IAEA/AQ/60

IAEA Analytical Quality in Nuclear Applications Series No. 60

Worldwide Interlaboratory Comparison on the Determination of Trace Elements and Methylmercury in Sediment Sample

IAEA-MESL-ILC-TE-SEDIMENT-2018

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WORLDWIDE INTERLABORATORY COMPARISON ON THE DETERMINATION OF TRACE ELEMENTS AND METHYL MERCURY IN SEDIMENT SAMPLE

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IAEA-MESL-ILC-TE-SEDIMENT-2018

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2019

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IAEA, VIENNA, 2019
IAEA/AQ/60
ISSN 2074–7659

Printed by the IAEA in Austria
September 2019

FOREWORD

The protection of the marine environment is a high priority worldwide. The identification of environmental pollution is based on monitoring campaigns that periodically assess the quality of sea water, marine sediments and biota samples. The reliability and comparability of the analytical data produced in this context are crucial for management of the marine environment in general, including for taking decisions and meaningful actions in remediation policies.

The primary goal of the IAEA Environment Laboratories is to assist Member States in understanding, monitoring and protecting the marine environment. Relevant activities include the organization of global interlaboratory comparisons and regional proficiency tests, the production of marine certified reference materials, and the development of recommended analytical methods for determination of trace elements and organic pollutants in marine samples. The IAEA's Marine Environmental Studies Laboratory in Monaco, part of the IAEA Environment Laboratories, actively assists Member States through the organization of interlaboratory comparisons and the provision of certified reference materials.

This publication summarizes the results of the IAEA-MESL-ILC-TE-SEDIMENT-2018 interlaboratory comparison on the determination of trace elements and methylmercury in a sediment test sample. The determination of trace elements in marine sediment samples is fundamental for geochemical studies and pollution assessment of coastal and marine environments. This interlaboratory comparison was initiated to give laboratories involved in trace element analyses of marine sediments the opportunity to check their analytical performance. The interlaboratory comparison was coordinated by the IAEA's Marine Environmental Studies Laboratory in Monaco.

The IAEA is grateful to the Government of Monaco for the support provided to its Environment Laboratories, to the Member State laboratories that took part in this interlaboratory comparison exercise, and to the James Cook University (Australia) and Australian Nuclear Science Technology Organisation (ANSTO) for their organization of the sampling campaign and the provision of the raw sediment material. The IAEA officers responsible for this publication were S. Azemard and E. Vasileva from the IAEA Environment Laboratories.

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1 INTRODUCTION

The Marine Environmental Studies Laboratory (MESL) of the IAEA's Environment Laboratories (IAEA-EL) has the programmatic responsibility to provide assistance to Member States' laboratories in maintaining and improving the reliability of analytical measurement results, both in trace elements and organic pollutants. This is accomplished through the provision of certified reference materials of marine origin, validated analytical procedures, training in the implementation of internal quality control, and through the evaluation of measurement performance by the organization of worldwide and regional interlaboratory comparisons.

For more than thirty years, the MESL has conducted worldwide laboratory performance studies, also known as interlaboratory comparison [1, 2]. The results have been used for the evaluation of laboratories performances with respect to a wide range of organic [3] and inorganic pollutants, including methylmercury [4, 5]. The periodic external assessments of measurement performances of monitoring laboratories via interlaboratory comparisons (ILCs) and targeted proficiency tests (PTs) are of crucial interest for laboratories as they provide clear information of their measurement capabilities.

These exercises are designed not only to monitor and demonstrate the performance and analytical capabilities of the participating laboratories,but also to identify gaps and problem areas where further development is needed.

2 SCOPE OF THE INTERCOMPARISON

Letters of invitation for the present ILC on the determination of trace elements and methyl mercury (MeHg) in marine sediment sample have been sent to 250 laboratories from 86 Member States, previously participated or expressed the interest in participation in the IAEA ILCs. Positive responses were received from 100 laboratories from 55 Member States.

Each participating laboratory received one bottle of the test sample, accompanied by one information sheet and instruction for the use of the IAEA-NAEL on-line results reporting system.

Participants were requested to determine as many elements as possible from the following list of elements: Ag, Al, As, Cd, Co, Cr, Cu, Fe, Hg, MeHg, Li, Mn, Ni, Pb, Sr and Zn, using analytical procedures routinely applied in their laboratories.

In total 81 laboratories from 48 countries reported obtained results for trace elements and methyl mercury back to the organizers. All results were treated confidentially, and each laboratory was identified with a unique confidential code number.

The data reported by laboratories, together with the technical and statistical evaluations of the results are described in this report.

3 DESCRIPTION OF ILC TEST MATERIAL

The test sample for the ILC exercise was the CRM IAEA 475 coastal sediment from the region of Townsville, Australia. All details about homogeneity, stability and characterization of the sample can be found in the certification report [6].

The certified values of the IAEA 475 were used as the assigned values for As, Co, Cr, Cu, Fe, Hg, MeHg, Ni, Pb and Zn.

For trace elements were no certified values were available, namely - Ag, Al, Cd, Li, Mn and Sr, the assigned values were calculated from the results reported by the participants in this ILC by applying robust statistics as recommended in the ISO 13528 [7].

Kernel density was used as an appropriate method to represent the overall structure of the element data set [8]. Several bimodality distributions were observed for Al, Li, Mn and Sr, mainly connected to the incomplete digestion of the sediment sample. Therefore, only data reported with total digestion or non-destructive techniques were kept for derive the assigned values. For Ag and Cd the assigned values were calculated with all reported results.

The uncertainties associated with the assigned values were calculated according to the ISO standard 35 [9]. The combined uncertainty of the assigned value consisted of uncertainties related to characterization (u_{char}), between bottle heterogeneity (u_{hom}) and long–term stability (u_{stab}). Above mentioned contributions were combined to estimate the expanded uncertainty using Eq. (1).

$$U = k \times \sqrt{u_{char}^2 + u_{stab}^2 + u_{hom}^2} \quad (1)$$

where:

k: coverage factor, k=2, representing level of confidence of about 95%

u_{hom} is the standard uncertainty, coming from between unit inhomogeneity, evaluated by ANOVA [9]

u_{stab} is the standard uncertainty on long term stability of the sample. Based on our experience u_{stab} component was considered to have negligible contribution and was not further propagated during the estimation of the total combined uncertainty.

u_{char} is the uncertainty of characterization, estimated according to the recommendations of the ISO 13528 [7] using Eq. (2).

$$u_{char} = 1.25 \times \frac{s^*}{\sqrt{n}} \quad (2)$$

where: s^* is the robust standard deviation and n the number of measurement results.

All assigned values, combined uncertainties and target standard deviations, obtained in this study and used in the evaluation process are presented in Table 1. For Ag and Cd expanded uncertainty was beyond 20%, therefore those values are given for information only and will not be used for the evaluation of measurement performances of laboratories, participating in this interlaboratory comparison.

TABLE 1. ASSIGNED VALUES AND UNCERTAINTIES FOR TRACE ELEMENTS IN THE SEDIMENT ILC SAMPLE

Element	Unit	Assigned value	Combined uncertainties (k=1)	Target standard deviation
Ag	*mg kg^{-1}*	*0.139*	*0.026*	*0.017*
Al	g kg-1	68.8	2.95	8.6
As	mg kg^{-1}	12.6	0.35	1.6
Cd	*mg kg^{-1}*	*0.095*	*0.011*	*0.011*
Co	mg kg^{-1}	12.4	0.25	1.6
Cr	mg kg^{-1}	65.8	1.45	8.2
Cu	mg kg^{-1}	27.5	0.90	3.4
Fe	g kg^{-1}	34.2	0.95	4.3
Hg	µg kg^{-1}	29.9	0.75	3.7
Li	mg kg^{-1}	40.3	1.35	5.0
MeHg	µg kg^{-1} as Hg	0.200	0.019	0.025
Mn	mg kg^{-1}	539	8	67
Ni	mg kg^{-1}	28.5	0.55	3.5
Pb	mg kg^{-1}	29.9	0.75	3.7
Sr	mg kg^{-1}	233	10.5	29
Zn	mg kg^{-1}	100	3	13

4 EVALUATION OF ANALYTICAL PERFORMANCE

The individual laboratory performance was expressed in terms of *z*-scores and Zeta-scores, in accordance with the requirement of the ISO 17043 [10].

The determination of target standard deviation was based on the outcome from the previous ILCs, organized by the MESL with similar sample matrices for the same population of laboratories. The standard deviation for the proficiency assessment, σ_p, was fixed to 12.5 % of the assigned values. The appropriateness of this level of tolerated variability of results was confirmed by calculation of the robust standard deviation of the participants' results and the uncertainty of the assigned values for the respective measurands.

z-score, calculated following the Eq. (3), effectively expresses the difference between the mean of the laboratory and the assigned value in the units of the target standard deviation (σ_p).

$$z = \frac{x_{lab} - x_{ass}}{\sigma_p} \quad (3)$$

Zeta-score, calculated following the Eq. (4), states, if the participant result agrees with the assigned value within the respective uncertainties. The denominator in the Eq. (4) is calculated from the combined uncertainty of the assigned value and the measurement uncertainty reported by the respective participant.

$$\text{Zeta} = \frac{x_{lab} - x_{ass}}{\sqrt{u_{x_{lab}}^2 + u_{x_{ass}}^2}} \quad (4)$$

Where:
x_{lab}: Reported result by the participating in the ILC laboratory (express as the mean value from multiple determination)
x_{ass}: Assigned value
σ_p: Target standard deviation
u_{xlab}: Standard uncertainty reported by the participating in the ILC laboratory
u_{ref}: Standard uncertainty of the assigned value

The interpretation of laboratory's performance was evaluated according to the following internationally accepted limits [10]:

	$\lvert z \text{ or Zeta} \rvert \leq 2$	Satisfactory
$2 <$	$\lvert z \text{ or Zeta} \rvert < 3$	Questionable
	$\lvert z \text{ or Zeta} \rvert \geq 3$	Unsatisfactory

5 RESULTS AND DISCUSSION

5.1 OVERVIEW OF THE REPORTED RESULTS

Eighty-one sets of data were submitted comprising 839 analytical results for the 16 requested elements. As explained above, *z*-scores and Zeta-scores were evaluated only for 14 elements (770 measurement results).

Almost 75% of participants reported results for at least half part of the requested analytes. More than 80% of participants reported obtained measurement results for Cu, Fe, Mn, Pb and Zn. On the other hand, only 5 of laboratories (6%) reported results for methyl mercury mass fraction in the sediment sample, while 49 laboratories provided results for total mercury mass fraction (60%).

Graphical presentations of reported results and Kernel density plots [8] (in the case were more than 8 measurement results for analyte were available) are presented in Appendix I. More details on z-score, Zeta-scores and summary of statistical evaluation for the assessed elements are also given the same appendix.

All reported by participants in this ILC measurement results, are compiled in the Appendix II. (For editorial purposes some results have been rounded to appropriate number of significant figures).

5.2 LABORATORY PERFORMANCES

5.2.1 *z*-scores:

Table 2 shows the overall performance (*z*-scores) of laboratories element by element. Figures 1 and 3 summarize *z*-scores of the participating in the ILC laboratories by element and by participating laboratory.

The *z*-score compares the bias of the reported results from the assigned value with the target standard deviation (σp for proficiency assessment) defined by the ILC organizer as the maximum acceptable standard deviation of 25% of the assigned value for each of investigated trace elements.

In total from 770 *z*-scores obtained in this exercise, 77% were with $|z| \leq 2$, 85% with $|z| < 3$, and 15% were considered as unsatisfactory with $|z| > 3$. Almost 25% of participants succeed to get satisfactory z-scores ($|z| \leq 2$) for all reported data, while 15% have more than half of their results considered as unsatisfactory with z-scores $|z| > 3$.

Overall, when comparing with the last global ILC organized on marine sediment - IAEA 457, one decrease in the demonstrated analytical performance can be observed [5]. One possible reason for this result could be related with the lower concentrations for some of the analytes (Pb, Hg, Cr, Ni) in the present sediment sample. As only part of the laboratories (37%) are participating in both exercises, it was difficult to make an evaluation on the evolution of measurement performances over the long period of time.

