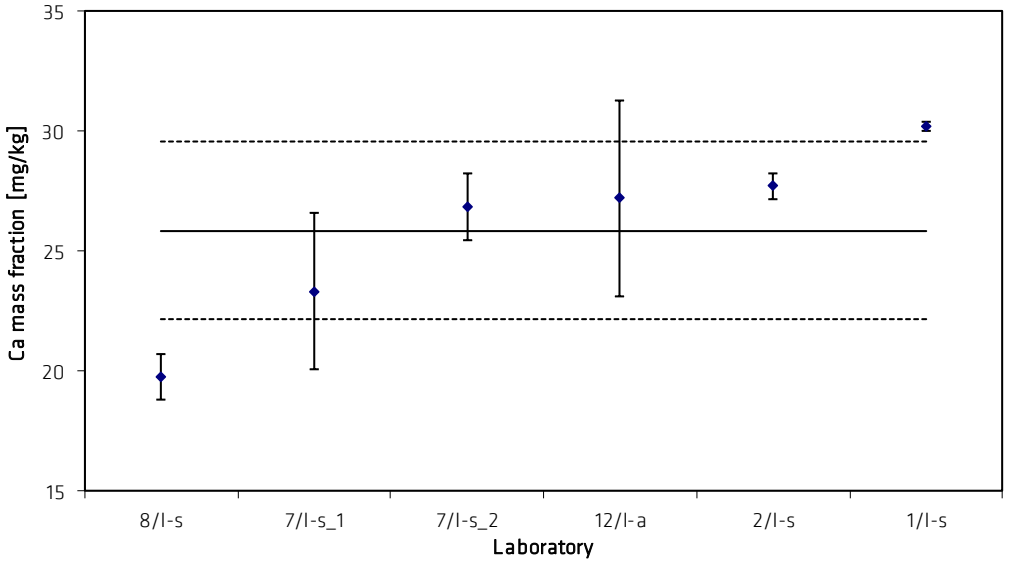


Table 12: Results for Cd

Lab./Meth.	9/I-s	7/I-s_2(R)	7/IMS-s	9/I-a	10/I-s	12/I-a	5/I-a	9/I-s(HF)	10/IMS-s	1/I-s	7/I-s_1(R)	11/I-a	2/IMS-s	8/I-s	3/I-a		
M_i [mg/kg]	20.3	20.4	21.1	20.8	21.7	22	22.1	21.2	22.2	23.3	22.9	23.5	24.2	24.4	<70		*n*
	20.4	20.0	20.8	21.5	22.2	22	22.0	21.7	22.4	23.6	22.4	22.2	22.7	24.1	<70		14
	20.1	20.4	20.7	21.6	21.9	22	22.1	22.6	22.1	21.8	22.7	22.0	23.3	24.1	<70		
	18.7	20.1	20.7	22.5	21.8	22	22.1	22.4	22.5	22.3	22.2	23.3	22.9	24.1	<70		
	20.8	20.4	21.1	21.9	21.7	22	22.2	22.7	23.1	21.9	22.7	23.7	22.5	24.2	<70		
	19.8	20.8	22.0	21.7	22.0		22.1	22.0	22.6	22.2	22.5	21.2	22.6	24.1	<70		
								22.4									
***M* [mg/kg]**	**20.02**	**20.35**	**21.07**	**21.67**	**21.86**	**22.00**	**22.10**	**22.14**	**22.48**	**22.51**	**22.59**	**22.65**	**23.03**	**24.17**	**<70**		**22.0**
s [mg/kg]	0.74	0.28	0.49	0.57	0.18	0.00	0.06	0.59	0.33	0.74	0.25	1.00	0.63	0.12		s_M [mg/kg]	1.06
																$\bar{s}_i$ [mg/kg]	0.51
s_{rel}	0.0368	0.0138	0.0234	0.0265	0.0082	0.0000	0.0029	0.0265	0.0147	0.0330	0.0110	0.0440	0.0272	0.0050			0.0481

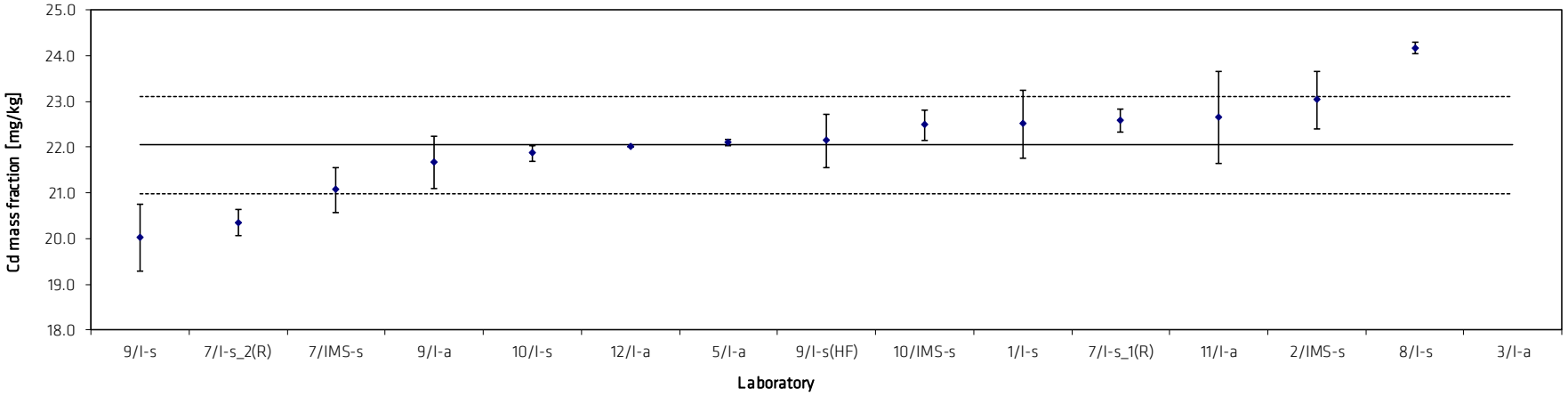


Table 13: Results for Ga

Lab./Meth.	7/IMS-s	9/I-s	9/I-s(HF)	2/IMS-s	11/I-a	1/I-a	10/I-s	5/I-a	8/I-a	10/I-a	12/I-a	10/IMS-s	7/I_2	7/I-s_1(R)	9/I-a		
M_i [mg/kg]	180.9	182.8	182.5	186.6	187	187.9	186.3	189.2	189.4	194.0	196	196.5	197	199.1	198		*n*
	175.8	182.8	182.5	184.4	193	189.4	191.3	189.5	191.4	191.6	194	198.8	196	201.3	204		15
	177.9	180.4	191.2	186.9	188	189.4	188.3	190.4	191.6	194.8	192	192.1	196	197.3	211		
	178.1	178.1	185.7	192.2	189	189.3	188.8	189.9	191.5	190.1	195	193.8	200	200.4	198		
	181.2	185.1	186.9	186.5	186	188.6	189.6	189.1	192.3	193.2	193	190.9	198	197.6	207		
	180.0	180.4	187.1	189.5	185	189.8	190.2	189.6	189.7	194.7		196.2	194	198.3	194		
			190.1														
***M* [mg/kg]**	**179.0**	**181.6**	**186.6**	**187.7**	**188.0**	**189.1**	**189.1**	**189.6**	**191.0**	**193.1**	**194.0**	**194.7**	**196.8**	**199.0**	**201.9**		**190.7**
s [mg/kg]	2.08	2.46	3.36	2.75	2.83	0.68	1.72	0.48	1.16	1.87	1.58	2.98	2.04	1.59	6.39	s_M [mg/kg]	6.13
																$\bar{s}_i$ [mg/kg]	2.694
s_{rel}	0.012	0.014	0.018	0.015	0.015	0.004	0.009	0.003	0.006	0.010	0.008	0.015	0.010	0.008	0.032		0.032

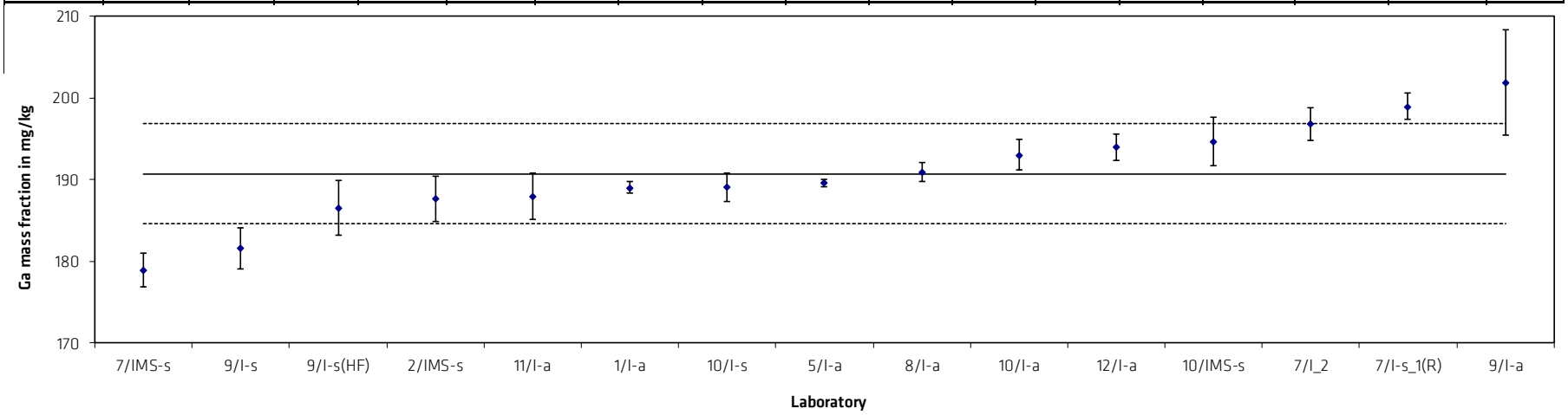


Table 14: Results for Li

Lab./Meth.	8/I-s(R)	7/I-s_1	7/IMS-s	1/I-a	9/ES	9/I-s	9/I-s(HF)	10/I-a	2/IMS-s	12/I-a		
M_i [mg/kg]	7.4	7.7	7.6	8.5	8.46	7.8	8.3	8.7	8.9	9.0		*n*
	7.4	8.0	8.0	8.3	8.35	8.0	8.3	8.6	8.8	9.0		10
	7.3	7.9	7.3	8.3	8.42	8.1	8.5	8.7	9.0	9.0		
	7.2	7.6	7.6	8.3	8.35	8.6	8.3	8.5	9.2	9.0		
	7.3	7.6	7.9	8.3	8.40	9.6	8.4	8.6	8.8	9.0		
	7.1	7.5	8.2	8.3	8.31	8.3	8.6	8.6	9.1			
					8.34		8.9					
					8.25							
***M* [mg/kg]**	**7.28**	**7.73**	**7.77**	**8.34**	**8.36**	**8.43**	**8.46**	**8.62**	**8.97**	**9.00**		**8.30**
s [mg/kg]	0.117	0.173	0.327	0.098	0.066	0.649	0.226	0.074	0.131	0.000	s_M [mg/kg]	0.552
											$\bar{s}_i$ [mg/kg]	0.257
s_{rel}	0.016	0.022	0.042	0.012	0.008	0.077	0.027	0.009	0.015	0.000		0.066

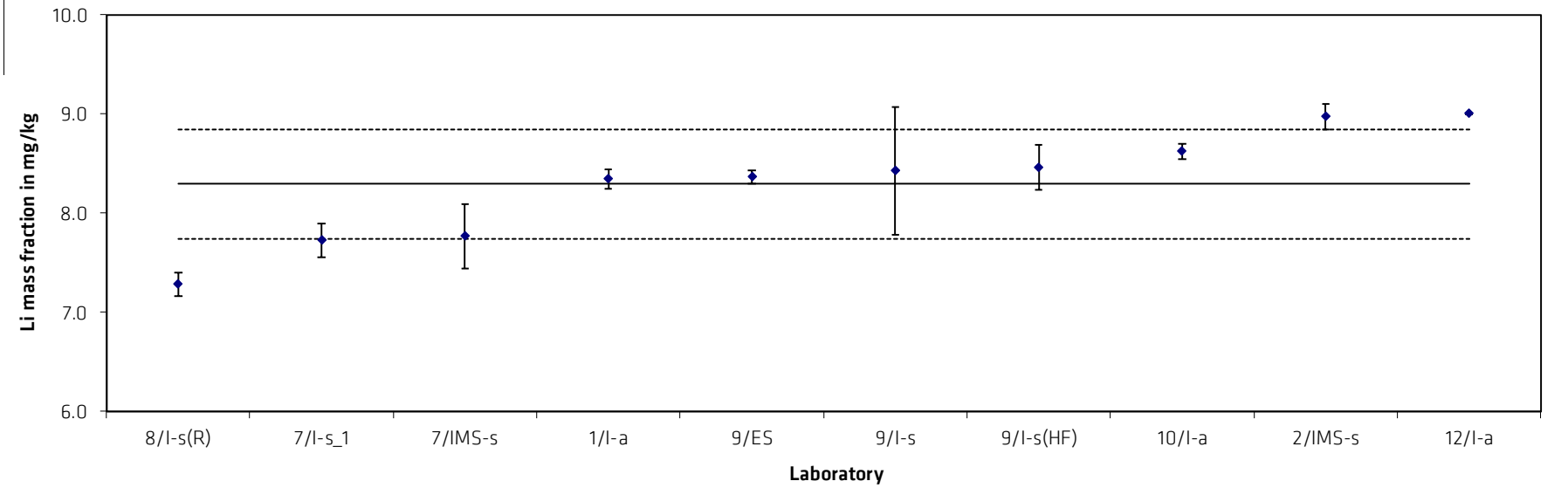


Table 15: Results for Na

Lab./Meth.	1/I-s	7/I-s_1	2/I-s		
M_i [mg/kg]	12.3	12.3	14.9		*n*
	12.2	12.6	14.7		3
	12.3	14.5	14.3		
	12.4	15.8	14.5		
	12.3	13.7	13.9		
	12.4	12.9	14.8		
M [mg/kg]	**12.3**	**13.6**	**14.5**		**13.5**
s [mg/kg]	0.08	1.32	0.38	s_M [mg/kg]	1.104
				$\bar{s}_i$ [mg/kg]	0.795
s_{rel}	0.0061	0.0970	0.0262		0.082

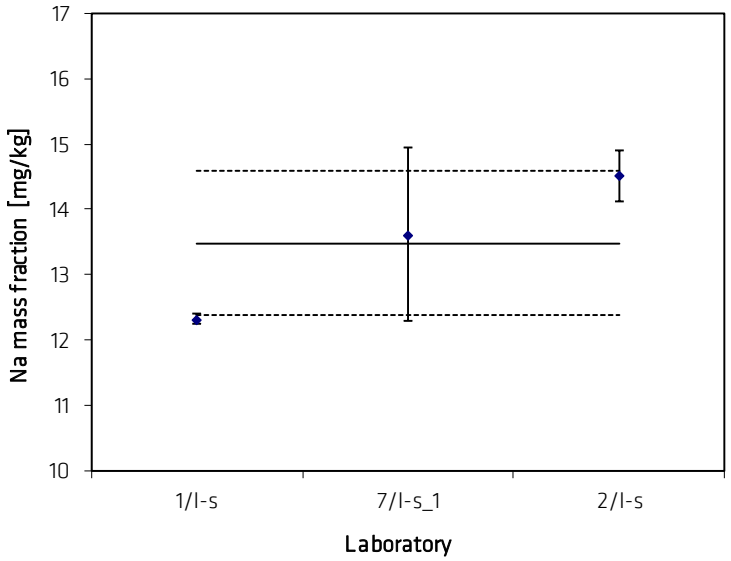


Table 16: Results for Pb

Lab./Meth.	9/I-s	5/I-a	9/I-s(HF)	1/I-a	10/IMS-s	12/I-a	2/IMS-s	7/IMS-s	7/I-s_2(R)	8/I-a	7/I-s_1	11/I-a	3/I-a		
M_i [mg/kg]	90.3	97.1	93.7	97.3	92.0	100.0	111.1	105.3	113	113.3	111.9	114	<200		*n*
	90.7	95.6	94.7	97.4	99.2	99.0	106.2	105.1	111	113.3	112.1	123	<200		12
	91.1	96.7	100.4	97.3	100.1	98.0	108.1	107.6	111	112.8	118.1	109	<200		
	90.5	94.0	99.1	97.0	100.1	99.0	106.6	107.8	108	112.7	112.7	112	<200		
	94.8	95.5	97.4	97.3	94.9	98.0	103.3	111.9	115	113.2	115.6	123	<200		
	89.5	96.3	101.3	97.4	98.3		102.5	118.3	113	113.4	110.3	110	<200		
			92.7												
M [mg/kg]	**91.2**	**95.9**	**97.0**	**97.3**	**97.4**	**98.8**	**106.3**	**109.3**	**111.8**	**113.1**	**113.5**	**115.2**	**<200**		**103.9**
s [mg/kg]	1.88	1.10	3.06	0.15	3.30	0.84	3.15	5.03	2.40	0.29	2.86	6.31		s_M [mg/kg]	8.458
														$\bar{s}_i$ [mg/kg]	2.971
s_{rel}	0.0206	0.0115	0.0315	0.0015	0.0339	0.0085	0.0297	0.0460	0.0215	0.0026	0.0252	0.0548			0.081

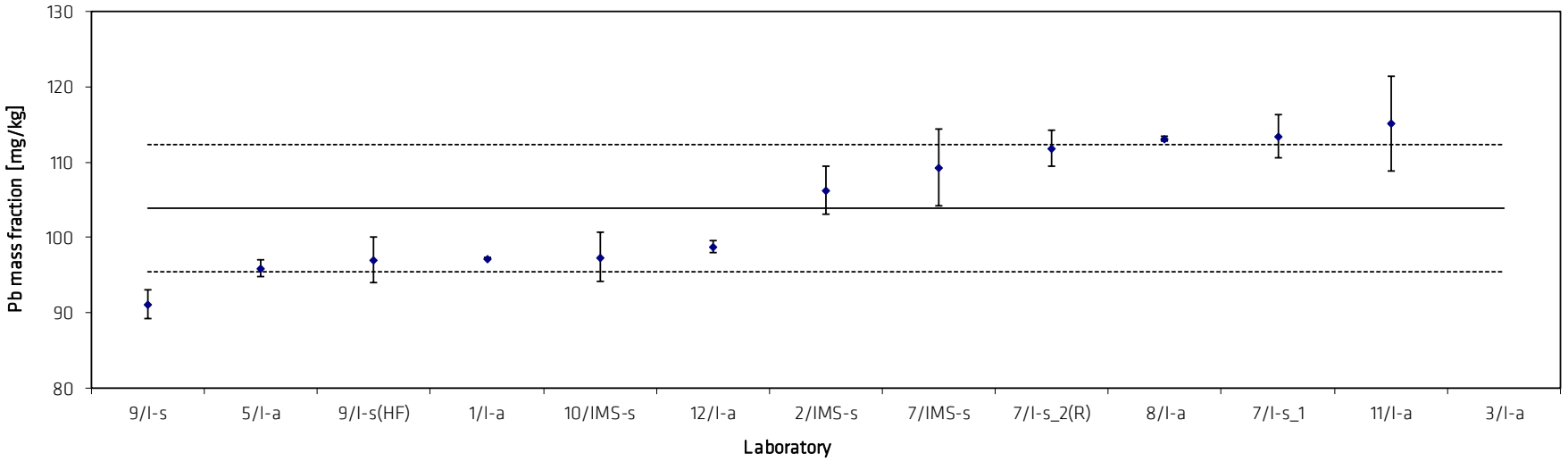


Table 17: Results for Sb

Lab./Meth.	9/I-a	9/I-s	3/I-a(R)	9/I-s(HF)	1/I-a	2/IMS-s	7/IMS-s	9/EA		
M_i [mg/kg]	27.3	31.5	38	36.0	38.4	39.5	40.6	41.6		*n*
	36.2	33.9	35	41.2	38.0	38.1	39.7	40.5		8
	30.3	34.4	33	37.4	39.0	39.5	39.6	41.0		
	36.6	33.8	32	39.7	39.0	38.8	40.4	39.3		
	34.4	35.4	36	39.6	38.0	37.8	40.4	40.3		
	28.6	34.7	33	32.9	38.0	38.7	40.4			
				40.2						
M [mg/kg]	**32.2**	**33.9**	**34.5**	**38.2**	**38.4**	**38.7**	**40.2**	**40.5**		**37.1**
s [mg/kg]	4.03	1.35	2.26	2.91	0.49	0.71	0.42	0.83	s_M [mg/kg]	3.10
									$\bar{s}_i$ [mg/kg]	2.038
s_{rel}	0.125	0.040	0.065	0.076	0.013	0.018	0.010	0.021		0.084

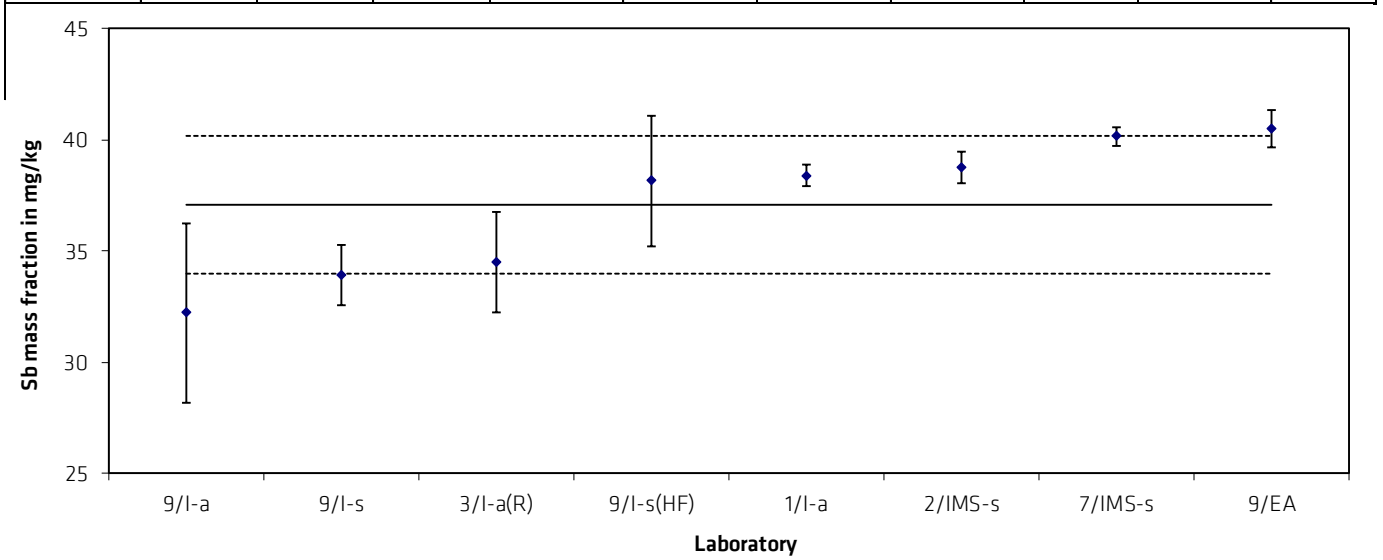


Table 18: Results for Sn

Lab./Meth.	7/I_2	5/I-a_1	9/I-s(HF)	1/I-a	2/I-s	10/IMS-s	10/I-s	8/I-a(R)	10/I-a	7/IMS-s	3/I-a(R)	7/I-s_1	11/I-a	12/I-a		
M_i [mg/kg]	173	176.7	169.8	178.2	177.6	174.0	175.3	181	184.7	183.9	180	191.9	191	196		*n*
	170	173.9	172.4	178.2	179.2	184.0	183.9	167	181.1	177.9	190	185.9	191	196		14
	189	175.9	182.0	178.0	179.3	182.4	183.2	167	185.4	181.2	190	193.7	188	195		
	172	177.3	179.7	178.1	172.4	182.6	180.3	187	181.0	181.3	200	192.8	195	194		
	178	176.3	180.0	178.1	177.0	171.3	172.1	191	181.7	198.1	200	190.6	195	193		
	171	177.2	176.5	178.8	185.0	182.3	181.9	185	184.7	197.1	170	191.6	191			
			180.1													
***M* [mg/kg]**	**175.5**	**176.2**	**177.2**	**178.2**	**178.4**	**179.4**	**179.5**	**179.7**	**183.1**	**186.6**	**188.3**	**191.1**	**191.8**	**194.8**		**182.8**
s [mg/kg]	7.18	1.25	4.53	0.29	4.10	5.36	4.73	10.33	2.04	8.75	11.69	2.75	2.71	1.30	s_M [mg/kg]	6.44
															$\bar{s}_i$ [mg/kg]	5.87
s_{rel}	0.041	0.007	0.026	0.002	0.023	0.030	0.026	0.057	0.011	0.047	0.062	0.014	0.014	0.007		0.035

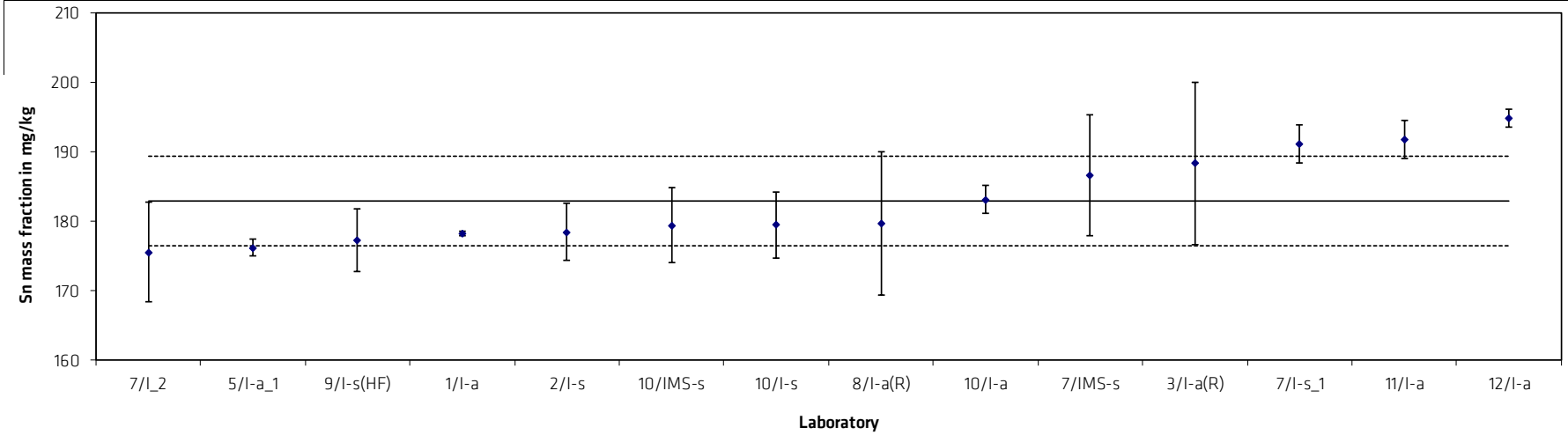


Table 23: Results for Sr

Lab./Meth.	9/I-s(HF)	9/I-s	11/I-a	5/I-a	7/IMS-s	9/I-a	10/I-a	1/I-a	7/I-s_1(R)	8/I-a	7/I-s_2	2/I-s	12/I-a	3/I-a(R)		
M_i [mg/kg]	305.0	295.1	291	294.1	302.2	289.0	304.9	297.7	307.6	301.1	294	310.3	308	330		*n*
	277.7	289.2	298	296.1	295.5	298.2	302.4	306.0	304.2	304.1	301	306.1	312	350		14
	278.2	280.6	294	293.5	295.9	298.9	306.7	306.0	305.4	303.1	300	310.4	310	350		
	297.1	305.6	296	298.5	296.1	306.0	300.5	306.0	304.8	307.3	311	315.6	311	360		
	306.1	273.0	291	295.4	303.3	299.4	303.6	304.0	306.1	306.1	312	306.9	316	360		
	282.3	299.5	293	292.8	301.5	304.1	305.7	307.0	301.5	308.6	315	309.1		330		
	284.0															
***M* [mg/kg]**	**290.1**	**290.5**	**293.8**	**295.1**	**299.1**	**299.2**	**304.0**	**304.4**	**304.9**	**305.1**	**305.5**	**309.7**	**311.4**	**346.7**		**301.0**
s [mg/kg]	12.39	12.13	2.79	2.07	3.61	5.92	2.28	3.45	2.05	2.80	8.31	3.38	2.97	13.66	s_M [mg/kg]	6.95
															$\overline{s}_i$ [mg/kg]	6.07
s_{rel}	0.043	0.042	0.009	0.007	0.012	0.020	0.007	0.011	0.007	0.009	0.027	0.011	0.010	0.039		0.023