As shown on Figure 1, except for MeHg, 50% of z-scores for all reported results were satisfactory. Considering the obtained *z*-scores for 6 of the determined elements (MeHg, Al, Li, Cr, Hg and Fe) more than 20% of reported results can be classified as unsatisfactory.

90% of the results for Hg evaluated as unsatisfactory ($|z| > 3$) were overestimated (i.e. positive bias), most probably due to the low level of Hg mass fraction in the test sediment sample. This finding demonstrates that some laboratories have problem to accurately determine low level Hg in complex environmental matrices. The observed overestimation could arise also form a contamination during the sample preparation step and/or from wrong selection of the quantification method. The laboratories concerned should carefully check their analytical procedure and their blank.

For Al and Fe some of obtained results were reported in the wrong unit (i.e. mg kg^{-1} instead of the requested g kg^{-1} unit). This is one of the reasons explaining why part of the results were considered as unsatisfactory (47% for Al and 72% for Fe).

The digestion method applied by some participants, resulting in partial decomposition of the sediment test sample, was also affecting results especially for elements considered as refractory ones - Al, Cr and Sr.

Erroneous calibration standards were another source of measurement bias. Only certified reference materials with stated SI traceability should be used for calibration purposes. It is important to note that losses related with the working standard solutions at low concentration levels, are leading to the overestimation of the concentrations of elements in the samples (e.g., standard solutions should not be stored for an extended period).

Laboratories with questionable and unacceptable results are strongly advised to check carefully the laboratory procedures and working instructions, related to the analytical method they have applied in the present ILC.

5.2.2 Zeta-scores:

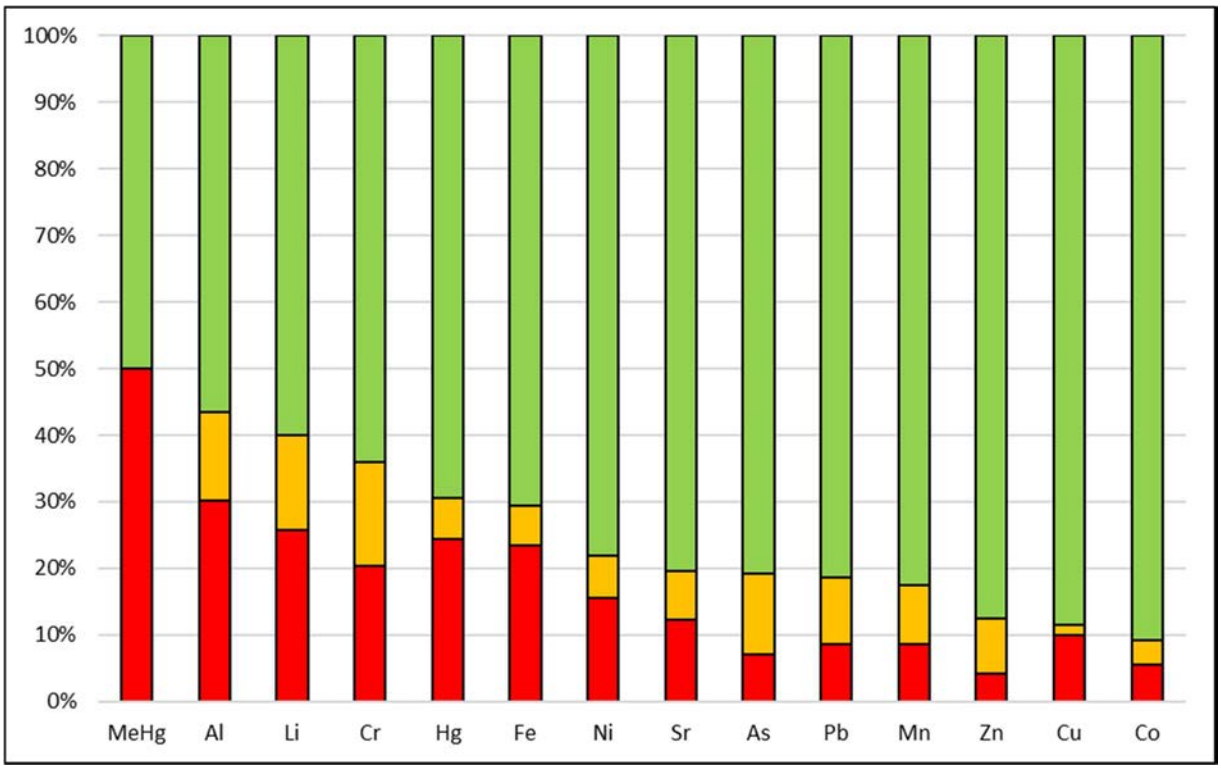
Table 5 shows the overall performance (Zeta-scores) of laboratories for all investigated trace elements. Figure 2 and 4 summarizes Zeta-scores of the participating laboratories in the ILC by element and by participating laboratory.

The Zeta-score shows the agreement of laboratory result with the assigned value within the respective combined uncertainties. The denominator in the Eq. (4) is the combined uncertainty of the assigned value and the combined uncertainty, reported by the respective participating laboratory.

Twenty-two laboratories (27%) didn't provide the uncertainty of their reported results and Zeta -scores were not calculated. This is a higher proportion in comparison with the two previous ILCs [5, 6] organized by the MESL.

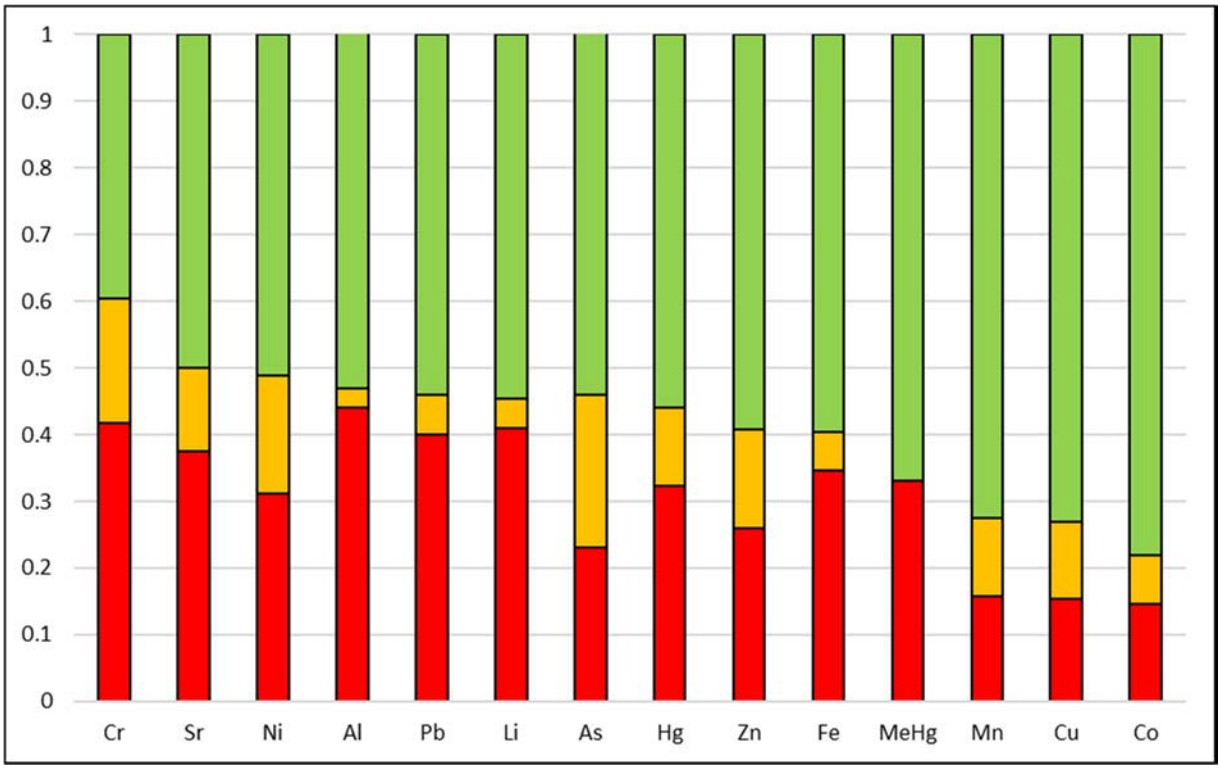
As it can be seen on Figures 2 and 4, the comparison of measurement performances evaluated with *z*-score and Zeta-score clearly indicate that the number of unsatisfactory Zeta-scores is significantly higher than the number of unsatisfactory *z*-scores (15% for *z*-scores and 30% for Zeta-scores). Only 7 laboratories (8.5%) reported 100% of their results with $|z|$ and $|\text{Zeta}| \leq 2$. As the Zeta-score is the evaluation parameter, reflecting all steps of the measurement process, laboratories with unsatisfactory Zeta-scores should invest additional efforts in the proper estimation of measurement uncertainty. Obtained results show that they are still remaining problems with the realistic estimation of this important part of every measurement result.

It should be mentioned here that an unsatisfactory Zeta-score can be also caused by an inappropriate estimation of the mass fraction of the respective trace element.



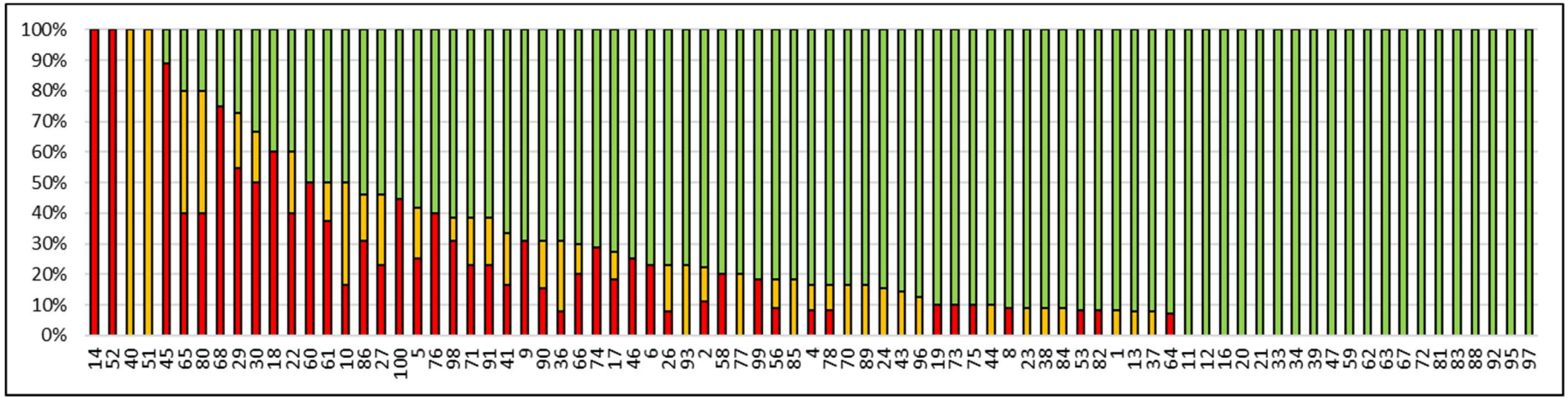
$|z| \geq 3$, $2 < |z| < 3$, $|z| \leq 2$

FIG. 1. The z-scores of results reported by the participants per element.



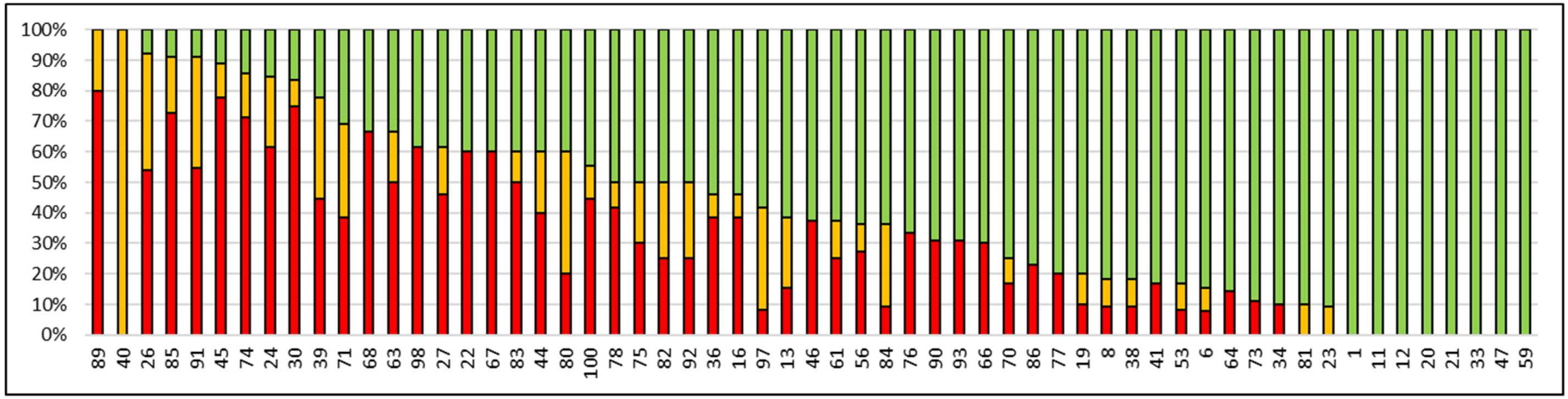
$|\text{Zeta}| \geq 3$, $2 < |\text{Zeta}| < 3$, $|\text{Zeta}| \leq 2$

FIG. 2. The Zeta-scores of results reported by the participants per element.



$|z| \geq 3$, $2 < |z| < 3$, $|z| \leq 2$

FIG. 3. The z-scores of results reported by the participants per laboratory.



$|\text{Zeta}| \geq 3$, $2 < |\text{Zeta}| < 3$, $|\text{Zeta}| \leq 2$

FIG. 4. The Zeta-scores of results reported by the participants per laboratory.

TABLE 2. OVERALL ASSESSMENT OF LABORATORIES PERFORMANCE (*z*-SCORE) BY ELEMENTS

Lab Code	Al	As	Co	Cr	Cu	Fe	Hg	Li	MeHg	Mn	Ni	Pb	Sr	Zn
1	-0.45	0.71	0.80	0.64	-0.46	-0.29	-1.22			0.61	-0.04	2.02	0.24	-0.41
2		0.41		-2.25	-0.75	0.41	-0.59			-0.14	-1.32	-1.65		-0.16
4	-0.78	-2.29	1.06	0.27	1.03	-0.45	-1.30	5.50		0.34	0.41	-0.25		0.39
5	-3.81	-1.53	-2.80	-1.47	-3.06	0.49		1.56		-2.16	49.03	-1.91	1.35	-0.60
6	0.98	3.40	0.82	-1.47	-0.61	0.79	-0.32	8.07		-0.77	-0.67	-1.93	19.83	0.15
8	-0.33	-1.16	-0.40	1.04	-0.45	0.16	8.96			0.42	-0.25	0.02		0.31
9	2678.05	-1.22	-1.07	-3.12	-1.07	6503.26	0.68	-3.02		-0.58	-1.77	-1.40	-1.65	-1.40
10					-1.08		1274.77			-2.34	0.82	1.38		-2.43
11							-0.26							
12	0.07	0.20	-0.27	-0.01		0.05				0.17				-0.08
13	0.17	-0.96	-0.86	-1.51	-0.90	-0.09	2.00	0.16		-0.41	-0.86	-2.24	-1.03	0.61
14											-4.16	-6.52		-3.81
16	-0.48	-0.82	0.11	1.02	-1.16	-0.53	-0.86	-1.87		-0.19	-0.47	-0.85	0.13	0.45
17	-2.77	0.74	-0.74	-0.75	-0.25	-0.11	18.78			3.16	0.34	0.10		0.13
18	-1.64			-4.73	-3.52	-0.41	42.89	-4.19		-4.30	-4.02	-0.63	-1.00	
19		1.90	-0.84	-1.27	-0.16	7987.85				0.35	0.05	-1.45	0.34	1.02
20	0.42				0.85	0.13	1.64			0.02	-0.18	0.08		-0.64
21			0.31		-0.14						0.27	0.66		-0.45
22	8304.98		-0.05			6961.55				1.42				-2.30
23	0.76	2.52		-0.22	0.25	-0.01	-1.65			0.11	1.05	-0.43	0.29	0.00
24	0.62	2.50	1.03	-2.69	1.33	1.04	1.20	0.47		-0.71	0.88	1.24	1.69	0.63
26	-5.02	-1.15	-1.38	-2.94	-1.03	-1.39	1.25	-2.96		-0.70	-1.71	-1.83	-1.87	-1.99
27	3224.56	-1.20	-1.07	-2.88	-1.11	6628.18	-1.06	-3.45		-0.92	-1.60	-2.31	-2.58	-1.44
29	-7.65	-7.03	0.10	-5.98	-0.10	33.36	88.06			-2.99	48.51	-2.33		-0.45
30	-6.36		1.25	-3.45	3.16	-2.28	24.76	-2.35		-1.77	0.53	-4.68	-4.52	-1.59
33				-0.17	-0.20	0.03		0.23		-0.07	-0.21	-0.05		-0.35
34		0.11	-0.71	0.04	-0.17	0.42				-0.25	-1.03	-0.15	1.73	0.39

TABLE 2. OVERALL ASSESSMENT OF LABORATORIES PERFORMANCE (*z*-SCORE) BY ELEMENTS (cont.)

Lab Code	Al	As	Co	Cr	Cu	Fe	Hg	Li	MeHg	Mn	Ni	Pb	Sr	Zn
36	2.69	-2.65	-0.14	-0.41	-0.10	0.23	-2.39	0.32		0.40	-0.27	-0.91	-4.03	-0.16
37	-2.70	-0.48	0.18	-0.23	0.43	-0.06	-0.86	0.32		0.38	0.35	0.86	-0.58	1.06
38	-0.01	-1.47		0.39	0.12	0.99	-0.63	-0.22		0.27	-1.04	-2.36		-0.80
39		-1.45	-1.01	-1.33	-1.56	-0.78				-1.13	-0.93	-1.34		-1.04
40							2.27							
41	0.37	-0.75		-0.22	4.12	0.42	-0.41	11.66		-0.02	-2.08	-2.73	1.67	0.46
43		-0.71	-0.88	-2.65	-0.40						-1.22	-1.08		-1.29
44	0.97	-0.69		-0.67	-2.08	-0.27				-0.17	-1.41	-0.66	-0.38	-0.93
45	6581.15		68.18	6.27	4.52	11531.14				4.69	8.55		0.15	4.58
46		-1.63	0.05	9.27	-0.35	-7.22				0.39		-0.06		-0.42
47	0.05	0.11	-0.10	-0.29	0.09	-0.02	1.64	-0.53		0.22	-0.23	0.18	0.79	0.08
51							-2.62							
52		-7.44										-7.99		
53	1.95	-0.22	-0.19	-1.81	0.02	-0.63		-3.18		-0.16	-1.35	-0.84	0.73	0.58
56	-0.03	-0.57	-0.09	-1.09	-0.75	-0.10	868.66			1.60		2.52	-1.89	-0.87
58					-1.04	-1.72				-3.81		-1.35		-1.56
59							-0.93							
60							-0.32		3.20					
61	5274.95			2.01	4.23	7885.15				-0.11		-1.94	-0.74	0.26
62	-0.28	0.48	0.13	-0.16	0.25	-0.44	-0.68	0.00		-0.03	-0.29	0.08		-0.19
63		-0.77			-0.31	-1.48		-0.77		-1.37				-1.54
64	-0.13	-1.47	-0.27	0.08	-0.20	-0.28	-1.04	0.12	65.87	0.03	-0.18	-0.30	0.72	-0.26
65	-2.66		22.97	9.60	-1.49	2.69		-2.69		-0.54	7.41	5.72		-2.12
66		0.31	0.05	3.64	-0.21	0.10	8.07			-2.63	-0.39	-0.23		0.13
67				-1.24	0.17		-1.22					-1.46		-0.43
68					-0.49					-3.63	35.16	35.72		
70	0.35	2.34	-0.23	0.06	0.11	0.38	0.57			0.12	0.66	0.93	2.24	-0.08

TABLE 2. OVERALL ASSESSMENT OF LABORATORIES PERFORMANCE (*z*-SCORE) BY ELEMENTS (cont.)

Lab Code	Al	As	Co	Cr	Cu	Fe	Hg	Li	MeHg	Mn	Ni	Pb	Sr	Zn
71	1891.22	-1.13	-1.12	-3.48	-0.31	5308.75	-0.05		-1.15	-1.12	-2.14	-1.42	-1.69	-2.34
72	0.72	-0.10	-0.49	-0.49	-0.19	0.45	0.30	-0.42		0.51	-0.39	-0.29	0.13	-0.52
73		1.93	1.45	0.36	0.24	6732.56	-1.13			-0.22	1.70	1.11		-0.33
74				1.73	29.53	6659.39				-1.29	-0.78	0.51		-1.12
75	0.22	-0.96	-0.66	0.69	-0.26	1.15				-3.64	-0.71	0.06		-0.06
76		1.21	3.01	-3.32	0.10	0.08				-0.93	4.71	0.59	-6.31	0.19
77	0.39					0.72				-0.67			-0.07	-2.32
78		2.54	-0.38	0.12	-0.41	7752.43	0.70	0.73		-0.67	1.75	1.70	-0.48	-1.86
80		-2.52	-2.75	-3.01	-0.85	-2.32	33.62			-2.82	-3.12	-0.80		-3.28
81	0.18	-0.27		-0.82	-0.47	0.84		-0.38		-0.42	-0.74	1.56		-1.07
82	0.90	0.37	-0.17	-3.78	-1.24	0.29		-0.46		-0.06	-1.27	-1.27	-1.20	-0.96
83	-1.81	0.04	-1.24	-1.76	-1.25	-1.08				-0.93	-1.24	-1.28		-1.17
84	-2.86	-0.82	-0.21	-1.74	-0.52	-0.75	-0.50			-0.49	-0.63	-1.13		-0.94
85	-2.44	-1.00	-1.03	-2.77	-1.27	-1.74				-1.82	-0.72	-1.03	-0.81	-1.95
86	-7.25	-1.10	-1.84	-2.25	-1.59	-7.32	-0.32	-0.85		-2.70	-1.39	20.05	-6.04	-1.84
88	1.34	-1.60	0.31	-0.70	-0.14	0.66		-0.13		0.96	-0.78	1.54	0.00	-0.11
89		-1.25	-0.96		-1.64		0.03					-1.67		-2.17
90	-5.04	-0.93	-0.78	-2.61	-0.09	-0.48	-4.12	-2.43		-0.36	-0.97	-0.88	-1.39	-1.24
91	-4.62	-1.82	-1.22	-2.98	-1.35	2.06	25.83	-3.17		-0.58	-1.92	-1.71	-1.37	-1.14
92		0.31	1.31	0.52		1.07								
93	-2.07	0.43		-0.16	0.69	0.08	-0.82	-2.54	-0.45	0.21	0.67	-0.38	-2.08	0.21
95	1.60	0.36	0.39	0.78	0.46	0.71	0.10	1.06		0.92	0.40	0.14	0.53	0.29
96	0.27		-0.63		-1.34	0.65				-0.53	-2.52	-2.00		-0.81
97	-0.88	0.01	0.14	0.26	0.49	-0.12		0.91		0.56	0.35	0.27	0.97	-0.05
98	6296.30	10.66	-0.53	-1.44	-1.01	7154.16	51.63	-0.14		0.53	-2.17	-1.38	-0.32	-1.14
99	-4.13			-0.95	-0.53	-0.14	-0.41	4.51		-0.22	-0.33	-1.14	-1.67	-0.08
100	8162.38			-7.16	0.02	8289.54	0.77			0.34	25.67	0.07		-1.42