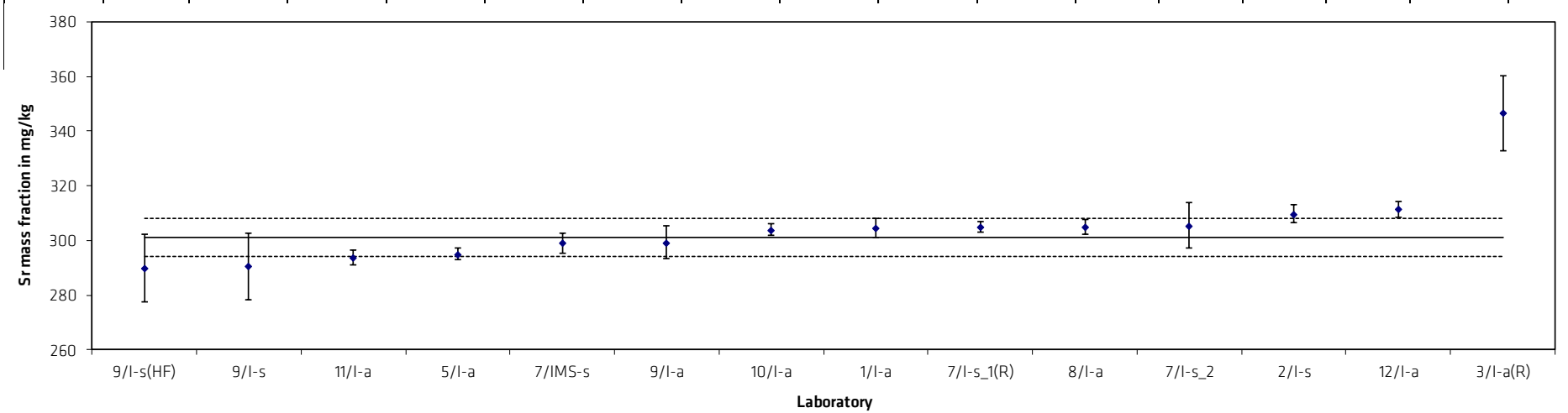


Table 25: Results for V

Lab./Meth.	8/I-a	1/I-a	7/I-s_1	10/IMS-s	10/I-s	2/I-a	10/I-a	12/I-a	9/I-a	9/I-s(HF)	7/I-s_2	9/I-s	5/I-a	7/IMS-s	3/I-a(R)		
M_i [mg/kg]	93.2	94.1	94.8	95.4	94.7	94.6	96.9	97	96.2	96.7	97	96.9	97.8	97.7	110		*n*
	93.5	93.5	92.9	93.7	94.3	95.2	95.7	97	96.6	98.4	98	98.7	97.7	97.1	110		15
	92.3	93.7	92.8	93.7	95.0	95.0	96.7	95	96.2	96.7	96	97.9	97.6	94.7	100		
	92.1	93.5	94.3	94.4	94.7	95.7	94.7	96	96.4	95.7	96	94.7	96.9	97.7	100		
	93.3	93.2	92.3	94.9	94.7	95.6	95.6	95	96.6	97.8	98	97.3	97.4	97.5	110		
	93.5	93.4	95.2	95.3	95.3	95.2	94.9		95.6	95.7	98	98.0	97.8	101.3	120		
										98.9							
***M* [mg/kg]**	**93.0**	**93.6**	**93.7**	**94.5**	**94.8**	**95.2**	**95.8**	**96.0**	**96.3**	**97.1**	**97.2**	**97.2**	**97.5**	**97.7**	**108.3**		**95.7**
s [mg/kg]	0.6	0.3	1.2	0.8	0.4	0.4	0.9	1.0	0.4	1.3	1.0	1.4	0.3	2.1	7.5	s_M [mg/kg]	1.58
																$\bar{s}_i$ [mg/kg]	1.00
s_{rel}	0.007	0.003	0.013	0.008	0.004	0.004	0.009	0.010	0.004	0.013	0.010	0.014	0.004	0.022	0.069		0.016

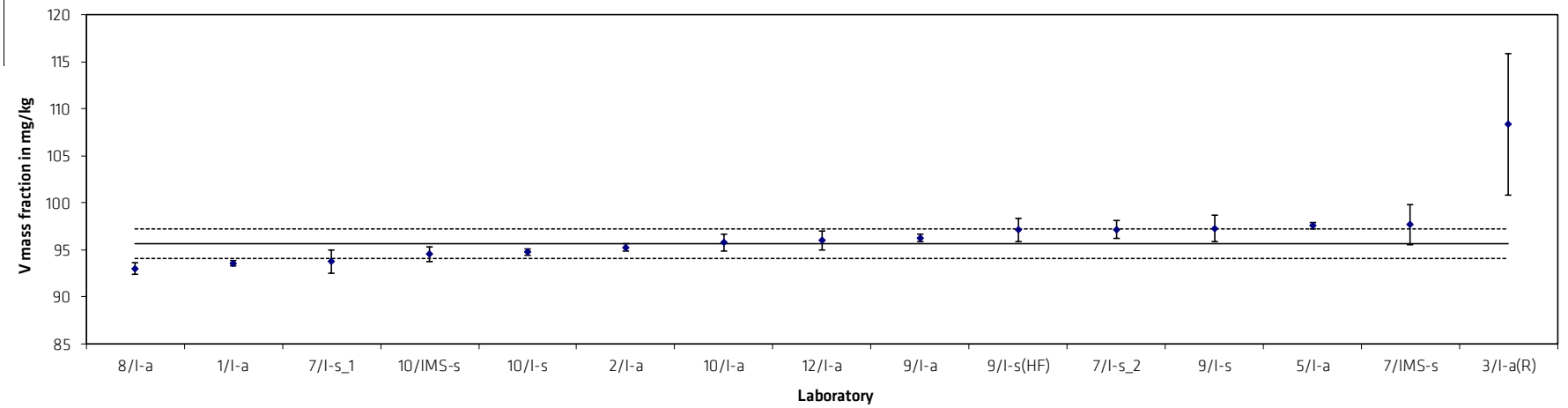
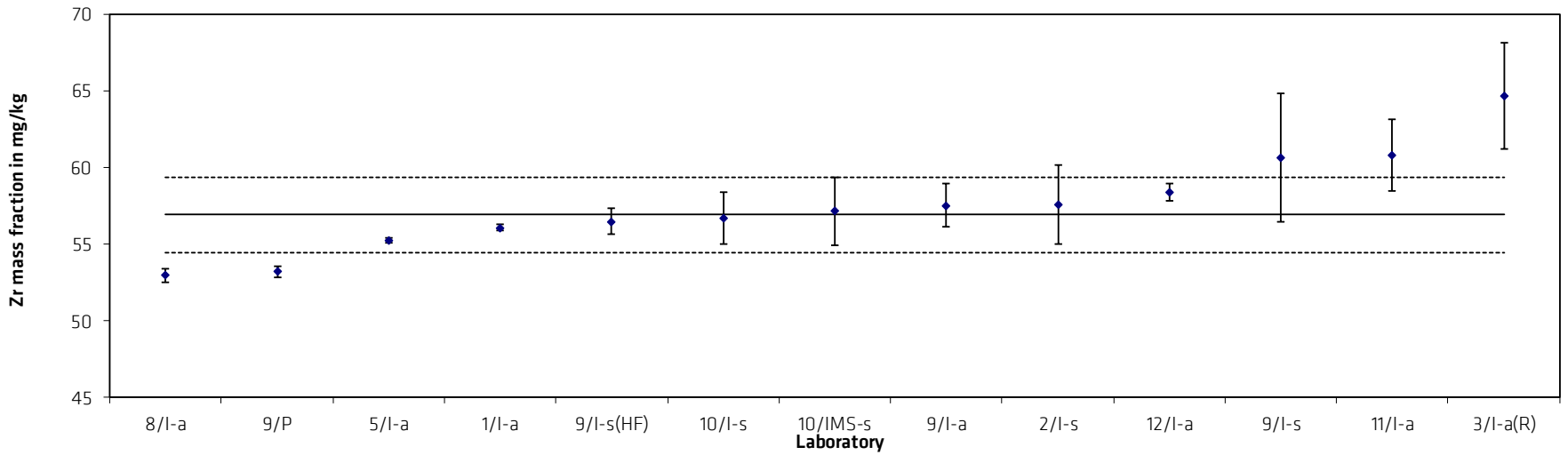


Table 26: Results for Zr

Lab./Meth.	8/I-a	9/P	5/I-a	1/I-a	9/I-s(HF)	10/I-s	10/IMS-s	9/I-a	2/I-s	12/I-a	9/I-s	11/I-a	3/I-a(R)		
M_i [mg/kg]	53.1	53.2	55.1	56.3	56.1	54.7	55.7	55.7	59.6	59	56.9	61.0	60		*n*
	52.9	52.8	55.3	56.3	55.4	57.2	58.1	57.0	59.4	59	60.2	63.6	62		13
	52.3	52.8	55.1	55.9	57.7	58.2	58.0	57.2	60.4	58	58.8	62.3	65		
	52.7	53.4	55.5	55.8	55.6	58.0	59.2	58.0	56.6	58	66.6	61.4	66		
	53.1	53.3	55.1	56.0	56.8	54.4	53.4	60.1	55.2	58		59.9	70		
	53.7	53.7	55.4	56.2	57.1	57.7	58.6	57.2	54.3			56.8	65		
					56.7										
***M* [mg/kg]**	**53.0**	**53.2**	**55.3**	**56.1**	**56.5**	**56.7**	**57.2**	**57.5**	**57.6**	**58.4**	**60.6**	**60.8**	**64.7**		**56.9**
s [mg/kg]	0.47	0.35	0.18	0.22	0.83	1.70	2.19	1.44	2.55	0.55	4.19	2.34	3.44	s_M [mg/kg]	2.44
														$\overline{s}_i$ [mg/kg]	1.84
s_{rel}	0.009	0.007	0.003	0.004	0.015	0.030	0.038	0.025	0.044	0.009	0.069	0.038	0.053		0.043



Using the BAM-software eCerto [4] the data was statistically evaluated to detect outlying values (Grubbs, 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 and Fe

	Si	Fe
Number of data sets	10	15
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	---	Lab. 3
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier was not removed.

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

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

The outliers were not removed.

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

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

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

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

The outliers were not removed.

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

	1st run	2nd run
Number of data sets	17	15
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	Labs. 7/IMS and 3	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 3	---
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were removed.

Tab. 32: Outcome of statistical tests on the results obtained for Ca and Cd

	Ca	Cd
Number of data sets	6	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)	---	---
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 outlier was not removed.

Tab. 33: Outcome of statistical tests on the results obtained for Ga and Li

	Ga	Li
Number of data sets	15	10
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 9/I-a	Lab. 9/I-s
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outliers were not removed.

Tab. 34: Outcome of statistical tests on the results obtained for Pb and Sb

	Pb	Sb
Number of data sets	12	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)	---	---
Grubbs (α = 0.05)	---	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	---	Lab. 9/I-a
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

The outlier was not removed.

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

	Sn
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)	---
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

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

	1st run	2nd run
Number of data sets	13	12
Scheffe's test (data compatible?)	yes	yes
Snedecor-F-Test and Bartlett-Test	Pooling not allowed	Pooling not allowed
Dixon (α = 0.05)	---	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	Lab. 3	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 9/I-s	Lab. 9/I-s
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

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

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

	1st run	2nd run
Number of data sets	14	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. 3	---
Dixon (α = 0.01)	---	---
Grubbs (α = 0.05)	Lab. 3	---
Grubbs (α = 0.01)	---	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 9/I-s	Lab. 9/I-s
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

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

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

	1st run	2nd run
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)	Lab. 3	---
Dixon (α = 0.01)	Lab. 3	---
Grubbs (α = 0.05)	Lab. 3	---
Grubbs (α = 0.01)	Lab. 3	---
Grubbs Pair (α = 0.05)	---	---
Grubbs Pair (α = 0.01)	---	---
Cochran (α = 0.01)	Lab. 3	Lab. 7/IMS
Kolmogorov-Smirnov-Lilliefors Test	Distribution: normal	Distribution: normal

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

The certified mass fractions of all elements were calculated as mean of the accepted data sets. These values are given in Table 39.
The resp. combined uncertainties were calculated from the spread resulting from the certification inter-laboratory comparison (u_{ilc}) and the uncertainty contributions from

possible inhomogeneity over the length ($u_{bb}(1)$) and over area ($u_{bb}(2)$) of the material using Equation 3.