TABLE 3. OVERALL ASSESSMENT OF LABORATORIES PERFORMANCE (ZETA-SCORE) BY ELEMENTS

Lab Code	Al	As	Co	Cr	Cu	Fe	Hg	Li	MeHg	Mn	Ni	Pb	Sr	Zn
1	-0.69	0.74	0.95	0.62	-0.58	-1.01	-1.47			0.52	-0.05	1.86	0.23	-0.89
2														
4														
5														
6	1.13	1.56	0.66	-0.77	-0.53	0.87	-0.19	2.53		-0.81	-0.53	-1.74	13.80	0.14
8	-0.42	-1.95	-1.42	2.07	-1.53	0.67	8.64			1.48	-1.42	0.11		1.16
9														
10														
11							-0.79							
12	0.21	0.08	-1.06	-0.02		0.20				0.57				-0.02
13	0.44	-2.16	-0.87	-5.04	-2.04	-0.30	1.83	0.25		-1.07	-2.31	-8.30	-1.50	1.28
14														
16	-1.07	-3.32	0.62	5.03	-4.19	-1.16	-0.79	-6.09		-0.68	-2.71	-4.15	0.34	1.54
17														
18														
19		1.96	-1.20	-1.92	-0.20	10.52				0.42	0.06	-2.24	0.39	1.14
20	1.06				1.94	0.31	1.51			0.05	-0.46	0.07		-1.35
21			1.17		-0.33						0.92	1.13		-1.44
22	26.36		-0.17			31.69				1.51				-8.09
23	0.66	1.32		-0.11	0.20	-0.02	-2.66			0.11	0.95	-0.17	0.44	-0.01
24	1.74	8.54	5.24	-9.94	4.84	4.56	2.09	1.66		-2.30	5.23	6.07	4.64	2.32
26	-12.75	-2.69	-2.81	-8.14	-2.02	-2.91	2.18	-4.67		-1.41	-4.31	-4.10	-3.19	-4.43
27	10.87	-1.94	-1.60	-5.64	-1.81	10.68	-0.87	-7.47		-1.19	-2.95	-5.64	-4.70	-2.64
29														
30	-19.24		0.73	-7.37	4.53	-4.55	6.60	-3.11		-3.25	0.70	-14.37	-8.01	-2.96
33				-0.28	-0.35	0.11		0.50		-0.25	-0.40	-0.12		-0.94
34		0.28	-1.44	0.08	-0.21	0.80				-0.37	-1.81	-0.33	4.16	0.57

TABLE 3. OVERALL ASSESSMENT OF LABORATORIES PERFORMANCE (ZETA-SCORE) BY ELEMENTS (cont.)

Lab Code	Al	As	Co	Cr	Cu	Fe	Hg	Li	MeHg	Mn	Ni	Pb	Sr	Zn
36	-5.95	8.1	-0.66	-2.15	-0.33	0.87	-8.14	1.06		1.28	-1.67	-4.53	-10.74	-0.55
37														
38	-0.02	-2.64		0.52	0.23	1.64	-0.72	-0.28		0.38	-1.88	-4.35		-1.48
39		-4.22	-1.58	-2.51	-4.76	-1.70				-2.61	-2.21	-4.79		-3.32
40							2.08							
41	0.55	-0.12		-0.22	1.91	0.29	0.00	6.45		-0.07	-0.76	-0.89	3.86	0.55
43														
44	0.64	-2.64		-2.37	-7.41	-0.68				-0.46	-4.07	-3.30	-1.03	-3.57
45	377.25		4.48	4.87	2.20	231.14				11.74	3.80		0.10	5.00
46		-3.09	0.16	10.67	-0.76	-32.16				0.78		-0.13		-1.22
47	0.09	0.21	-0.21	-0.58	0.17	-0.04	1.21	-1.00		0.40	-0.46	0.34	1.26	0.15
51														
52														
53	1.87	-0.28	-0.24	-2.81	0.02	-0.83		-5.63		-0.33	-1.96	-1.12	1.29	1.16
56	-0.09	-1.15	-0.23	-3.07	-1.85	-0.42	18.02			2.76		6.45	-1.83	-1.57
58														
59							-1.63							
60														
61	6.13			2.04	1.80	60.12				-0.30		-1.03	-1.57	0.55
62														
63		-2.93			-0.64	-4.34		-0.92		-4.93				-4.93
64	-0.36	-4.91	-1.27	0.40	-0.59	-1.06	-1.81	0.21	22.70	0.10	-0.88	-0.96	1.32	-0.81
65														
66		0.36	0.07	3.20	-0.25	0.12	3.00			-6.95	-0.50	-0.29		0.21
67				-6.28	0.62		-4.81					-6.89		-1.53
68					-1.83						225.26	183.85		
70	1.02	2.40	-0.24	0.17	0.27	1.17	1.60			0.41	3.25	1.23	5.75	-0.29

TABLE 3. OVERALL ASSESSMENT OF LABORATORIES PERFORMANCE (ZETA-SCORE) BY ELEMENTS (cont.)

Lab Code	Al	As	Co	Cr	Cu	Fe	Hg	Li	MeHg	Mn	Ni	Pb	Sr	Zn
71	9.95	-2.37	-3.84	-7.16	-0.38	9.98	-0.10		-0.81	-1.52	-8.38	-2.90	-2.33	-2.68
72														
73		1.08	0.77	0.21	0.15	5.00	-0.83			-0.14		0.61		-0.21
74				4.39	24.60	37.06				-3.30	-2.39	0.63		-3.82
75	0.58	-2.80	-1.93	2.58	-0.87	3.75				-12.79	-3.74	0.10		-0.20
76		1.07	1.54		0.22	0.22				-3.48	9.40	1.33	-17.45	0.72
77	1.01					1.41				-1.77			-0.13	-5.01
78		3.91	-0.48	0.17	-0.89	21.63	1.09	0.64		-2.26	6.41	5.92	-1.19	-3.96
80		-2.26	-2.59	-2.00	-0.46	-1.63	3.14			-2.63	-2.17	-0.44		-3.36
81	0.19	-0.22		-2.67	-0.63	0.56		-0.32		-0.55	-1.33	1.62		-1.52
82	1.62	0.74	-0.37	-13.70	-2.83	0.61		-0.99		-0.12	-3.42	-3.18	-2.41	-2.21
83	-5.15	0.09	-1.72	-7.12	-3.69	-1.68				-1.88	-2.26	-5.60		-3.18
84	-6.37	-1.67	-0.42	-2.69	-1.12	-1.75	-0.41			-0.94	-0.84	-2.49		-2.14
85	-7.36	-3.75	-4.60	-10.54	-2.98	-4.36				-4.30	-1.95	-3.22	-2.07	-5.81
86	-21.16	-1.11	-1.30	-1.71	-1.27	-29.52	-0.39	-0.92		-1.50	-0.95	0.29	-3.81	-1.67
88														
89		-2.85	-5.02		-5.28							-8.47		-7.53
90	-11.46	-1.25	-1.05	-4.59	-0.11	-0.61	-9.43	-3.94		-0.44	-1.35	-1.19	-1.85	-1.72
91	-9.37	-3.48	-2.21	-7.18	-2.38	2.11	7.70			-1.43	-3.92	-3.42		-2.01
92		0.57	3.27	1.88		2.76								
93	-3.25	0.64		-0.31	1.03	0.08	-3.82	-4.96	-0.58	0.42	1.26	-0.95	-3.47	0.49
95														
96														
97	-2.70	0.05	0.80	1.33	1.82	-0.55		3.40		2.11	2.23	1.37	2.68	-0.19
98	59.37	3.35	-0.80	-5.12	-1.40	41.61	9.63	-0.44		0.42	-3.15	-6.41	-0.22	-4.02
99														
100	12.49			-29.38	0.03	19.98	1.37			0.68	5.08	0.09		-2.00

5.3 ANALYTICAL METHODS

Analytical methods used by the participating in this ILC laboratories are presented on Figure 5. Abbreviation used in the Figure 5 and in the report are shown in Table 4.

Generally, they can be divided to three groups: nondestructive techniques (NAA, XRF); plasma spectrometric methods (ICP-MS and ICP-OES) and atomic absorption spectrometry methods, representing 11%, 60% and 21% of all reported results respectively.

ICP-MS is representing almost half of all reported measurement results for all analytes, except for Hg. It is interesting to note that almost half part of the reported for total mercury results have been produced by solid mercury analyzer. This method was representing only about 25% of mercury data in the past two ILC's [4, 5].

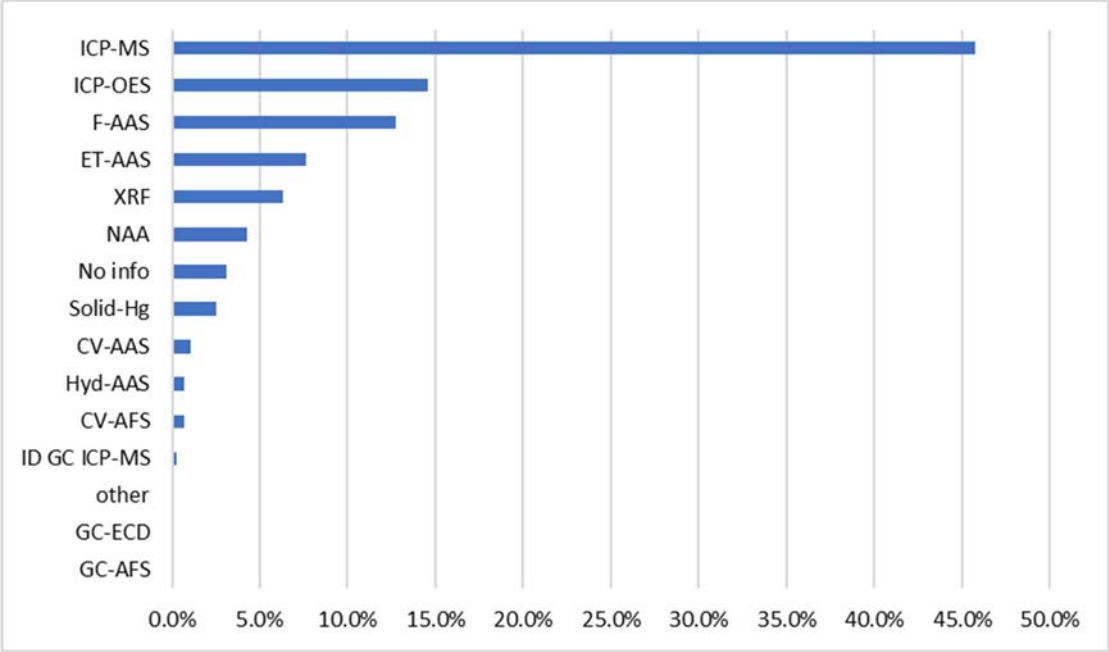


FIG. 5. Graphical distribution of instrumental techniques.

TABLE 4. ABBREVIATIONS USED FOR ANALYTICAL TECHNIQUES

Abbreviation	
AAS	Atomic Absorption Spectrometry
AFS	Atomic Fluorescence Spectrometry
CV	Cold Vapor
ET	Electro Thermal
F	Flame
GC	Gaz Chromatography
Hyd	Hydride
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ICP-OES	Inductively Coupled Plasma Optical Emission Spectroscopy
ID	Isotope Dilution
NAA	Neutron Activation Analysis (or instrumental neutron activation)
XRF	X Ray Fluorescence

5.4 SAMPLE TREATMENT, IMPACT OF WATER CONTENT, THE USE OF CRM AND CORRECTIONS FOR RECOVERY RATE

Due to high level of silicates in marine sediment sample, its dissolution is not trivial analytical task. The addition of hydrofluoric acid (HF) is mandatory for the total decomposition of the silicate lattice. Without HF, the dissolution of a sediment sample will be incomplete, resulting in the negatively biased mass fractions for certain refractory elements, such as Al, Cr, Mn, Pb, V and Sr. Only 36 laboratories participating in the ILC have used hydrofluoric acid (or XRF) in their sample preparation step.

Thirteen participants (16%) didn't provide QC results for all requested elements and 5 of them declared to be accredited and to have a quality system in place.

An important principle for the selection of the certified reference materials (CRMs), used for quality control of the applied analytical procedure, was principally the matrix and concentration range matching. CRMs used in this ILC from participating laboratories, were appropriately selected in most of the applied analytical procedures. Participants in the ILC have used sediment matrices of marine origin (i.e. IAEA 458, marine sediment from the IAEA; MESS-3, marine sediment from NRC Canada, etc.).

Twenty-seven participants (33%) claimed to be accredited, but only part of them were accredited for the determination of trace elements in sediment sample matrix. In general, results reported by accredited laboratories were comparable with the results reported by non-accredited laboratories.

Forty-six participants have reported recoveries for all or for a part of the determined trace elements, but only eleven claimed correcting their results for recovery rates. Most of recoveries reported were in the range of 100 ± 25% and were calculated using appropriate matrix CRMs. High proportion of the laboratories not performing correction for recovery rates have obtained

satisfactory scorings, meaning that the laboratories have correctly estimated that the recovery rates achieved were not significantly different from 100%.

The ILC sediment test sample was subject to freeze drying as part of sample preparation process. At the time of bottling, the moisture content of the material, determined with dry oven method was 1.5±0.2%. Depending on the local storage conditions and humidity level in laboratory, the sediment test sample might absorb moisture from the environment. Consequently, participants in this ILC were advised to perform a separate determination of the moisture content of the material. As the moisture is operationally dependent parameter [11] the procedure on moisture content determination in the test sample was provided to all participating laboratories in the beginning of the ILC exercise. Only 42 participants (52%) claimed to report results corrected for moisture content and 22 of them have used effectively the prescribed by the organizers protocol (dry oven at 105°C). The moisture content reported by the laboratories was in the range from 0.3 to 7%.

It should be noted that from 81 data sets received, 15 participants didn't fill the questionnaire as requested by the organizers of the ILC.

6 RECOMMENDATIONS

Participants are recommended to review their data element by element, appraising whether the *z*-scores and Zeta-scores are less than or equal to 2. The use of *z*-scores and Zeta-scores will help laboratories to identify systematic errors in their measurement results (*e.g.* from calibration, reagent contamination or incomplete digestion) and should ultimately improve data quality.

Laboratories should investigate all unsatisfactory scores (i.e. $|z|$ or $|\text{Zeta}| > 3$) and put in place the necessary corrective actions to prevent reoccurring of the same problems in the future. This is valid requirement also for accredited according to the ISO/IEC 17025 standard laboratories [12].

Some laboratories still need to improve quality assurance / quality control procedures, to implement regular analysis of certified reference materials and the use of quality control chart in their daily laboratory practice. Systematic application of above-mentioned points, provides continuous feedback to the analyst and is essential tools for the production of reliable measurement results, used in the monitoring and risk assessment studies.

7 CONCLUSIONS

The overall performance of the laboratories taking part in this ILC exercise is satisfactory. Based on the obtained z-scores, nearly 80% of reported results were considered as satisfactory. Nevertheless, there are still unresolved analytical problems and about 35% of participants are reporting results, where less than 25% of them can be considered as satisfactory.

The implementation of Minamata convention, especially the article 19, will increase the number of laboratories involved in the monitoring of mercury in sediment samples. Compared with previous global ILCs in marine sediment sample [5] an increase of 20% of reported results for total mercury can be observed. Obtained results from this exercise demonstrated that about 25% of participants still have problems to report accurate results when the content of mercury in the sediment matrix is relatively low.

An extra effort is still needed for relevant evaluation of measurement uncertainties, associated with measurement results. There is still almost 30% of participants that do not report results with associated uncertainties. The uncertainty is a part of measurement result and in the frame of different regulations and international agreements, it is of paramount importance, measurement result to be reported together with a complete uncertainty statement.

The ILC test marine sample was further certified in one independent characterization exercise and is available as IAEA 475 CRM. The reference sheet and certification report can be downloaded from http://www.iaea.org/programmes/aqcs.

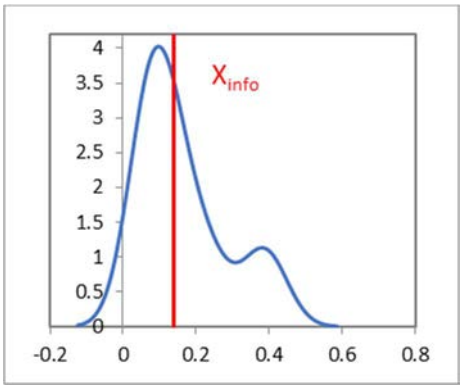
A full catalogue of available IAEA reference materials is published regularly and can be consulted on the IAEA website: http://www.iaea.org/programmes/aqcs.

APPENDIX I

PERFORMANCE EVALUATION BY ELEMENT IN IAEA-MESL-ILC-TE-SEDIMENT-2018

Evaluation of Reported data for Ag

Kernel density Plot

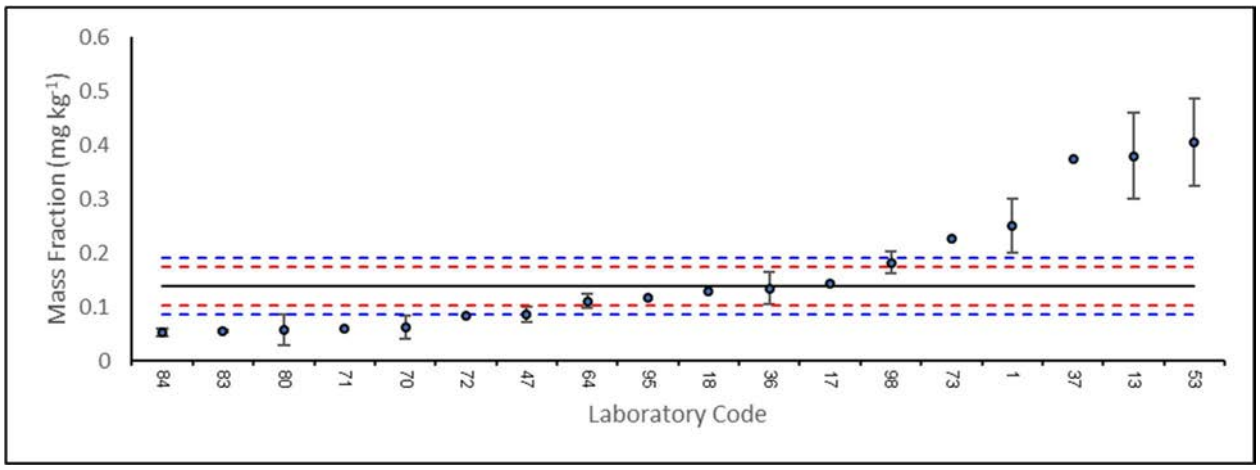


Summary of results:

X_{info}:	0.139 mg kg^{-1}
U_{info} (k=2):	0.053 mg kg^{-1}
$2\sigma_p$:	0.035 mg kg^{-1}
Number of results:	18
Number of method:	2

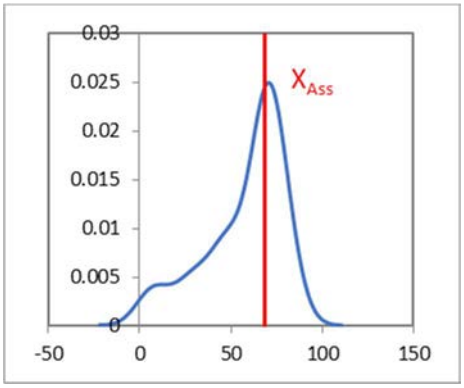
Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$



Evaluation of Reported data for Al

Kernel density Plot



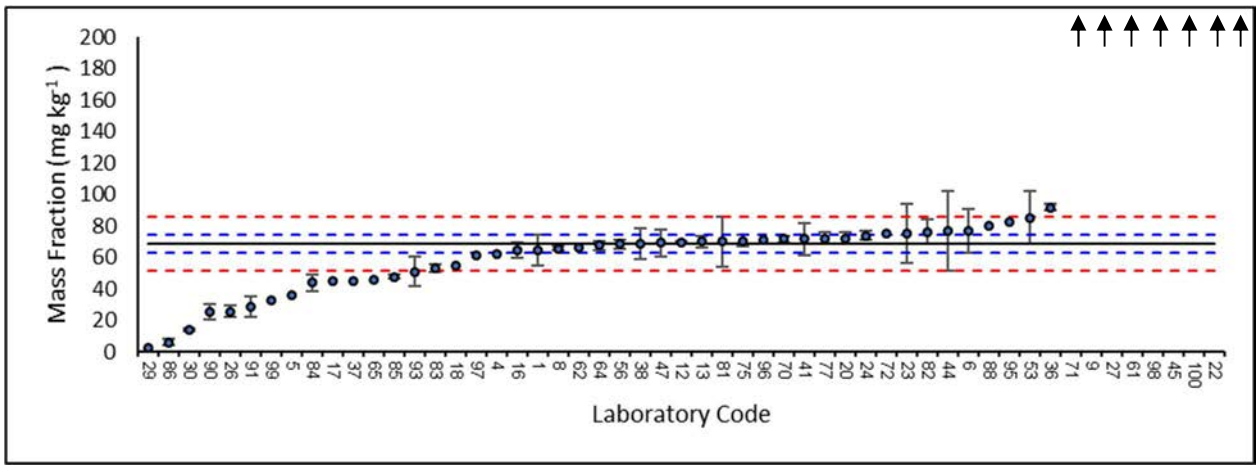
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	57%	13%	30%
Zeta-score	54%	3%	44%

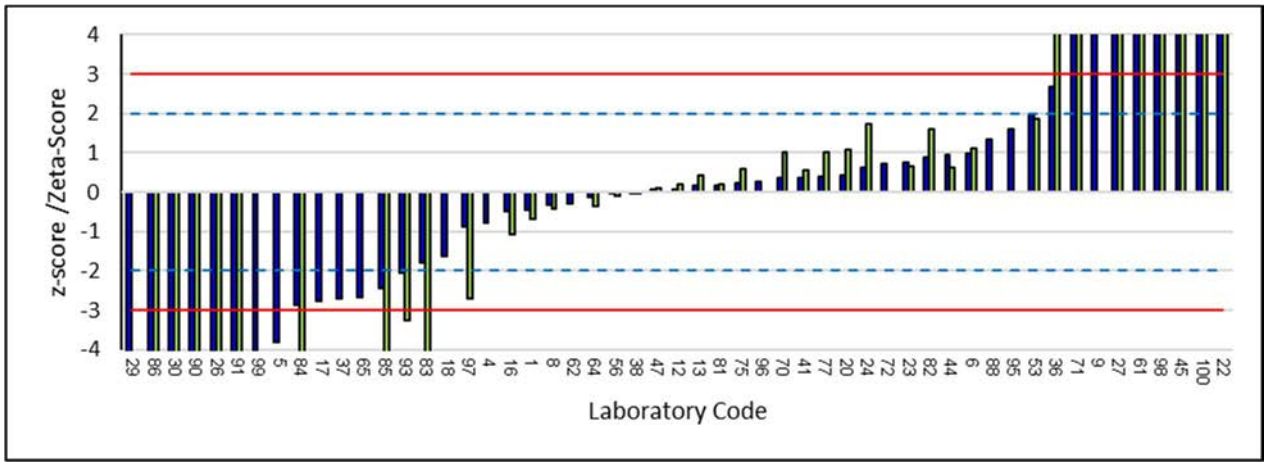
X_{ass}:	68.8 g kg^{-1}
U_{ass} (k=2):	5.6 g kg^{-1}
$2\sigma_p$:	17.2 g kg^{-1}
Number of results:	53
Number of method:	7