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

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

	uncertainty contribution from								u_{bb} (rel)	
	M	n	s_M	u_{ilc}	$u_{bb}(1)$** Length	$u_{bb}(2)$** Area	u (comb)	U	Length	Area
	%		%	%	%	%	%	%		
Si	6.826	10	0.13684	0.0433	0.0132	0.0530	0.0697	0.1393	0.1934	0.7758
Fe	0.1434	15	0.00517	0.0013	0.0018	0.0009	0.0024	0.0048	1.2252	0.6399
Cu	0.0197	12	0.00055	0.0002	0.0001	0.0002	0.0003	0.00055	0.3330	1.1037
Mn	0.0112	15	0.00025	0.0001	0.0000	0.0000	0.0001	0.00015	0.2456	0.2516
Mg	0.504	15	0.01126	0.0029	0.0012	0.0027	0.0041	0.00829	0.2329	0.5382
Zn	0.0555	16	0.00120	0.0003	0.0001	0.0001	0.0004	0.00071	0.2133	0.2624
Ti	0.1171	15	0.00305	0.0008	0.0002	0.0014	0.0016	0.00324	0.1699	1.1974
	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		
Cr	63.4	16	2.794	0.6985	0.2544	0.2593	0.787	1.575	0.4012	0.4089
Ni	47.8	12	2.687	0.7756	0.0489	0.4514	0.899	1.797	0.1023	0.9443
Ca	25.9	6	3.711	1.5149	0.3433	0.1554	1.561	3.122	1.3281	0.6012
Cd	22.0	14	1.061	0.2837	0.1425	0.3660	0.484	0.969	0.6476	1.6635
Ga	190.7	15	6.125	1.5815	0.5732	1.0905	2.005	4.009	0.3006	0.5719
Li	8.3	10	0.552	0.1746	0.6841	0.0228	0.706	1.413	8.2425	0.2750
Na	13.5	3	1.104	0.6374	1.0716	0.1383	1.255	2.509	7.9381	1.0242
Pb	103.9	12	8.458	2.4415	1.4110	1.2672	3.092	6.183	1.3580	1.2196
Sb	37.1	8	3.104	1.0973	0.7402	1.1631	1.762	3.524	1.9952	3.1350
Sn	182.8	14	6.440	1.7212	0.7400	0.9493	2.100	4.201	0.4048	0.5193
Sr	301.0	13	6.954	1.9287	5.0770	2.7354	6.081	12.162	1.6867	0.9088
V	95.7	14	1.578	0.4217	0.2228	0.3314	0.581	1.162	0.2329	0.3463
Zr	56.9	12	2.440	0.7043	0.2093	0.2178	0.766	1.533	0.3678	0.3827

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

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

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

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

In addition to the wet chemical characterisation an accompanying inter-laboratory comparison with spark emission was performed to check if there is agreement between SOES and wet chemistry. Tab. 40 shows the mean values of wet chemical and spark

emission results as well as their standard deviations. The data obtained with wet chemistry and SOES are consistent for all elements considering their uncertainties. The data from the spark emission inter-laboratory comparison was not used for the calculation of the certified values.

Tab. 40: 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	6.83	0.14	10	6.90	0.12	15
Fe	0.143	0.006	15	0.147	0.006	15
Cu	0.0197	0.0006	12	0.0202	0.0013	14
Mn	0.0112	0.0003	15	0.0114	0.0011	14
Mg	0.504	0.012	15	0.510	0.012	14
Zn	0.0555	0.0012	16	0.0550	0.0030	14
Ti	0.1171	0.0031	15	0.1173	0.0034	13
	in mg/kg	in mg/kg		in mg/kg	in mg/kg	
Cr	63.4	2.8	16	62.5	4.5	13
Ni	47.8	2.7	12	48.8	3.7	12
Ca	25.9	3.8	6	26.7	2.3	13
Cd	22.0	1.1	14	21.8	2.0	12
Ga	190.7	6.2	15	197.2	9.1	10
Li	8.3	0.6	10	8.2	1.5	12
Na	13.5	1.2	3	11.6	2.0	11
Pb	103.9	8.5	12	97.6	5.6	13
Sb	37.1	3.1	8	38.0	7.9	9
Sn	182.8	6.5	14	180.5	9.4	12
Sr	301.0	7.0	13	306.4	20.9	12
V	95.7	1.6	14	96.7	2.1	11
Zr	56.9	2.5	12	56.8	3.4	12

6. Instructions for users and stability

The certified reference material BAM-M325 is intended for the calibration and quality control of spark emission and X-ray fluorescence spectrometers used for the analysis of similar materials. It is also suitable for validation and quality control of wet chemical analysis methods. If chips prepared from the compact material are used for wet chemical analysis, a minimum sample intake of 0.2 g has to be used.
The surface of the material should be cleaned by turning or milling before analysis.
The material will remain stable provided that it is not subjected to excessive heat (eg, during preparation of the working surface).

7. Metrological Traceability

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

8. Information on and purchase of the CRM

Certified reference material BAM-M325 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-M325 will be distributed together with a detailed certificate containing the certified values and their uncertainties, the mean values and standard deviations of all accepted data sets and information on the analytical methods used and the names of the participating laboratories.
Information on certified reference materials can be obtained from BAM:
https://www.bam.de.
Tel. +49 30 8104 1111.

9. References

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

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

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

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

[5] DIN 1333:1992-02 Zahlenangaben

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

(u_{bb}(rel.) here means u_{bb} (rel) Length in Table 39)

Silicon (mass fraction in %):

	1	2	3	4	5
A1	6.880	6.860	6.860	6.870	6.890
A2	6.860	6.910	6.870	6.880	6.890
A3	6.860	6.850	6.840	6.850	6.880
A4	6.880	6.880	6.860	6.910	6.860
A5	6.870	6.860	6.850	6.900	6.880
B1	6.880	6.890	6.860	6.840	6.890
B2	6.910	6.880	6.870	6.890	6.890
B3	6.870	6.860	6.890	6.890	6.890
B4	6.860	6.890	6.890	6.890	6.890
B5	6.890	6.840	6.880	6.860	6.870
C1	6.830	6.890	6.880	6.900	6.860
C2	6.870	6.870	6.870	6.880	6.840
C3	6.860	6.890	6.860	6.870	6.860
C4	6.880	6.870	6.890	6.870	6.880
C5	6.840	6.870	6.860	6.860	6.890
D1	6.830	6.830	6.860	6.850	6.860
D2	6.870	6.850	6.890	6.850	6.870
D3	6.910	6.850	6.850	6.860	6.870
D4	6.840	6.850	6.800	6.840	6.850
D5	6.850	6.840	6.870	6.860	6.840
E1	6.830	6.840	6.890	6.890	6.860
E2	6.850	6.850	6.880	6.860	6.860
E3	6.850	6.850	6.840	6.830	6.850
E4	6.810	6.830	6.850	6.850	6.840
E5	6.850	6.850	6.860	6.850	6.860
F1	6.850	6.840	6.860	6.860	6.840
F2	6.840	6.840	6.840	6.840	6.830
F3	6.850	6.860	6.840	6.840	6.850
F4	6.830	6.850	6.850	6.860	6.860
F5	6.840	6.840	6.810	6.860	6.840

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.033536	29	0.001156414	4.1949714	1.38043E-08	1.562071
Within groups	0.03308	120	0.000275667			
Total	0.066616	149				
within-sd	0.0166032					
effective n	4.00					
s_{bb}	0.0148387					
u^*_{bb}	0.0029828					
u_{bb}	0.0148387					
u_{bb}(rel.)	0.216257					

Iron (mass fraction in %):

	1	2	3	4	5
A1	0.1520	0.1507	0.1499	0.1505	0.1508
A2	0.1506	0.1505	0.1508	0.1498	0.1507
A3	0.1495	0.1490	0.1496	0.1503	0.1518
A4	0.1516	0.1516	0.1503	0.1516	0.1520
A5	0.1508	0.1511	0.1501	0.1529	0.1517
B1	0.1494	0.1505	0.1483	0.1512	0.1515
B2	0.1531	0.1522	0.1505	0.1520	0.1531
B3	0.1528	0.1529	0.1533	0.1541	0.1551
B4	0.1532	0.1540	0.1534	0.1543	0.1527
B5	0.1543	0.1518	0.1527	0.1546	0.1534
C1	0.1531	0.1549	0.1525	0.1552	0.1528
C2	0.1517	0.1546	0.1537	0.1547	0.1543
C3	0.1539	0.1543	0.1535	0.1518	0.1528
C4	0.1531	0.1525	0.1534	0.1528	0.1525
C5	0.1539	0.1539	0.1536	0.1553	0.1533
D1	0.1540	0.1550	0.1548	0.1558	0.1541
D2	0.1530	0.1530	0.1543	0.1551	0.1553
D3	0.1576	0.1564	0.1548	0.1550	0.1537
D4	0.1535	0.1528	0.1523	0.1528	0.1565
D5	0.1539	0.1544	0.1534	0.1551	0.1557
E1	0.1557	0.1537	0.1550	0.1564	0.1551
E2	0.1548	0.1548	0.1548	0.1558	0.1559
E3	0.1568	0.1564	0.1542	0.1552	0.1567
E4	0.1560	0.1554	0.1543	0.1562	0.1569
E5	0.1538	0.1533	0.1553	0.1554	0.1541
F1	0.1547	0.1576	0.1561	0.1572	0.1544
F2	0.1556	0.1569	0.1577	0.1559	0.1571
F3	0.1555	0.1564	0.1562	0.1546	0.1559
F4	0.1568	0.1563	0.1561	0.1578	0.1550
F5	0.1553	0.1554	0.1557	0.1573	0.1571

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000545	29	1.8799E-05	18.01431	2.47024E-31	1.562071
Within groups	0.000125	120	1.0436E-06			
Total	0.00067	149				
within-sd	0.001022					
effective n	4.00					
s_{bb}	0.002107					
u^*_{bb}	0.000184					
u_{bb}	0.002107					
u_{bb}(rel.)	1.36978					

Copper (mass fraction in %):

	1	2	3	4	5
A1	0.0201	0.0201	0.0199	0.0200	0.0201
A2	0.0201	0.0200	0.0201	0.0199	0.0201
A3	0.0197	0.0199	0.0198	0.0199	0.0201
A4	0.0199	0.0201	0.0200	0.0200	0.0200
A5	0.0199	0.0201	0.0199	0.0198	0.0198
B1	0.0200	0.0200	0.0197	0.0200	0.0199
B2	0.0198	0.0199	0.0200	0.0197	0.0199
B3	0.0201	0.0202	0.0200	0.0202	0.0200
B4	0.0199	0.0200	0.0199	0.0201	0.0201
B5	0.0201	0.0199	0.0199	0.0199	0.0199
C1	0.0198	0.0198	0.0200	0.0201	0.0199
C2	0.0198	0.0200	0.0201	0.0200	0.0198
C3	0.0198	0.0200	0.0199	0.0200	0.0200
C4	0.0199	0.0199	0.0200	0.0199	0.0200
C5	0.0199	0.0199	0.0198	0.0200	0.0199
D1	0.0198	0.0201	0.0199	0.0200	0.0198
D2	0.0199	0.0198	0.0199	0.0200	0.0201
D3	0.0199	0.0198	0.0198	0.0199	0.0197
D4	0.0197	0.0198	0.0198	0.0198	0.0200
D5	0.0199	0.0198	0.0197	0.0199	0.0199
E1	0.0200	0.0200	0.0199	0.0200	0.0199
E2	0.0197	0.0197	0.0197	0.0198	0.0198
E3	0.0202	0.0201	0.0199	0.0199	0.0199
E4	0.0200	0.0200	0.0199	0.0200	0.0203
E5	0.0198	0.0198	0.0199	0.0199	0.0198
F1	0.0199	0.0202	0.0200	0.0200	0.0201
F2	0.0199	0.0198	0.0201	0.0200	0.0200
F3	0.0199	0.0200	0.0200	0.0200	0.0200
F4	0.0201	0.0200	0.0201	0.0199	0.0200
F5	0.0198	0.0200	0.0199	0.0198	0.0200

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	9.49E-07	29	3.2738E-08	3.05962	1.02131E-05	1.562071
Within groups	1.28E-06	120	1.07E-08			
Total	2.23E-06	149				
within-sd	0.000103					
effective n	4.00					
s_{bb}	7.42E-05					
u^*_{bb}	1.86E-05					
u_{bb}	7.42E-05					
u_{bb}(rel.)	0.372284					

Manganese (mass fraction in %):

	1	2	3	4	5
A1	0.0110	0.0110	0.0110	0.0109	0.0111
A2	0.0111	0.0112	0.0111	0.0111	0.0110
A3	0.0111	0.0111	0.0110	0.0111	0.0112
A4	0.0111	0.0111	0.0112	0.0113	0.0113
A5	0.0110	0.0111	0.0111	0.0111	0.0111
B1	0.0111	0.0111	0.0112	0.0111	0.0111
B2	0.0110	0.0111	0.0111	0.0111	0.0110
B3	0.0112	0.0111	0.0111	0.0110	0.0111
B4	0.0111	0.0110	0.0110	0.0110	0.0111
B5	0.0112	0.0111	0.0112	0.0110	0.0110
C1	0.0110	0.0111	0.0111	0.0112	0.0111
C2	0.0111	0.0110	0.0112	0.0110	0.0110
C3	0.0111	0.0111	0.0112	0.0110	0.0111
C4	0.0112	0.0110	0.0110	0.0110	0.0111
C5	0.0111	0.0111	0.0111	0.0111	0.0111
D1	0.0111	0.0112	0.0110	0.0111	0.0111
D2	0.0111	0.0111	0.0111	0.0110	0.0112
D3	0.0110	0.0109	0.0110	0.0111	0.0109
D4	0.0110	0.0110	0.0110	0.0110	0.0111
D5	0.0110	0.0110	0.0110	0.0110	0.0111
E1	0.0111	0.0111	0.0111	0.0110	0.0110
E2	0.0111	0.0111	0.0110	0.0110	0.0111
E3	0.0112	0.0110	0.0110	0.0109	0.0111
E4	0.0110	0.0112	0.0110	0.0110	0.0109
E5	0.0111	0.0110	0.0110	0.0110	0.0110
F1	0.0111	0.0110	0.0110	0.0110	0.0111
F2	0.0110	0.0110	0.0111	0.0111	0.0111
F3	0.0109	0.0112	0.0111	0.0110	0.0110
F4	0.0112	0.0111	0.0110	0.0110	0.0111
F5	0.0111	0.0112	0.0109	0.0110	0.0112

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.74E-07	29	9.4621E-09	1.640821	0.033803159	1.562071
Within groups	6.92E-07	120	5.7667E-09			
Total	9.66E-07	149				
within-sd	7.59E-05					
effective n	4.00					
s_{bb}	3.04E-05					
u^*_{bb}	1.36E-05					
u_{bb}	3.04E-05					
u_{bb}(rel.)	0.27462					

Magnesium (mass fraction in %):