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

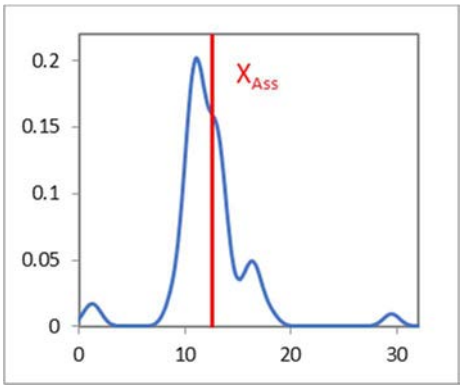


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for As

Kernel density Plot



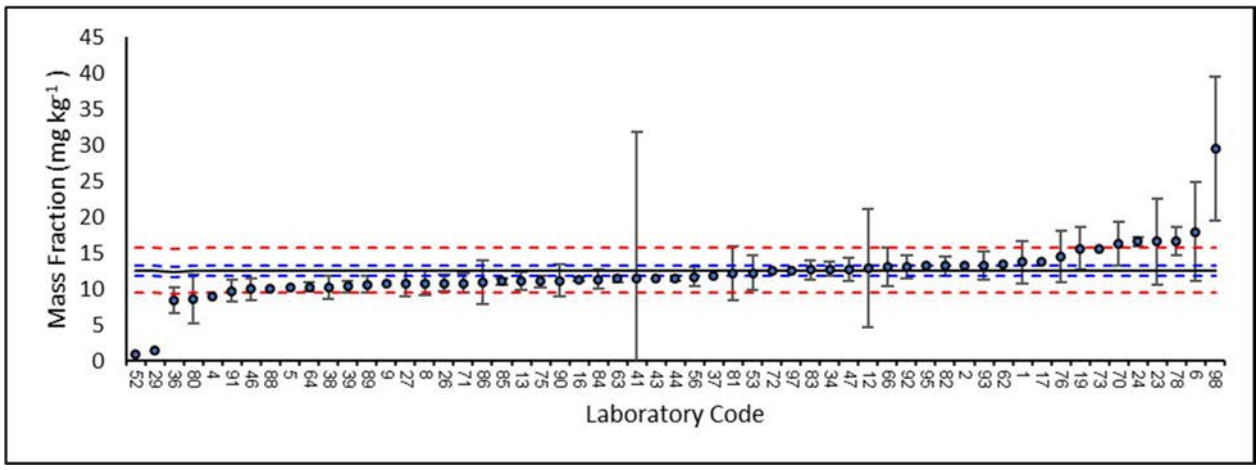
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	81%	12%	7%
Zeta-score	55%	23%	23%

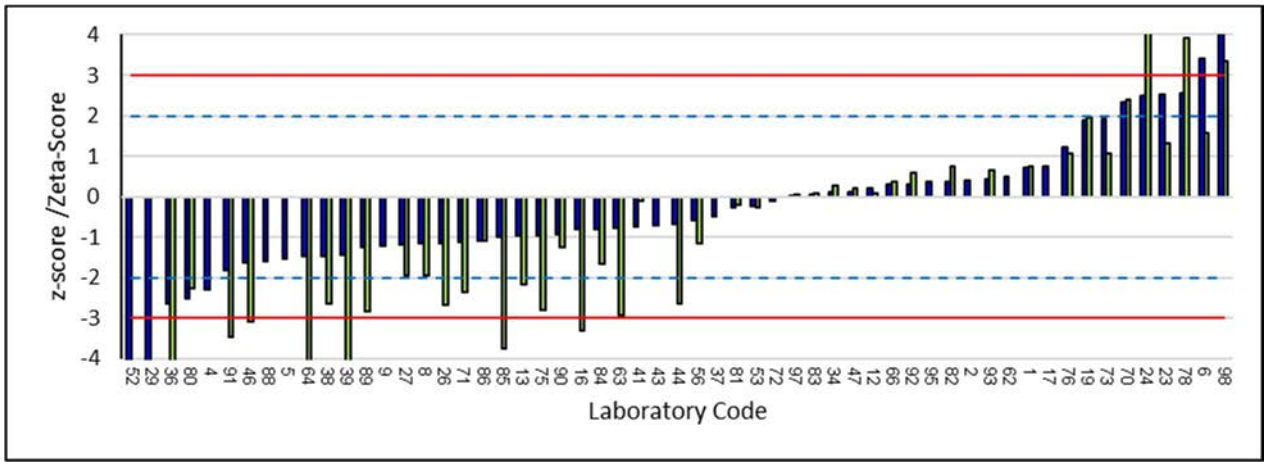
X_{ass}:	12. 6 mg kg^{-1}
U_{ass} (k=2) :	0.73 mg kg^{-1}
$2\sigma_p$:	3.15 mg kg^{-1}
Number of results:	57
Number of method:	7

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

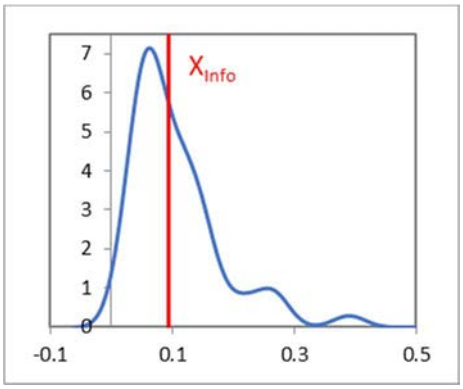


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Cd

Kernel density Plot

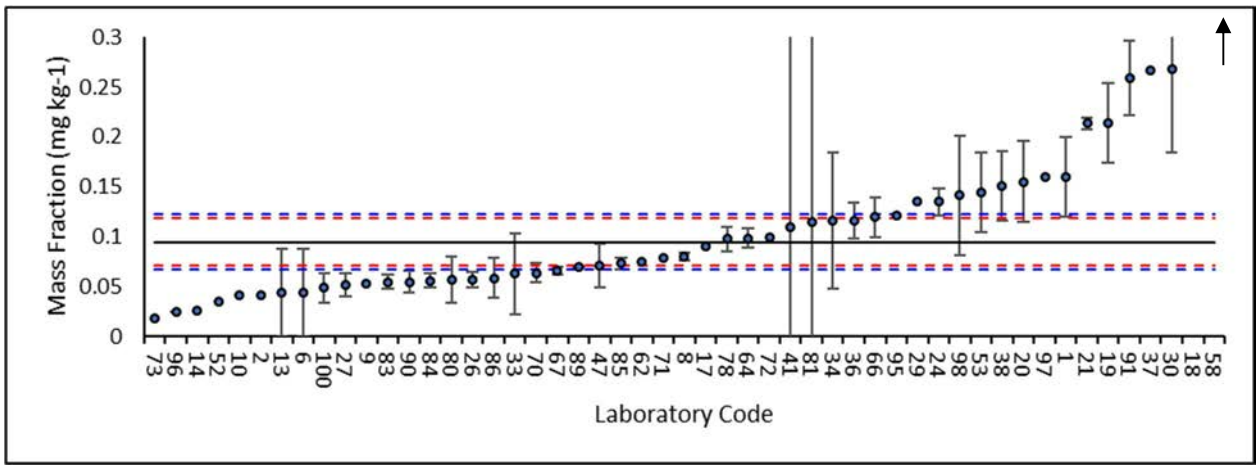


Summary of results:

X_{info}:	0.095 mg kg^{-1}
U_{info} (k=2) :	0.022 mg kg^{-1}
$2\sigma_p$:	0.024 mg kg^{-1}
Number of results:	51
Number of method:	5

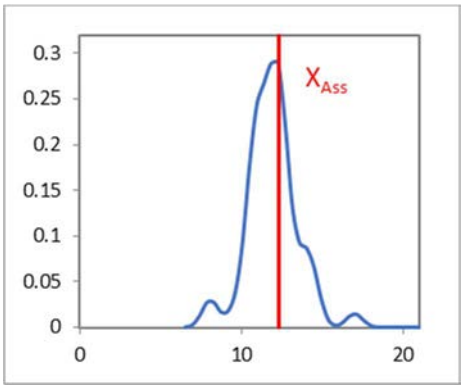
Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$



Evaluation of Reported data for Co

Kernel density Plot



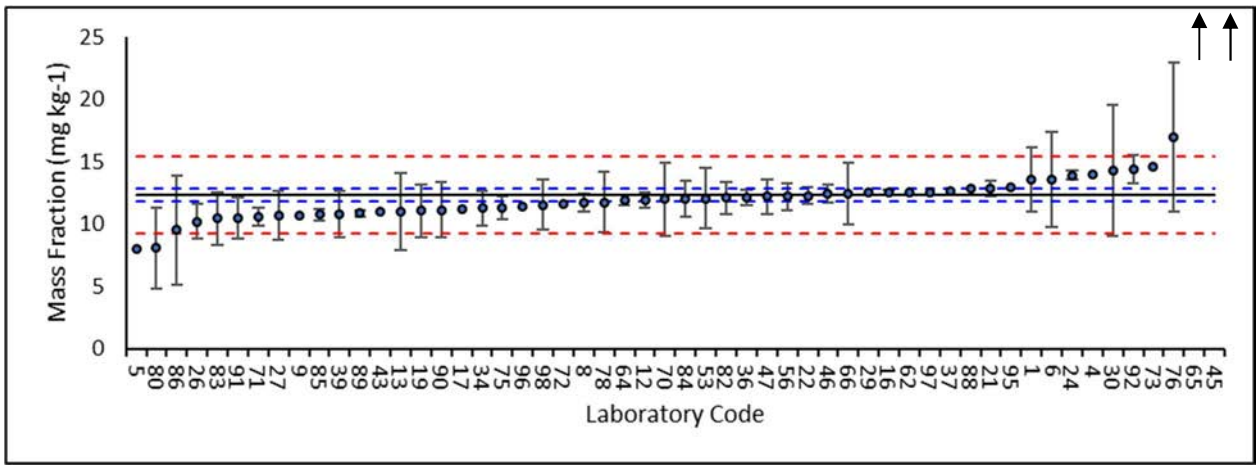
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	91%	4%	6%
Zeta-score	78%	7%	15%

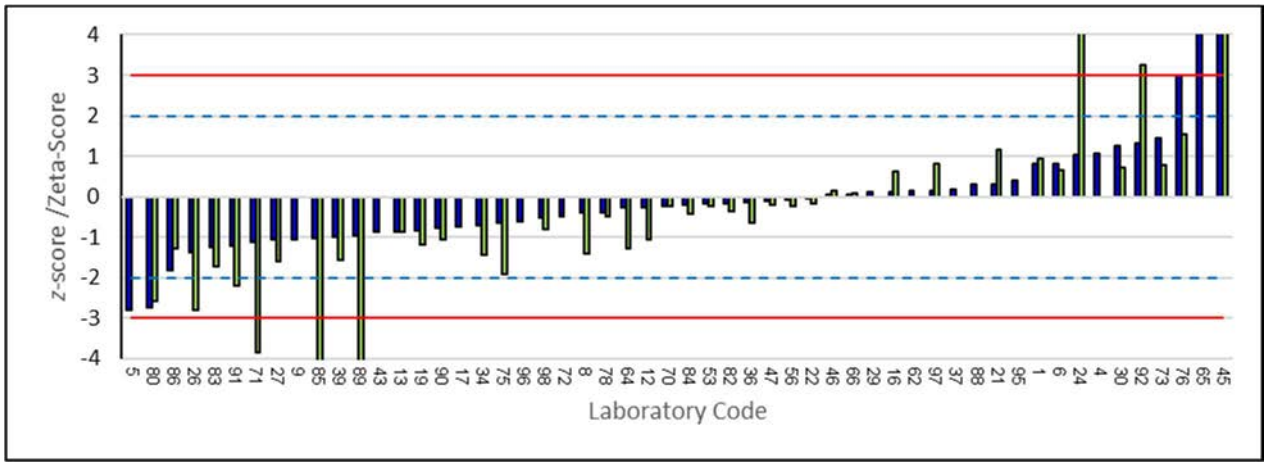
X_{ass}:	12.3 mg kg^{-1}
U_{ass} (k=2) :	0.53 mg kg^{-1}
$2\sigma_p$:	3.75 mg kg^{-1}
Number of results:	41
Number of method:	6

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

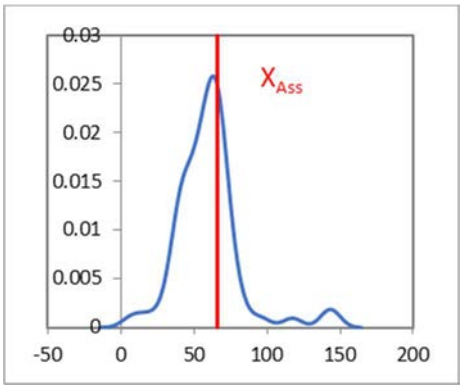


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Cr

Kernel density Plot



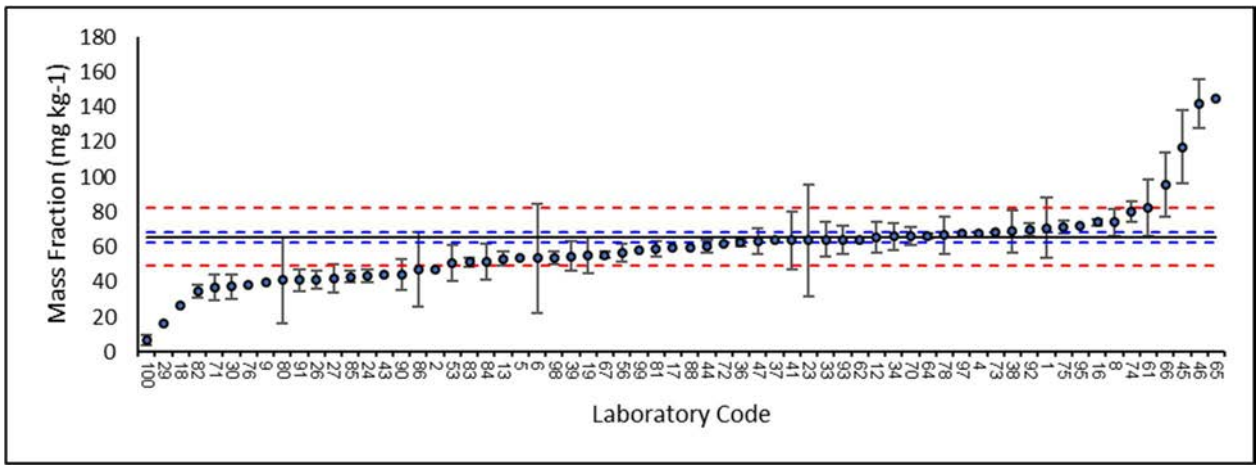
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	64%	16%	20%
Zeta-score	40%	19%	42%

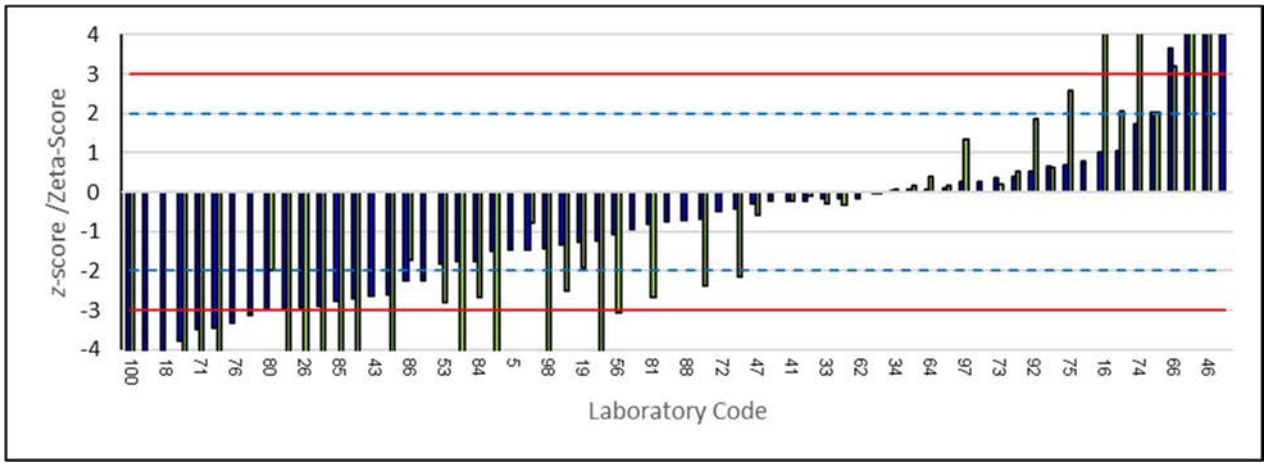
X_{ass}:	65.8 mg kg^{-1}
U_{ass} (k=2) :	2.9 mg kg^{-1}
$2\sigma_p$:	16.4 mg kg^{-1}
Number of results:	64
Number of method:	6

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

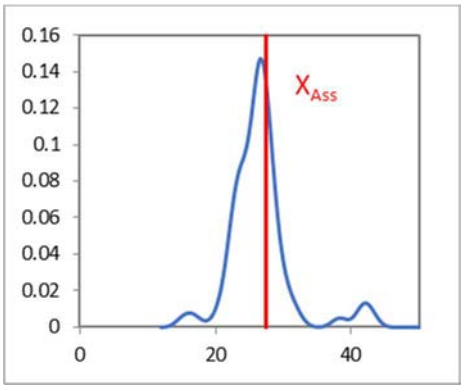


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Cu

Kernel density Plot



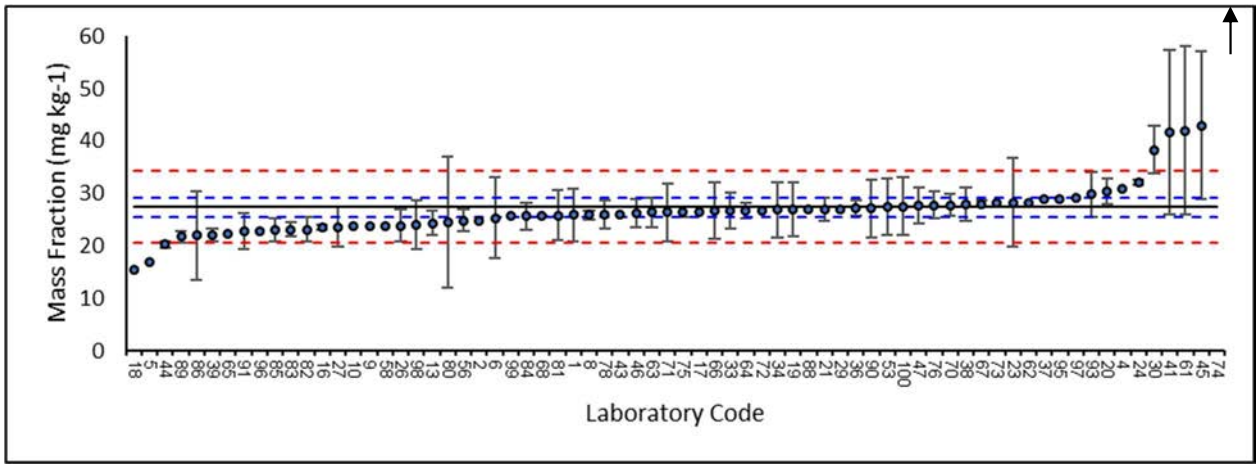
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	89%	1%	10%
Zeta-score	73%	12%	15%

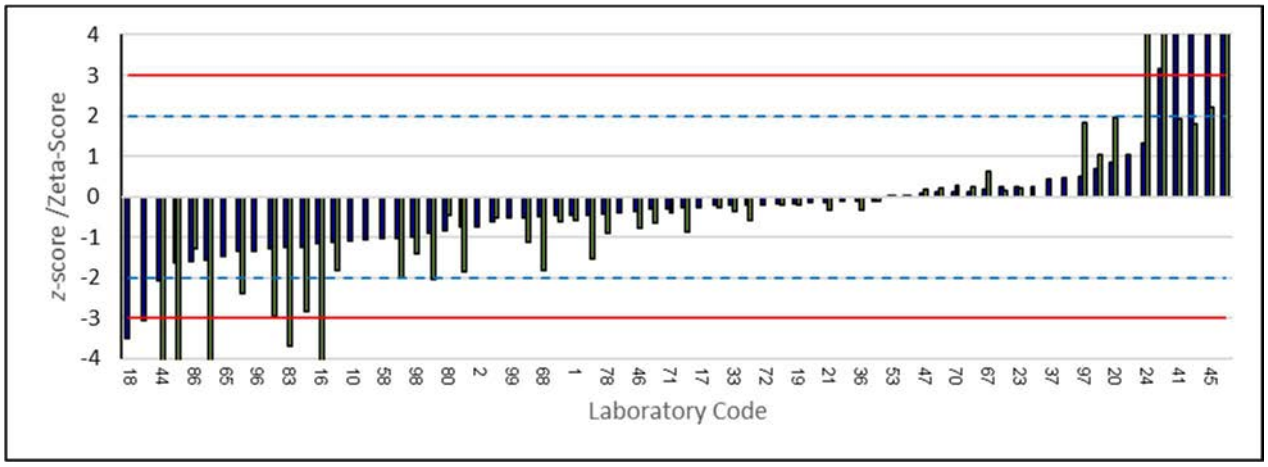
X_{ass}:	27.5 mg kg^{-1}
U_{ass} (k=2) :	1.8 mg kg^{-1}
$2\sigma_p$:	6.9 mg kg^{-1}
Number of results:	70
Number of method:	5

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

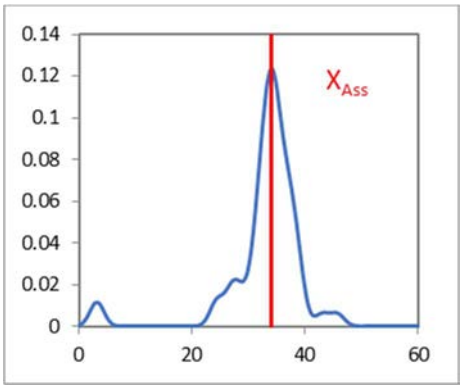


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Fe

Kernel density Plot



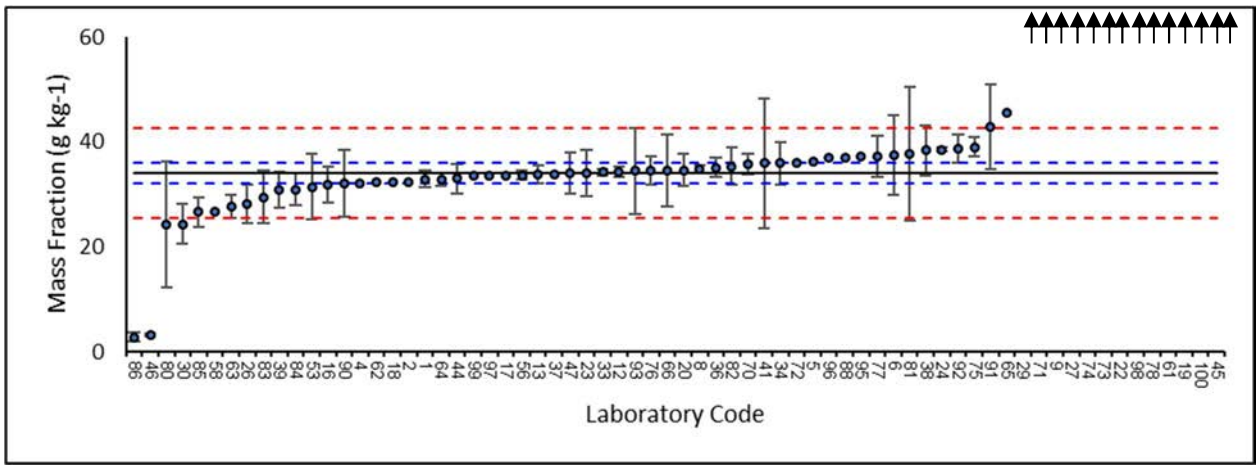
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	71%	6%	24%
Zeta-score	60%	6%	35%

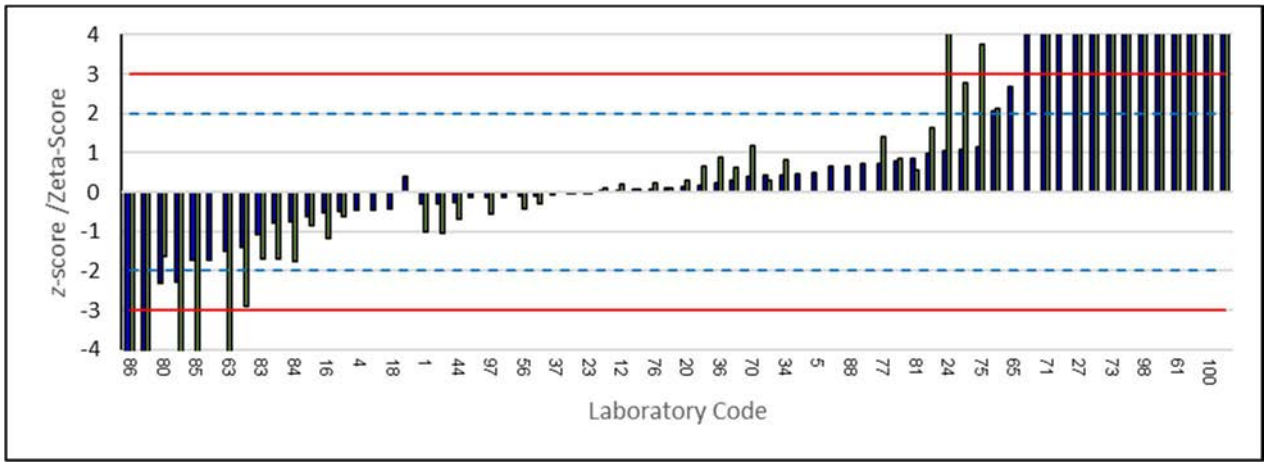
X_{ass}:	34.1 g kg^{-1}
U_{ass} (k=2) :	1.9 g kg^{-1}
$2\sigma_p$:	8.5 g kg^{-1}
Number of results:	68
Number of method:	6