	1	2	3	4	5
A1	0.5123	0.5108	0.5086	0.5078	0.5121
A2	0.5090	0.5101	0.5118	0.5074	0.5115
A3	0.5062	0.5079	0.5056	0.5067	0.5111
A4	0.5065	0.5108	0.5093	0.5114	0.5094
A5	0.5074	0.5109	0.5083	0.5098	0.5086
B1	0.5078	0.5109	0.5070	0.5098	0.5097
B2	0.5080	0.5089	0.5125	0.5058	0.5082
B3	0.5107	0.5124	0.5131	0.5133	0.5112
B4	0.5083	0.5096	0.5101	0.5113	0.5138
B5	0.5147	0.5089	0.5128	0.5105	0.5107
C1	0.5055	0.5082	0.5102	0.5147	0.5108
C2	0.5097	0.5129	0.5153	0.5136	0.5095
C3	0.5089	0.5111	0.5104	0.5101	0.5119
C4	0.5107	0.5081	0.5112	0.5099	0.5111
C5	0.5093	0.5112	0.5068	0.5106	0.5107
D1	0.5074	0.5130	0.5112	0.5129	0.5086
D2	0.5109	0.5076	0.5092	0.5091	0.5136
D3	0.5115	0.5067	0.5078	0.5110	0.5063
D4	0.5055	0.5097	0.5059	0.5096	0.5112
D5	0.5090	0.5059	0.5084	0.5105	0.5084
E1	0.5093	0.5126	0.5113	0.5130	0.5103
E2	0.5076	0.5069	0.5095	0.5104	0.5103
E3	0.5148	0.5130	0.5105	0.5104	0.5113
E4	0.5105	0.5124	0.5132	0.5141	0.5160
E5	0.5102	0.5095	0.5104	0.5087	0.5088
F1	0.5098	0.5139	0.5135	0.5127	0.5142
F2	0.5097	0.5078	0.5119	0.5114	0.5123
F3	0.5091	0.5116	0.5111	0.5119	0.5098
F4	0.5136	0.5127	0.5128	0.5113	0.5119
F5	0.5118	0.5131	0.5105	0.5102	0.5145

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000314	29	1.0829E-05	2.876233	3.03019E-05	1.562071
Within groups	0.000452	120	3.765E-06			
Total	0.000766	149				
within-sd	0.00194					
effective n	4.00					
s_{bb}	0.001329					
u^*_{bb}	0.000349					
u_{bb}	0.001329					
u_{bb}(rel.)	0.26039					

Chromium (mass fraction in %):

	1	2	3	4	5
A1	0.0061	0.0060	0.0061	0.0061	0.0061
A2	0.0060	0.0060	0.0061	0.0060	0.0061
A3	0.0060	0.0060	0.0060	0.0060	0.0060
A4	0.0060	0.0060	0.0060	0.0060	0.0060
A5	0.0060	0.0060	0.0060	0.0060	0.0060
B1	0.0060	0.0061	0.0060	0.0061	0.0060
B2	0.0061	0.0060	0.0060	0.0060	0.0060
B3	0.0060	0.0061	0.0060	0.0060	0.0061
B4	0.0061	0.0061	0.0061	0.0061	0.0061
B5	0.0061	0.0060	0.0060	0.0061	0.0060
C1	0.0060	0.0061	0.0061	0.0061	0.0060
C2	0.0060	0.0060	0.0061	0.0060	0.0060
C3	0.0060	0.0060	0.0060	0.0060	0.0061
C4	0.0061	0.0061	0.0061	0.0061	0.0061
C5	0.0060	0.0061	0.0060	0.0061	0.0061
D1	0.0060	0.0061	0.0061	0.0060	0.0061
D2	0.0061	0.0060	0.0061	0.0061	0.0061
D3	0.0061	0.0061	0.0060	0.0061	0.0061
D4	0.0061	0.0060	0.0060	0.0061	0.0060
D5	0.0061	0.0060	0.0061	0.0061	0.0061
E1	0.0060	0.0060	0.0061	0.0060	0.0061
E2	0.0060	0.0060	0.0060	0.0060	0.0061
E3	0.0061	0.0061	0.0060	0.0061	0.0061
E4	0.0061	0.0061	0.0061	0.0060	0.0061
E5	0.0061	0.0061	0.0062	0.0061	0.0060
F1	0.0060	0.0061	0.0061	0.0061	0.0062
F2	0.0061	0.0061	0.0061	0.0061	0.0061
F3	0.0060	0.0061	0.0060	0.0061	0.0061
F4	0.0060	0.0061	0.0061	0.0062	0.0060
F5	0.0061	0.0061	0.0061	0.0061	0.0060

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.52E-07	29	5.2529E-09	2.283858	0.000988771	1.562071
Within groups	2.76E-07	120	2.3E-09			
Total	4.28E-07	149				
within-sd	4.8E-05					
effective n	4.00					
s_{bb}	2.72E-05					
u^*_{bb}	8.62E-06					
u_{bb}	2.72E-05					
u_{bb}(rel.)	0.448599					

Nickel (mass fraction in %):

	1	2	3	4	5
A1	0.0049	0.0048	0.0048	0.0048	0.0048
A2	0.0048	0.0048	0.0048	0.0048	0.0048
A3	0.0048	0.0048	0.0048	0.0047	0.0048
A4	0.0048	0.0048	0.0048	0.0048	0.0048
A5	0.0048	0.0048	0.0048	0.0048	0.0048
B1	0.0048	0.0048	0.0048	0.0048	0.0048
B2	0.0048	0.0048	0.0049	0.0047	0.0048
B3	0.0048	0.0049	0.0048	0.0048	0.0048
B4	0.0048	0.0048	0.0048	0.0048	0.0048
B5	0.0048	0.0048	0.0048	0.0048	0.0048
C1	0.0048	0.0048	0.0048	0.0048	0.0048
C2	0.0048	0.0048	0.0048	0.0048	0.0048
C3	0.0048	0.0047	0.0048	0.0048	0.0048
C4	0.0049	0.0048	0.0048	0.0048	0.0048
C5	0.0048	0.0048	0.0048	0.0048	0.0048
D1	0.0048	0.0048	0.0048	0.0048	0.0047
D2	0.0048	0.0048	0.0048	0.0048	0.0048
D3	0.0048	0.0048	0.0048	0.0048	0.0048
D4	0.0048	0.0049	0.0048	0.0048	0.0048
D5	0.0048	0.0047	0.0048	0.0048	0.0048
E1	0.0048	0.0048	0.0048	0.0048	0.0048
E2	0.0047	0.0048	0.0048	0.0048	0.0048
E3	0.0048	0.0048	0.0048	0.0048	0.0048
E4	0.0048	0.0048	0.0048	0.0048	0.0048
E5	0.0047	0.0047	0.0048	0.0048	0.0048
F1	0.0048	0.0048	0.0048	0.0048	0.0048
F2	0.0048	0.0048	0.0048	0.0048	0.0048
F3	0.0047	0.0048	0.0048	0.0048	0.0048
F4	0.0048	0.0048	0.0048	0.0048	0.0048
F5	0.0048	0.0048	0.0048	0.0048	0.0048

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.69E-08	29	9.2874E-10	0.995074	0.482875358	1.562071
Within groups	1.12E-07	120	9.3333E-10			
Total	1.39E-07	149				
within-sd	3.06E-05					
effective n	4.00					
s_{bb}	0					
u^*_{bb}	5.49E-06					
u_{bb}	5.49E-06					
u_{bb}(rel.)	0.114406					

Zinc (mass fraction in %):

	1	2	3	4	5
A1	0.0563	0.0564	0.0562	0.0559	0.0565
A2	0.0561	0.0562	0.0565	0.0559	0.0562
A3	0.0555	0.0557	0.0558	0.0560	0.0564
A4	0.0562	0.0564	0.0563	0.0565	0.0567
A5	0.0559	0.0559	0.0559	0.0569	0.0566
B1	0.0556	0.0563	0.0556	0.0563	0.0563
B2	0.0561	0.0566	0.0562	0.0563	0.0562
B3	0.0560	0.0568	0.0567	0.0570	0.0566
B4	0.0559	0.0564	0.0563	0.0566	0.0566
B5	0.0564	0.0556	0.0563	0.0559	0.0562
C1	0.0558	0.0564	0.0561	0.0562	0.0565
C2	0.0559	0.0568	0.0565	0.0569	0.0565
C3	0.0559	0.0562	0.0560	0.0564	0.0565
C4	0.0561	0.0559	0.0564	0.0564	0.0563
C5	0.0561	0.0559	0.0560	0.0564	0.0565
D1	0.0561	0.0564	0.0559	0.0564	0.0561
D2	0.0560	0.0560	0.0562	0.0564	0.0567
D3	0.0573	0.0566	0.0562	0.0560	0.0563
D4	0.0557	0.0561	0.0558	0.0561	0.0561
D5	0.0562	0.0561	0.0560	0.0564	0.0563
E1	0.0560	0.0561	0.0566	0.0562	0.0566
E2	0.0567	0.0560	0.0561	0.0566	0.0564
E3	0.0568	0.0565	0.0562	0.0560	0.0566
E4	0.0559	0.0560	0.0565	0.0565	0.0566
E5	0.0558	0.0561	0.0564	0.0562	0.0561
F1	0.0561	0.0566	0.0566	0.0563	0.0563
F2	0.0561	0.0567	0.0568	0.0563	0.0567
F3	0.0564	0.0566	0.0561	0.0566	0.0560
F4	0.0567	0.0567	0.0560	0.0566	0.0565
F5	0.0565	0.0564	0.0563	0.0567	0.0571

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	4.69E-06	29	1.6168E-07	1.804418	0.014444151	1.562071
Within groups	1.08E-05	120	8.96E-08			
Total	1.54E-05	149				
within-sd	0.000299					
effective n	4.00					
s_{bb}	0.000134					
u^*_{bb}	5.38E-05					
u_{bb}	0.000134					
u_{bb}(rel.)	0.238487					

Titanium (mass fraction in %):

	1	2	3	4	5
A1	0.1215	0.1225	0.1224	0.1221	0.1224
A2	0.1231	0.1223	0.1226	0.1222	0.1228
A3	0.1213	0.1221	0.1224	0.1242	0.1218
A4	0.1225	0.1234	0.1236	0.1220	0.1231
A5	0.1216	0.1232	0.1222	0.1230	0.1229
B1	0.1229	0.1229	0.1223	0.1239	0.1225
B2	0.1230	0.1225	0.1231	0.1232	0.1233
B3	0.1228	0.1233	0.1231	0.1230	0.1234
B4	0.1232	0.1233	0.1230	0.1235	0.1235
B5	0.1221	0.1232	0.1234	0.1228	0.1232
C1	0.1238	0.1227	0.1229	0.1236	0.1229
C2	0.1223	0.1229	0.1229	0.1229	0.1240
C3	0.1229	0.1229	0.1231	0.1239	0.1237
C4	0.1228	0.1233	0.1235	0.1238	0.1239
C5	0.1225	0.1230	0.1236	0.1232	0.1235
D1	0.1225	0.1225	0.1232	0.1232	0.1232
D2	0.1234	0.1238	0.1229	0.1236	0.1240
D3	0.1226	0.1226	0.1237	0.1221	0.1230
D4	0.1225	0.1221	0.1227	0.1234	0.1229
D5	0.1225	0.1228	0.1229	0.1232	0.1230
E1	0.1222	0.1223	0.1245	0.1232	0.1234
E2	0.1231	0.1226	0.1228	0.1232	0.1231
E3	0.1233	0.1229	0.1233	0.1235	0.1237
E4	0.1227	0.1229	0.1231	0.1234	0.1225
E5	0.1227	0.1232	0.1230	0.1237	0.1237
F1	0.1221	0.1224	0.1237	0.1223	0.1239
F2	0.1233	0.1229	0.1235	0.1234	0.1235
F3	0.1230	0.1232	0.1222	0.1229	0.1230
F4	0.1229	0.1233	0.1238	0.1236	0.1233
F5	0.1232	0.1225	0.1234	0.1226	0.1234

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.41E-05	29	4.8626E-07	1.815062	0.01364646	1.562071
Within groups	3.21E-05	120	2.679E-07			
Total	4.62E-05	149				
within-sd	0.000518					
effective n	4.00					
s_{bb}	0.000234					
u^*_{bb}	9.3E-05					
u_{bb}	0.000234					
u_{bb}(rel.)	0.189956					

Bismuth (mass fraction in %):

	1	2	3	4	5
A1	0.0029	0.0029	0.0031	0.0030	0.0029
A2	0.0031	0.0030	0.0031	0.0031	0.0030
A3	0.0032	0.0031	0.0029	0.0029	0.0029
A4	0.0030	0.0030	0.0030	0.0030	0.0030
A5	0.0029	0.0029	0.0030	0.0029	0.0029
B1	0.0028	0.0029	0.0030	0.0031	0.0029
B2	0.0032	0.0030	0.0030	0.0028	0.0029
B3	0.0030	0.0030	0.0029	0.0030	0.0028
B4	0.0028	0.0029	0.0028	0.0030	0.0030
B5	0.0028	0.0029	0.0028	0.0029	0.0029
C1	0.0030	0.0030	0.0029	0.0030	0.0028
C2	0.0031	0.0029	0.0029	0.0029	0.0029
C3	0.0029	0.0030	0.0029	0.0028	0.0029
C4	0.0031	0.0031	0.0028	0.0029	0.0030
C5	0.0029	0.0029	0.0029	0.0029	0.0027
D1	0.0031	0.0030	0.0029	0.0028	0.0031
D2	0.0029	0.0030	0.0028	0.0029	0.0028
D3	0.0028	0.0030	0.0031	0.0028	0.0028
D4	0.0030	0.0030	0.0030	0.0029	0.0029
D5	0.0030	0.0031	0.0030	0.0029	0.0030
E1	0.0029	0.0030	0.0031	0.0029	0.0028
E2	0.0030	0.0030	0.0029	0.0030	0.0029
E3	0.0031	0.0029	0.0030	0.0029	0.0029
E4	0.0029	0.0029	0.0029	0.0029	0.0030
E5	0.0030	0.0027	0.0030	0.0030	0.0029
F1	0.0030	0.0029	0.0029	0.0029	0.0029
F2	0.0030	0.0030	0.0029	0.0030	0.0028
F3	0.0030	0.0029	0.0029	0.0030	0.0029
F4	0.0029	0.0030	0.0029	0.0029	0.0030
F5	0.0030	0.0031	0.0030	0.0029	0.0029

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.78E-07	29	9.5724E-09	1.135069	0.309812403	1.562071
Within groups	1.01E-06	120	8.4333E-09			
Total	1.29E-06	149				
within-sd	9.18E-05					
effective n	4.00					
s_{bb}	1.69E-05					
u^*_{bb}	1.65E-05					
u_{bb}	1.69E-05					
u_{bb}(rel.)	0.573204					

Calcium (mass fraction in mg/kg):

	1	2	3	4	5
A1	25.03	25.54	25.19	25.28	25.34
A2	24.95	25.44	25.28	24.95	25.11
A3	25.81	25.52	25.68	25.44	26.04
A4	24.68	24.71	24.95	24.96	25.02
A5	25.74	25.70	25.30	25.88	25.51
B1	24.96	25.16	25.03	24.99	25.03
B2	25.16	25.09	25.23	25.21	25.18
B3	24.52	24.86	24.98	24.99	24.90
B4	24.99	24.45	24.89	25.03	25.21
B5	25.89	25.70	26.00	26.18	25.78
C1	24.92	25.60	25.48	25.67	25.50
C2	25.75	26.02	25.90	25.89	25.89
C3	25.26	25.58	25.77	25.31	25.10
C4	25.22	24.75	24.94	24.94	24.92
C5	24.76	24.84	24.58	24.68	24.95
D1	25.04	25.05	25.34	25.26	25.26
D2	24.90	25.10	25.47	24.60	24.89
D3	24.53	24.70	24.74	24.76	24.81
D4	25.80	25.90	25.42	25.56	25.77
D5	25.12	25.03	25.55	25.42	25.14
E1	24.79	25.21	25.44	25.53	25.19
E2	25.33	25.21	25.47	25.36	25.49
E3	24.90	25.06	25.00	24.97	24.88
E4	25.70	25.21	26.00	25.67	25.98
E5	25.22	24.92	25.00	25.03	24.82
F1	25.09	25.07	25.30	25.10	25.27
F2	24.77	24.99	24.51	24.94	24.99
F3	24.73	24.69	24.54	24.69	24.58
F4	25.41	25.31	24.99	25.21	25.09
F5	25.37	25.19	25.09	25.60	25.21

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	17.37948	29	0.59929253	15.3974	3.08491E-28	1.562071
Within groups	4.6706	120	0.03892167			
Total	22.05008	149				
within-sd	0.197286					
effective n	4.00					
s_{bb}	0.37429					
u^*_{bb}	0.035443					
u_{bb}	0.37429					
u_{bb}(rel.)	1.484903					

Cadmium (mass fraction in mg/kg):

	1	2	3	4	5
A1	22.11	22.03	21.48	21.61	21.90
A2	21.79	21.86	21.91	21.72	22.01
A3	21.62	21.53	21.52	21.35	21.64
A4	21.79	21.88	21.84	21.75	21.82
A5	21.71	21.93	21.80	21.37	21.42
B1	22.10	21.75	21.53	21.68	21.55
B2	21.66	21.64	22.15	21.33	21.54
B3	21.96	22.13	22.06	21.90	21.52
B4	21.79	21.94	21.60	22.08	21.78
B5	22.09	21.71	21.62	21.38	21.69
C1	21.63	21.85	21.83	22.16	21.78
C2	21.61	21.85	21.85	21.68	21.40
C3	21.84	21.82	21.93	21.64	21.77
C4	21.71	21.90	21.69	21.52	21.61
C5	21.94	21.84	21.58	21.96	21.45
D1	22.03	22.41	21.85	22.19	21.76
D2	21.70	21.58	21.63	21.70	22.14
D3	21.50	21.53	21.67	21.90	21.20
D4	21.86	21.86	21.71	21.65	21.82
D5	21.88	21.52	21.45	21.87	21.90
E1	22.13	22.09	21.68	21.92	21.50
E2	21.47	21.56	21.49	21.75	21.66
E3	22.18	22.01	21.80	21.98	21.80
E4	22.47	22.16	21.83	22.09	22.15
E5	21.76	21.71	21.69	21.68	21.62
F1	22.14	22.37	21.99	22.01	21.91
F2	22.19	21.82	22.09	21.96	21.85
F3	22.22	21.96	22.10	22.07	21.98
F4	22.65	22.19	22.24	21.84	21.85
F5	21.88	22.23	21.83	21.77	21.76

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	4.093213	29	0.14114529	3.414998	1.25229E-06	1.562071
Within groups	4.95972	120	0.041331			
Total	9.052933	149				
within-sd	0.2033					
effective n	4.00					
s_{bb}	0.157967					
u^*_{bb}	0.036523					
u_{bb}	0.157967					
u_{bb}(rel.)	0.723999					

Gallium (mass fraction in mg/kg):

	1	2	3	4	5
A1	201.6	202.1	201.0	200.3	200.9
A2	200.5	199.8	202.0	199.2	201.3
A3	200.0	199.4	199.2	200.7	200.8
A4	198.9	199.9	200.5	200.9	200.9
A5	199.4	201.3	200.2	200.3	198.9
B1	200.5	200.7	199.5	200.5	199.9
B2	199.8	199.5	200.6	198.6	199.3
B3	200.8	202.1	201.6	201.1	200.0
B4	200.1	199.4	200.3	200.8	201.6
B5	202.3	199.3	199.7	199.7	200.2
C1	198.8	199.3	200.6	200.9	199.4
C2	199.0	200.0	201.9	200.2	199.1
C3	199.9	200.6	199.8	200.0	200.3
C4	200.3	199.5	200.4	199.6	200.0
C5	200.1	199.6	198.7	200.5	199.8
D1	198.8	202.0	200.4	201.4	198.4
D2	200.1	199.5	198.9	199.7	200.7
D3	199.8	198.7	198.9	199.9	198.0
D4	198.2	199.3	197.5	198.6	198.8
D5	199.2	197.7	198.2	199.9	199.5
E1	199.7	200.1	199.6	199.6	199.2
E2	198.6	197.1	198.0	198.9	198.3
E3	201.9	201.2	200.1	199.6	199.6
E4	200.0	200.2	200.3	200.7	201.8
E5	199.4	198.5	199.5	197.6	198.2
F1	199.3	200.8	200.1	199.8	200.7
F2	199.6	198.7	200.5	199.7	199.4
F3	198.9	200.0	199.7	201.3	200.7
F4	199.8	199.6	200.3	198.5	198.9
F5	200.2	199.9	198.4	197.5	200.0

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	72.96841	29	2.51615221	3.533086	6.2649E-07	1.562071
Within groups	85.4602	120	0.71216833			
Total	158.4286	149				
within-sd	0.843901					
effective n	4.00					
s_{bb}	0.671562					
u^*_{bb}	0.151608					
u_{bb}	0.671562					
u_{bb}(rel.)	0.33603					

Lithium (mass fraction in mg/kg):

	1	2	3	4	5	
A1	9.46	9.30	9.21	9.11	9.53	9.32
A2	9.51	9.77	9.49	9.35	9.67	9.56
A3	10.38	10.54	10.43	10.67	10.64	10.53
A4	8.73	8.81	9.07	8.92	8.87	8.88
A5	10.49	10.57	10.29	10.62	10.68	10.53
B1	8.14	8.24	8.23	8.29	8.34	8.25
B2	9.27	9.28	9.53	9.33	9.58	9.40
B3	8.24	8.18	8.28	8.30	8.19	8.24
B4	8.90	8.92	9.09	9.02	8.86	8.96
B5	10.46	10.66	10.72	10.75	10.51	10.62
C1	9.32	9.71	9.64	9.58	9.69	9.59
C2	10.53	10.68	10.75	10.56	10.61	10.63
C3	9.78	9.60	9.72	9.93	9.76	9.76
C4	8.96	9.01	8.71	9.08	8.98	8.95
C5	8.10	8.34	8.36	8.04	8.18	8.20
D1	9.48	9.47	9.56	9.64	9.77	9.58
D2	9.10	9.16	8.95	9.03	9.08	9.06
D3	8.04	8.29	8.46	8.48	8.42	8.34
D4	10.41	10.51	10.20	10.77	10.67	10.51
D5	9.36	9.20	9.56	9.58	9.28	9.40
E1	9.36	9.35	9.84	9.73	9.48	9.55
E2	9.65	9.76	9.86	9.81	9.62	9.74
E3	9.08	8.98	9.13	9.28	9.14	9.12
E4	10.40	10.28	10.63	10.90	10.62	10.57
E5	8.99	9.06	8.57	8.84	9.04	8.90
F1	9.26	9.34	9.43	9.39	9.46	9.38
F2	8.24	8.32	8.00	8.29	8.36	8.24
F3	8.27	8.32	8.33	8.31	8.35	8.32
F4	9.31	9.33	9.38	9.41	9.15	9.32
F5	9.61	9.71	9.50	9.76	9.62	9.64

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	87.05719	29	3.00197205	148.7057	1.24301E-80	1.562071
Within groups	2.42248	120	0.02018733			
Total	89.47967	149				
within-sd	0.142082					
effective n	4.00					
s_{bb}	0.863392					
u^*_{bb}	0.025525					
u_{bb}	0.863392					
u_{bb}(rel.)	9.21535					

Sodium (mass fraction in mg/kg):

	1	2	3	4	5	
A1	11.72	11.37	11.31	11.23	11.79	11.48
A2	11.62	12.11	11.56	11.39	11.53	11.64
A3	12.44	12.72	12.48	12.71	12.98	12.67
A4	10.62	10.67	11.00	10.83	10.79	10.78
A5	12.88	12.85	12.26	12.86	13.26	12.82
B1	10.20	10.24	9.98	10.23	10.26	10.18
B2	11.35	11.49	11.82	11.52	11.91	11.62
B3	10.13	10.14	10.64	10.11	10.13	10.23
B4	10.63	10.68	10.82	10.95	10.79	10.77
B5	12.81	12.81	13.16	13.22	12.73	12.95
C1	11.39	11.96	11.96	11.81	12.17	11.86
C2	12.61	12.83	12.84	12.75	12.82	12.77
C3	12.13	11.60	11.87	12.44	11.96	12.00
C4	10.99	11.01	10.47	10.98	10.89	10.87
C5	10.06	10.36	10.19	10.02	10.13	10.15
D1	11.69	11.57	11.73	11.76	12.12	11.77
D2	11.03	11.12	10.92	10.83	11.02	10.98
D3	9.75	10.45	10.40	10.29	10.23	10.22
D4	12.69	12.98	12.60	13.17	12.97	12.88
D5	11.74	11.41	11.84	11.92	11.40	11.66
E1	11.41	11.60	12.10	12.15	11.97	11.85
E2	12.05	11.97	12.15	12.21	12.00	12.08
E3	11.00	10.83	11.13	11.05	11.00	11.00
E4	12.86	12.43	13.05	13.35	13.00	12.94
E5	10.86	10.83	10.57	10.60	11.26	10.82
F1	12.19	11.73	11.67	11.91	11.87	11.87
F2	10.29	10.46	10.04	10.25	10.39	10.29
F3	10.15	10.25	10.30	10.07	10.35	10.22
F4	11.71	11.54	11.50	11.71	11.48	11.59
F5	12.03	12.02	11.69	12.33	11.88	11.99

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	122.2618	29	4.21592515	84.44235	1.55444E-66	1.562071
Within groups	5.9912	120	0.04992667			
Total	128.253	149				
within-sd	0.223443					
effective n	4.00					
s_{bb}	1.020539					
u^*_{bb}	0.040142					
u_{bb}	1.020539					
u_{bb}(rel.)	8.875074					

Lead (mass fraction in %):

	1	2	3	4	5
A1	0.0101	0.0095	0.0094	0.0095	0.0100
A2	0.0101	0.0095	0.0100	0.0095	0.0100
A3	0.0100	0.0094	0.0094	0.0094	0.0101
A4	0.0094	0.0101	0.0095	0.0101	0.0095
A5	0.0094	0.0101	0.0096	0.0094	0.0094
B1	0.0100	0.0101	0.0095	0.0095	0.0101
B2	0.0100	0.0101	0.0102	0.0093	0.0101
B3	0.0101	0.0102	0.0102	0.0101	0.0101
B4	0.0101	0.0101	0.0100	0.0101	0.0102
B5	0.0101	0.0094	0.0101	0.0100	0.0095
C1	0.0094	0.0095	0.0101	0.0102	0.0102
C2	0.0095	0.0101	0.0101	0.0101	0.0095
C3	0.0101	0.0101	0.0095	0.0101	0.0102
C4	0.0101	0.0101	0.0101	0.0101	0.0101
C5	0.0100	0.0100	0.0096	0.0101	0.0097
D1	0.0101	0.0102	0.0100	0.0101	0.0094
D2	0.0101	0.0101	0.0096	0.0101	0.0101
D3	0.0101	0.0100	0.0096	0.0101	0.0095
D4	0.0094	0.0100	0.0100	0.0100	0.0101
D5	0.0101	0.0101	0.0094	0.0101	0.0102
E1	0.0102	0.0102	0.0100	0.0101	0.0101
E2	0.0095	0.0096	0.0094	0.0101	0.0094
E3	0.0102	0.0102	0.0101	0.0100	0.0101
E4	0.0102	0.0101	0.0101	0.0101	0.0103
E5	0.0101	0.0100	0.0101	0.0101	0.0096
F1	0.0102	0.0102	0.0100	0.0101	0.0101
F2	0.0101	0.0102	0.0102	0.0102	0.0101
F3	0.0101	0.0102	0.0101	0.0102	0.0102
F4	0.0102	0.0102	0.0101	0.0101	0.0101
F5	0.0100	0.0101	0.0100	0.0102	0.0101

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	4.46E-06	29	1.5395E-07	2.454066	0.000366865	1.562071
Within groups	7.53E-06	120	6.2733E-08			
Total	1.2E-05	149				
within-sd	0.00025					
effective n	4.00					
s_{bb}	0.000151					
u^*_{bb}	4.5E-05					
u_{bb}	0.000151					
u_{bb}(rel.)	1.518318					

Antimony (mass fraction in %):

	1	2	3	4	5
A1	0.0045	0.0047	0.0046	0.0047	0.0048
A2	0.0044	0.0048	0.0046	0.0047	0.0044
A3	0.0044	0.0044	0.0052	0.0039	0.0043
A4	0.0049	0.0051	0.0042	0.0046	0.0049
A5	0.0052	0.0041	0.0040	0.0045	0.0044
B1	0.0045	0.0047	0.0048	0.0045	0.0045
B2	0.0048	0.0051	0.0045	0.0049	0.0044
B3	0.0047	0.0048	0.0048	0.0044	0.0052
B4	0.0045	0.0044	0.0047	0.0048	0.0051
B5	0.0046	0.0048	0.0046	0.0048	0.0046
C1	0.0044	0.0047	0.0038	0.0045	0.0047
C2	0.0043	0.0043	0.0040	0.0040	0.0045
C3	0.0046	0.0049	0.0045	0.0041	0.0046
C4	0.0048	0.0049	0.0043	0.0052	0.0048
C5	0.0047	0.0043	0.0051	0.0049	0.0045
D1	0.0041	0.0047	0.0042	0.0042	0.0043
D2	0.0042	0.0047	0.0045	0.0044	0.0047
D3	0.0052	0.0048	0.0050	0.0045	0.0047
D4	0.0044	0.0046	0.0044	0.0043	0.0044
D5	0.0043	0.0047	0.0046	0.0045	0.0044
E1	0.0045	0.0047	0.0043	0.0045	0.0046
E2	0.0040	0.0047	0.0048	0.0049	0.0044
E3	0.0046	0.0047	0.0048	0.0049	0.0044
E4	0.0046	0.0047	0.0046	0.0045	0.0047
E5	0.0048	0.0043	0.0044	0.0048	0.0050
F1	0.0044	0.0043	0.0048	0.0048	0.0044
F2	0.0047	0.0048	0.0044	0.0047	0.0051
F3	0.0047	0.0051	0.0045	0.0045	0.0046
F4	0.0047	0.0051	0.0046	0.0047	0.0048
F5	0.0043	0.0044	0.0046	0.0046	0.0049

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	3.28E-06	29	1.1301E-07	1.59324	0.042890258	1.562071
Within groups	8.51E-06	120	7.0933E-08			
Total	1.18E-05	149				
within-sd	0.000266					
effective n	4.00					
s_{bb}	0.000103					
u^*_{bb}	4.78E-05					
u_{bb}	0.000103					
u_{bb}(rel.)	2.230701					

Tin (mass fraction in %):

	1	2	3	4	5
A1	0.0197	0.0197	0.0192	0.0194	0.0197
A2	0.0194	0.0194	0.0196	0.0193	0.0195
A3	0.0194	0.0193	0.0192	0.0192	0.0197
A4	0.0193	0.0198	0.0195	0.0195	0.0193
A5	0.0196	0.0195	0.0195	0.0193	0.0192
B1	0.0198	0.0195	0.0192	0.0195	0.0195
B2	0.0191	0.0195	0.0197	0.0190	0.0193
B3	0.0195	0.0201	0.0197	0.0196	0.0193
B4	0.0194	0.0195	0.0193	0.0196	0.0195
B5	0.0197	0.0194	0.0195	0.0192	0.0192
C1	0.0190	0.0192	0.0194	0.0195	0.0193
C2	0.0192	0.0195	0.0196	0.0195	0.0192
C3	0.0193	0.0194	0.0195	0.0193	0.0194
C4	0.0196	0.0194	0.0193	0.0190	0.0195
C5	0.0195	0.0192	0.0192	0.0196	0.0191
D1	0.0196	0.0199	0.0193	0.0195	0.0191
D2	0.0195	0.0194	0.0193	0.0194	0.0196
D3	0.0194	0.0192	0.0190	0.0194	0.0192
D4	0.0192	0.0195	0.0192	0.0191	0.0193
D5	0.0195	0.0194	0.0191	0.0193	0.0194
E1	0.0196	0.0196	0.0192	0.0194	0.0193
E2	0.0191	0.0189	0.0190	0.0191	0.0191
E3	0.0196	0.0195	0.0193	0.0194	0.0193
E4	0.0198	0.0197	0.0192	0.0194	0.0198
E5	0.0191	0.0193	0.0192	0.0191	0.0194
F1	0.0192	0.0195	0.0193	0.0194	0.0196
F2	0.0194	0.0193	0.0194	0.0193	0.0195
F3	0.0192	0.0194	0.0197	0.0196	0.0194
F4	0.0197	0.0194	0.0195	0.0192	0.0193
F5	0.0193	0.0193	0.0193	0.0191	0.0196

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.95E-06	29	6.7274E-08	1.844796	0.011634054	1.562071
Within groups	4.38E-06	120	3.6467E-08			
Total	6.33E-06	149				
within-sd	0.000191					
effective n	4.00					
s_{bb}	8.78E-05					
u^*_{bb}	3.43E-05					
u_{bb}	8.78E-05					
u_{bb}(rel.)	0.452586					

Strontium (mass fraction in mg/kg):

	1	2	3	4	5	
A1	289.2	293.4	292.2	293.3	294.3	292.5
A2	287.6	293.0	291.3	286.8	288.3	289.4
A3	299.3	295.1	297.5	291.8	307.6	298.3
A4	284.2	282.7	286.0	285.6	286.2	284.9
A5	297.8	294.9	291.7	297.2	292.9	294.9
B1	284.7	287.4	286.5	286.2	285.4	286.0
B2	288.1	288.4	289.4	288.2	289.1	288.6
B3	278.4	282.4	285.8	281.3	285.8	282.7
B4	283.8	278.5	283.8	286.9	289.2	284.4
B5	298.0	295.3	299.3	301.4	295.6	297.9
C1	284.5	293.8	290.5	294.1	292.2	291.0
C2	294.1	297.9	296.0	296.9	298.1	296.6
C3	288.5	291.4	286.5	288.0	286.8	288.2
C4	285.7	281.4	284.5	282.6	284.9	283.8
C5	281.4	282.7	279.8	281.0	283.3	281.6
D1	286.4	285.5	289.6	287.0	288.1	287.3
D2	281.4	286.6	291.3	280.0	283.1	284.5
D3	280.9	281.0	280.7	281.5	282.1	281.2
D4	295.2	298.3	291.3	292.1	295.6	294.5
D5	287.8	287.0	292.1	290.6	287.0	288.9
E1	282.0	288.8	291.0	292.0	287.1	288.2
E2	288.3	288.0	290.8	290.9	292.5	290.1
E3	282.5	286.7	284.4	284.6	283.6	284.4
E4	294.6	289.3	298.7	295.7	298.5	295.4
E5	288.1	284.6	284.0	284.5	284.3	285.1
F1	287.4	286.9	289.1	287.7	288.5	287.9
F2	281.5	285.3	278.4	284.4	286.1	283.1
F3	282.2	281.2	280.1	279.5	280.1	280.6
F4	290.6	288.7	285.7	289.3	288.8	288.6
F5	290.0	285.9	288.6	294.8	288.9	289.7

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	3640.411	29	125.531419	17.29638	1.6103E-30	1.562071
Within groups	870.9206	120	7.25767133			
Total	4511.332	149				
within-sd	2.694007					
effective n	4.00					
s_{bb}	5.437687					
u^*_{bb}	0.483984					
u_{bb}	5.437687					
u_{bb}(rel.)	1.885801					

Vanadium (mass fraction in mg/kg):

	1	2	3	4	5
A1	97.12	97.92	97.97	97.45	97.36
A2	98.65	97.22	98.38	97.51	97.31
A3	97.76	97.79	98.83	97.85	98.24
A4	99.24	98.53	98.27	98.38	98.05
A5	97.80	97.64	97.58	98.39	98.94
B1	98.64	98.67	97.83	98.34	98.70
B2	98.70	98.12	98.20	98.40	98.09
B3	98.25	99.16	98.78	98.63	98.19
B4	98.73	98.48	98.27	99.21	99.25
B5	97.78	98.65	98.42	97.53	98.62
C1	98.47	98.35	97.88	98.53	98.49
C2	97.34	98.33	98.13	98.23	98.82
C3	98.27	97.18	98.41	98.64	98.67
C4	98.55	98.59	99.31	98.02	99.17
C5	97.44	97.85	97.66	97.94	97.93
D1	98.20	97.78	97.82	97.74	97.83
D2	98.43	98.75	98.53	98.38	97.61
D3	99.72	98.95	97.88	98.33	98.10
D4	98.32	97.61	98.33	97.55	98.40
D5	97.84	98.25	98.68	97.50	97.71
E1	98.20	97.93	98.56	98.45	97.87
E2	97.45	97.96	97.42	98.57	97.90
E3	97.87	99.09	98.34	97.76	98.68
E4	99.06	98.24	97.72	96.81	97.88
E5	97.79	97.97	98.51	98.03	97.60
F1	98.48	97.92	98.05	97.32	98.23
F2	98.19	98.36	97.72	99.06	98.32
F3	98.07	97.68	97.49	97.40	98.18
F4	98.28	98.66	98.07	100.53	98.32
F5	97.58	97.19	97.74	98.48	98.50

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	14.96751	29	0.51612101	2.026226	0.004291954	1.562071
Within groups	30.56644	120	0.25472033			
Total	45.53395	149				
within-sd	0.504698					
effective n	4.00					
s_{bb}	0.255637					
u^*_{bb}	0.09067					
u_{bb}	0.255637					
u_{bb}(rel.)	0.260363					

Zirconium (mass fraction in mg/kg):

	1	2	3	4	5
A1	50.82	50.85	50.58	51.00	51.24
A2	50.71	50.88	50.84	50.77	51.07
A3	50.49	50.27	50.43	50.48	50.68
A4	50.25	51.27	50.34	51.18	50.59
A5	49.93	50.20	50.31	50.57	50.54
B1	50.54	50.62	51.01	50.55	50.68
B2	50.69	51.29	51.35	50.41	50.63
B3	50.61	51.41	50.56	51.03	50.49
B4	50.58	51.02	51.19	50.81	51.15
B5	50.67	50.18	50.51	50.64	50.45
C1	50.52	50.67	50.82	51.12	51.26
C2	50.70	50.23	50.73	50.81	50.84
C3	51.34	50.52	50.54	50.95	51.01
C4	51.01	50.85	51.07	50.72	51.05
C5	50.36	51.11	51.00	50.68	51.35
D1	50.22	50.49	50.64	50.72	50.54
D2	50.90	50.59	50.84	51.05	50.95
D3	50.30	50.97	51.04	50.94	50.62
D4	50.88	50.89	50.79	50.77	50.66
D5	50.63	50.18	50.58	51.30	51.17
E1	50.61	51.06	51.46	51.09	50.51
E2	50.75	51.18	50.20	50.45	51.01
E3	51.40	50.94	51.37	51.47	51.91
E4	50.67	50.59	50.96	50.91	51.34
E5	50.73	50.53	50.93	51.65	51.13
F1	50.57	50.81	51.39	51.43	51.81
F2	51.23	51.01	51.36	51.79	50.83
F3	50.39	51.44	51.67	51.34	51.20
F4	50.81	51.04	51.00	50.62	51.10
F5	50.78	51.68	51.10	50.68	51.25

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	8.184496	29	0.282224	2.63159	0.000129039	1.562071
Within groups	12.86936	120	0.10724467			
Total	21.05386	149				
within-sd	0.327482					
effective n	4.00					
s_{bb}	0.209153					
u^*_{bb}	0.058833					
u_{bb}	0.209153					
u_{bb}(rel.)	0.411261					

Annex 2: Calculation of uncertainty contribution of potential inhomogeneity (area)
(u_{bb}(rel.) here means u_{bb} (rel) Area in Table 39)
The number of degrees of freedom (effective n) is calculated using the following equation

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

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

Silicon (mass fraction in %):

Centre	6.9669	7.1595														
Inner	7.1205	7.0617	7.1243	7.1469	7.1185	7.1109										
Middle	7.1566	7.1408	7.1487	7.1107	7.1887	7.1745	7.1374	7.1707	7.1092	7.1216	7.0872	7.1659				
Outer	7.0667	7.1147	7.1149	7.0648	7.0062	7.0057	7.0076	7.0175	7.0097	7.0054	7.0416	6.9971	7.0205	7.0665	7.0666	7.0434

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.077099681	3	0.025699894	14.93523568	2.9677E-06	2.901119584
Within groups	0.055064186	32	0.001720756			
Total	0.132163868	35				

within-sd	0.041482
effective n	7.93
s_{bb}	0.055004
u^*_{bb}	0.007367
u_{bb}	0.055004
u_{bb}(rel.)	0.775845

Iron (mass fraction in %):

Centre	0.1314	0.1344														
Inner	0.1342	0.1335	0.1326	0.1338	0.1336	0.1318										
Middle	0.1340	0.1329	0.1334	0.1341	0.1340	0.1342	0.1349	0.1331	0.1333	0.1344	0.1329	0.1342				
Outer	0.1352	0.1332	0.1333	0.1329	0.1330	0.1321	0.1314	0.1316	0.1311	0.1305	0.1316	0.1311	0.1314	0.1313	0.1316	0.1323

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	2.03381E-05	3	6.77935E-06	6.468853032	0.00150939	2.901119584
Within groups	3.3536E-05	32	1.048E-06			
Total	5.3874E-05	35				

within-sd	0.001024
effective n	7.93
s_{bb}	0.000850
u^*_{bb}	0.000182
u_{bb}	0.000850
u_{bb}(rel.)	0.639865

Copper (mass fraction in %):

Centre	0.0182	0.0188														
Inner	0.0191	0.0192	0.0187	0.0190	0.0191	0.0190										
Middle	0.0188	0.0190	0.0191	0.0189	0.0193	0.0191	0.0189	0.0190	0.0191	0.0190	0.0191	0.0192				
Outer	0.0189	0.0190	0.0185	0.0190	0.0187	0.0188	0.0188	0.0188	0.0187	0.0187	0.0192	0.0186	0.0185	0.0181	0.0184	0.0186

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.18063E-06	3	3.93542E-07	7.963839058	0.000417853	2.901119584
Within groups	1.58131E-06	32	4.94161E-08			
Total	2.76194E-06	35				

within-sd	0.000222
effective n	7.93
s_{bb}	0.000208
u^*_{bb}	0.000039
u_{bb}	0.000208
u_{bb}(rel.)	1.103685

Manganese (mass fraction in %):

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

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

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

Magnesium (mass fraction in %):

Centre	0.6214	0.6432														
Inner	0.6423	0.6402	0.6406	0.6392	0.6372	0.6320										
Middle	0.6342	0.6407	0.6417	0.6439	0.6425	0.6477	0.6550	0.6420	0.6405	0.6387	0.6471	0.6471				
Outer	0.6383	0.6412	0.6380	0.6424	0.6306	0.6393	0.6296	0.6409	0.6322	0.6378	0.6399	0.6394	0.6375	0.6351	0.6381	0.6392

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.000358825	3	0.000119608	4.66558491	0.008159655	2.901119584
Within groups	0.00082036	32	2.56363E-05			
Total	0.001179185	35				

within-sd	0.005063
effective n	7.93
s_{bb}	0.003443
u^*_{bb}	0.000899
u_{bb}	0.003443
u_{bb}(rel.)	0.538210

Chromium (mass fraction in mg/kg):

Centre	44.24	49.24														
Inner	46.91	47.19	47.29	47.16	45.54	46.63										
Middle	46.97	48.89	46.47	45.90	47.41	46.94	47.53	47.25	46.18	46.16	46.18	46.20				
Outer	47.21	47.25	46.87	48.03	45.73	46.88	47.62	46.60	44.51	45.74	46.07	46.66	47.05	46.45	47.39	44.77

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.634297917	3	0.211432639	0.1829147	0.907221097	2.901119584
Within groups	36.989069	32	1.155908406			
Total	37.62336692	35				

within-sd	1.075132
effective n	7.93
s_{bb}	0.000000
u^*_{bb}	0.190944
u_{bb}	0.190944
u_{bb}(rel.)	0.408918

Nickel (mass fraction in %):

Centre	0.0031	0.0037														
Inner	0.0035	0.0035	0.0034	0.0037	0.0036	0.0034										
Middle	0.0037	0.0037	0.0035	0.0036	0.0037	0.0036	0.0037	0.0035	0.0035	0.0035	0.0035	0.0036				
Outer	0.0036	0.0037	0.0035	0.0036	0.0035	0.0036	0.0036	0.0035	0.0034	0.0036	0.0036	0.0035	0.0035	0.0034	0.0035	0.0037

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	7.25E-08	3	2.41667E-08	1.588277395	0.211444657	2.901119584
Within groups	4.86901E-07	32	1.52156E-08			
Total	5.59401E-07	35				

within-sd	0.000123
effective n	7.93
s_{bb}	0.000034
u^*_{bb}	0.000022
u_{bb}	0.000034
u_{bb}(rel.)	0.944289

Zinc (mass fraction in %):

Centre	0.0481	0.0519														
Inner	0.0496	0.0498	0.0496	0.0512	0.0506	0.0496										
Middle	0.0509	0.0504	0.0498	0.0503	0.0501	0.0503	0.0516	0.0501	0.0501	0.0500	0.0499	0.0506				
Outer	0.0496	0.0512	0.0494	0.0502	0.0493	0.0502	0.0499	0.0493	0.0491	0.0506	0.0505	0.0497	0.0500	0.0493	0.0495	0.0507

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.31812E-06	3	4.39375E-07	0.802494624	0.501725588	2.901119584
Within groups	1.75204E-05	32	5.47511E-07			
Total	1.88385E-05	35				

within-sd	0.000740
effective n	7.93
s_{bb}	0.000000
u^*_{bb}	0.000131
u_{bb}	0.000131
u_{bb}(rel.)	0.262365

Titanium (mass fraction in %):

Centre	0.0541	0.0559														
Inner	0.0546	0.0552	0.0547	0.0540	0.0550	0.0549										
Middle	0.0549	0.0547	0.0549	0.0549	0.0546	0.0549	0.0547	0.0548	0.0547	0.0548	0.0550	0.0549				
Outer	0.0558	0.0557	0.0557	0.0561	0.0563	0.0559	0.0561	0.0560	0.0560	0.0560	0.0560	0.0562	0.0563	0.0556	0.0554	0.0554

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.07903E-05	3	3.59678E-06	30.10775995	1.92906E-09	2.901119584
Within groups	3.82284E-06	32	1.19464E-07			
Total	1.46132E-05	35				

within-sd	0.000346
effective n	7.93
s_{bb}	0.000662
u^*_{bb}	0.000061
u_{bb}	0.000662
u_{bb}(rel.)	1.197448

Calcium (mass fraction in mg/kg):

Centre	31.57	33.55														
Inner	31.98	32.43	32.29	32.40	32.24	32.03										
Middle	32.03	31.92	31.96	31.81	32.44	32.35	33.48	31.73	32.12	32.39	32.75	32.40				
Outer	32.06	32.52	32.05	31.46	32.63	31.40	31.82	31.72	31.96	31.20	31.59	31.53	31.26	31.88	32.63	32.46

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.647978472	3	0.549326157	2.158956783	0.112202869	2.901119584
Within groups	8.142097689	32	0.254440553			
Total	9.790076162	35				

within-sd	0.504421
effective n	7.93
s_{bb}	0.192886
u^*_{bb}	0.089586
u_{bb}	0.192886
u_{bb}(rel.)	0.601157

Cadmium (mass fraction in mg/kg):

Centre	31.02	50.52														
Inner	36.76	34.31	33.49	39.51	37.92	42.45										
Middle	35.63	43.24	37.62	35.08	43.63	37.11	41.38	41.02	39.12	37.70	39.76	42.05				
Outer	37.04	38.16	36.39	36.67	38.78	43.47	43.27	41.52	38.41	40.72	39.82	40.75	43.87	40.21	41.70	36.43

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	30.41973681	3	10.13991227	0.749710481	0.530581755	2.901119584
Within groups	432.8033296	32	13.52510405			
Total	463.2230664	35				

within-sd	3.677649
effective n	7.93
s_{bb}	0.000000
u^*_{bb}	0.653154
u_{bb}	0.653154
u_{bb}(rel.)	1.663475

Gallium (mass fraction in mg/kg):

Centre	166.04	169.96														
Inner	171.30	170.20	169.10	169.90	172.00	169.30										
Middle	170.20	169.90	169.60	170.90	170.00	171.40	171.60	169.60	168.60	169.50	169.10	170.70				
Outer	168.80	168.00	167.00	168.10	167.90	167.90	167.90	168.40	166.90	168.50	171.40	170.60	168.00	167.80	168.30	170.70

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	26.82083333	3	8.940277778	5.94553904	0.002423061	2.901119584
Within groups	48.11824242	32	1.503695076			
Total	74.93907576	35				

within-sd	1.226252
effective n	7.93
s_{bb}	0.968638
u^*_{bb}	0.217783
u_{bb}	0.968638
u_{bb}(rel.)	0.571855

Lithium (mass fraction in mg/kg):

Centre	6.93	7.38														
Inner	7.27	7.16	7.35	7.26	7.29	7.23										
Middle	7.36	7.28	6.99	7.24	7.36	7.35	7.30	7.16	7.38	7.30	7.26	7.34				
Outer	7.12	7.15	7.30	7.35	7.31	7.27	7.28	7.10	7.33	7.23	7.21	7.07	7.14	7.35	7.39	7.29

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.028098476	3	0.009366159	0.741851312	0.534993593	2.901119584
Within groups	0.404012336	32	0.012625386			
Total	0.432110812	35				

within-sd	0.112363
effective n	7.93
s_{bb}	0.000000
u^*_{bb}	0.019956
u_{bb}	0.019956
u_{bb}(rel.)	0.274981

Sodium (mass fraction in mg/kg):

Centre	3.73	4.05														
Inner	4.03	3.90	4.02	4.04	4.08	4.08										
Middle	3.99	4.04	3.86	4.04	4.13	4.02	4.01	3.93	4.11	4.03	4.02	4.11				
Outer	3.87	3.91	3.96	4.03	3.93	3.96	4.07	3.91	3.99	4.05	3.93	3.89	3.93	3.98	3.97	3.96

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	0.056805556	3	0.018935185	3.33596748	0.03150792	2.901119584
Within groups	0.181634242	32	0.00567607			
Total	0.238439798	35				

within-sd	0.075340
effective n	7.93
s_{bb}	0.040901
u^*_{bb}	0.013380
u_{bb}	0.040901
u_{bb}(rel.)	1.024178

Lead (mass fraction in mg/kg):

Centre	117.26	127.54														
Inner	124.50	124.60	122.90	125.40	125.10	124.30										
Middle	129.80	126.60	124.20	127.90	128.40	126.40	126.40	127.40	124.20	123.90	124.00	125.10				
Outer	129.70	131.10	128.20	127.80	128.80	128.30	126.00	127.10	125.60	128.40	126.50	125.10	125.50	127.80	126.20	126.20

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	69.68034722	3	23.22678241	5.309994749	0.004382515	2.901119584
Within groups	139.9732151	32	4.374162971			
Total	209.6535623	35				

within-sd	2.091450
effective n	7.93
s_{bb}	1.542272
u^*_{bb}	0.371443
u_{bb}	1.542272
u_{bb}(rel.)	1.219641

Antimony (mass fraction in mg/kg):

Centre	4.42	88.70														
Inner	49.61	62.50	36.44	51.30	26.47	56.70										
Middle	29.21	37.01	55.80	58.40	59.40	41.90	57.70	54.20	25.50	36.53	42.08	65.00				
Outer	57.90	43.09	44.18	43.05	33.26	49.24	52.80	73.70	56.20	58.90	37.63	65.20	59.70	54.50	63.00	34.56

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	69.68034722	3	23.22678241	5.309994749	0.004382515	2.901119584
Within groups	139.9732151	32	4.374162971			
Total	209.6535623	35				

within-sd	2.091450
effective n	7.93
s_{bb}	1.542272
u^*_{bb}	0.371443
u_{bb}	1.542272
u_{bb}(rel.)	3.134961

Tin (mass fraction in mg/kg):

Centre	137.50	155.90														
Inner	142.70	144.60	142.40	151.70	148.70	144.70										
Middle	148.70	148.20	145.10	146.10	145.80	145.30	152.80	145.50	146.30	145.50	146.70	148.10				
Outer	141.70	148.30	142.30	146.30	141.10	145.80	144.30	141.30	140.80	149.90	146.60	142.80	145.10	141.60	143.00	148.20

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	52.72534722	3	17.57511574	1.346936134	0.276595259	2.901119584
Within groups	417.5429625	32	13.04821758			
Total	470.2683098	35				

within-sd	3.612232
effective n	7.93
s_{bb}	0.755745
u^*_{bb}	0.641535
u_{bb}	0.755745
u_{bb}(rel.)	0.519307

Strontium (mass fraction in mg/kg):

Centre	119.48	126.72														
Inner	126.90	124.60	125.40	126.50	128.00	129.50										
Middle	126.10	128.50	125.90	126.40	130.00	129.30	130.00	125.50	127.70	125.90	128.70	128.70				
Outer	126.40	126.70	123.50	128.70	123.70	124.50	128.50	125.90	128.20	130.80	125.40	123.40	124.10	123.90	127.40	125.20

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	45.31229167	3	15.10409722	3.293717423	0.032940008	2.901119584
Within groups	146.7433447	32	4.585729522			
Total	192.0556364	35				

within-sd	2.141432
effective n	7.93
s_{bb}	1.151991
u^*_{bb}	0.380320
u_{bb}	1.151991
u_{bb}(rel.)	0.908784

Vanadium (mass fraction in mg/kg):

Centre	148.07	161.73														
Inner	154.40	156.50	156.20	154.30	151.20	154.70										
Middle	150.60	158.20	151.40	151.80	153.40	154.90	155.30	155.90	152.80	151.50	153.30	151.70				
Outer	151.10	151.10	152.60	156.50	152.70	156.80	158.40	154.20	150.00	151.00	153.30	154.80	156.30	152.60	155.30	148.00

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	9.550625	3	3.183541667	0.354773219	0.785986563	2.901119584
Within groups	287.1505737	32	8.973455427			
Total	296.7011987	35				

within-sd	2.995573
effective n	7.93
s_{bb}	0.000000
u^*_{bb}	0.532016
u_{bb}	0.532016
u_{bb}(rel.)	0.346338

Zirconium (mass fraction in mg/kg):

Centre	56.71	62.89														
Inner	59.60	61.00	59.70	60.80	58.30	59.20										
Middle	59.50	62.00	59.20	58.00	59.50	59.40	60.00	60.30	59.60	59.20	59.70	59.20				
Outer	59.50	59.50	59.40	61.30	59.00	60.00	60.90	60.10	57.10	58.60	59.00	59.00	59.90	59.00	60.20	57.20

Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	1.088125	3	0.362708333	0.22045238	0.881474816	2.901119584
Within groups	52.64931439	32	1.645291075			
Total	53.73743939	35				

within-sd	1.282689
effective n	7.93
s_{bb}	0.000000
u^*_{bb}	0.227807
u_{bb}	0.227807
u_{bb}(rel.)	0.382698

Bismuth (data from external laboratory, mass fraction in mg/kg))

r_0	5.809	7.391				
r_in	8.640	7.500	5.970	7.010		
r_out	8.930	9.420	7.660	6.980		
Source of variation	*sums of squares (SS)*	*degrees of freedom (df)*	*Mean squares (MS)*	*F-value*	*P-value*	*critical F-value*
Between groups	4.039015	2	2.0195075	1.619226005	0.264254927	4.737414128
Within groups	8.730438158	7	1.247205451			
Total	12.76945316	9				

within-sd	1.116783529
effective n	3.20
s_{bb}	0.491268145
u^*_{bb}	0.456432962
u_{bb}	0.491268145
u_{bb}(rel.)	6.523279046