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

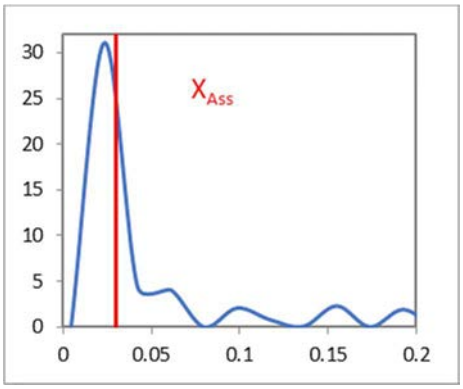


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Hg

Kernel density Plot



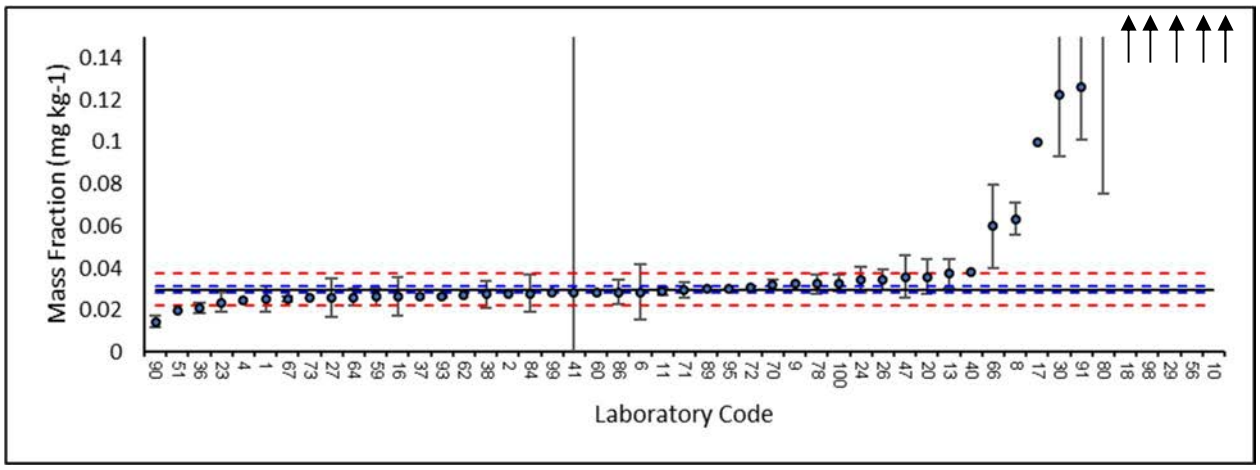
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	69%	6%	24%
Zeta-score	56%	12%	32%

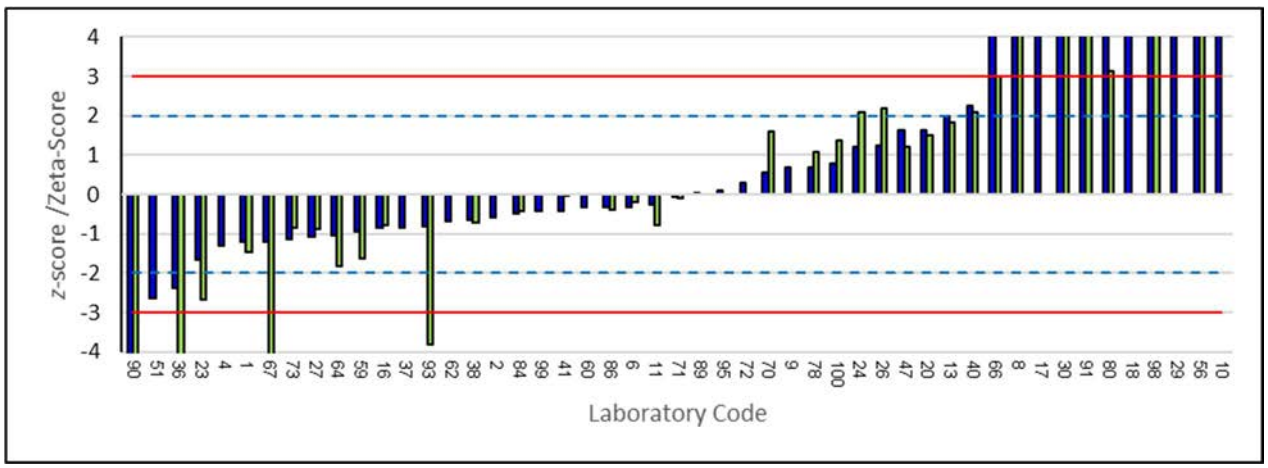
X_{ass}:	0.0299 mg kg^{-1}
U_{ass} (k=2) :	0.0015 mg kg^{-1}
$2\sigma_p$:	0.0075 mg kg^{-1}
Number of results:	49
Number of method:	8

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

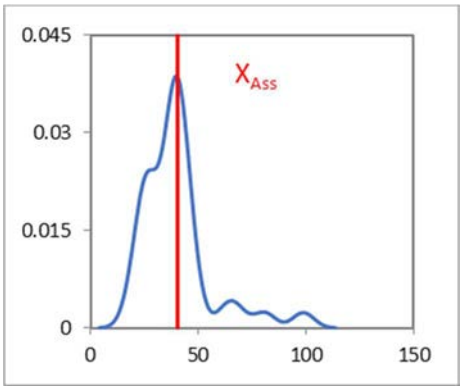


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Li

Kernel density Plot



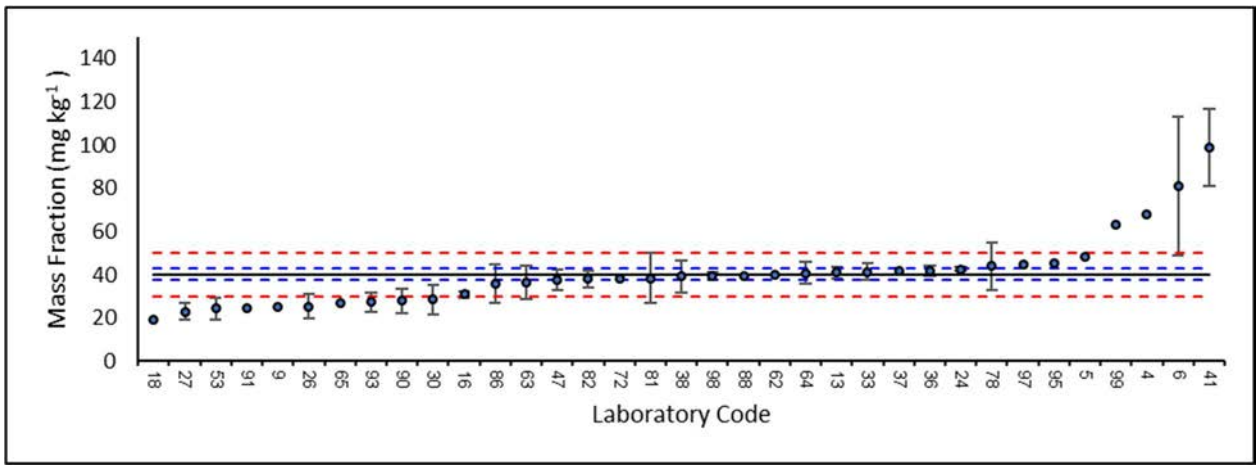
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	60%	26%	14%
Zeta-score	57%	4%	39%

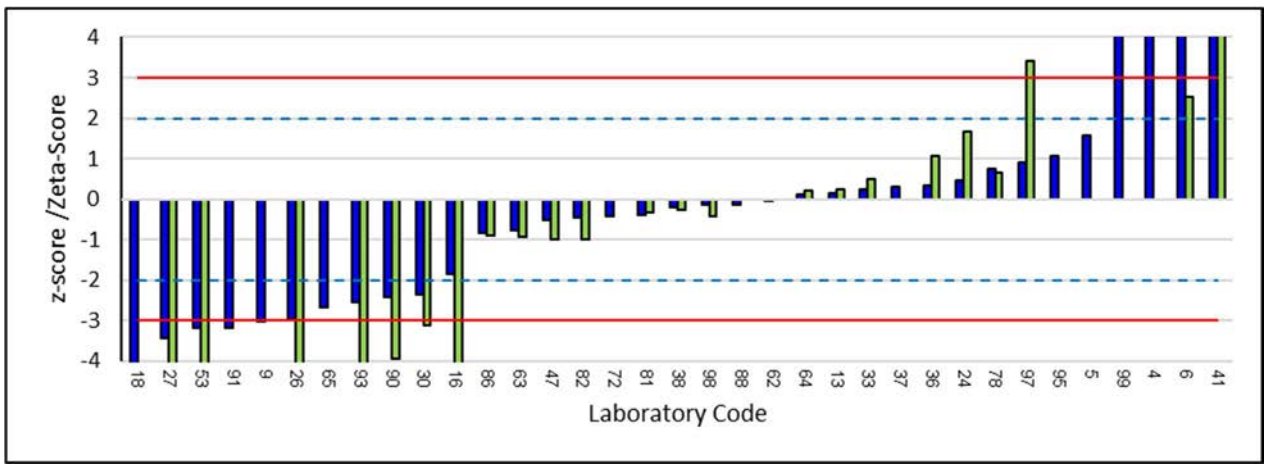
X_{ass}:	40.3 mg kg^{-1}
U_{ass} (k=2) :	2.7 mg kg^{-1}
$2\sigma_p$:	10.1 mg kg^{-1}
Number of results:	35
Number of method:	3

Reported results and expanded uncertainties:

— X_{ass} ; $X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$



Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for MeHg

Kernel density Plot

< 8 results

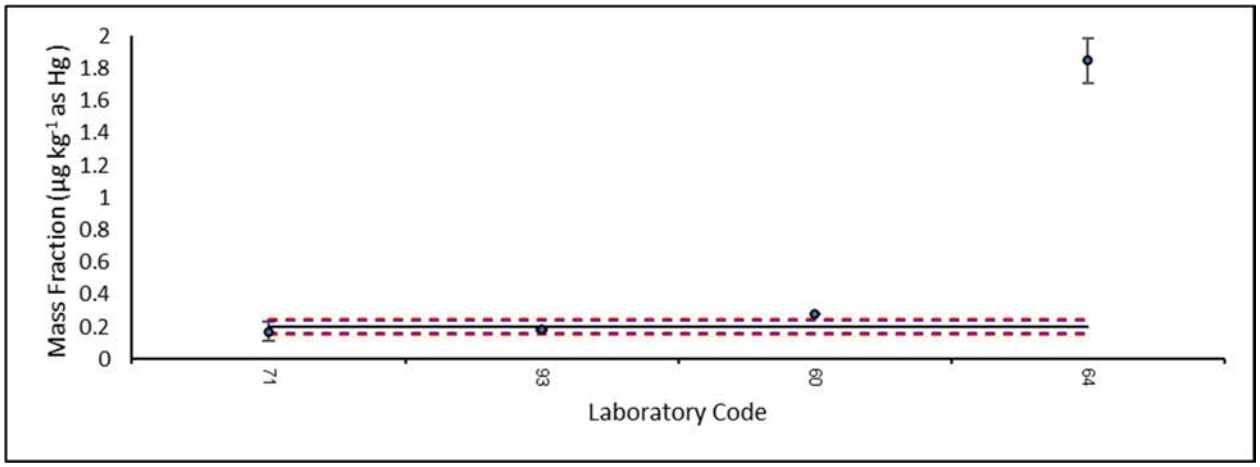
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	50%	0%	50%
Zeta-score	67%	0%	33%

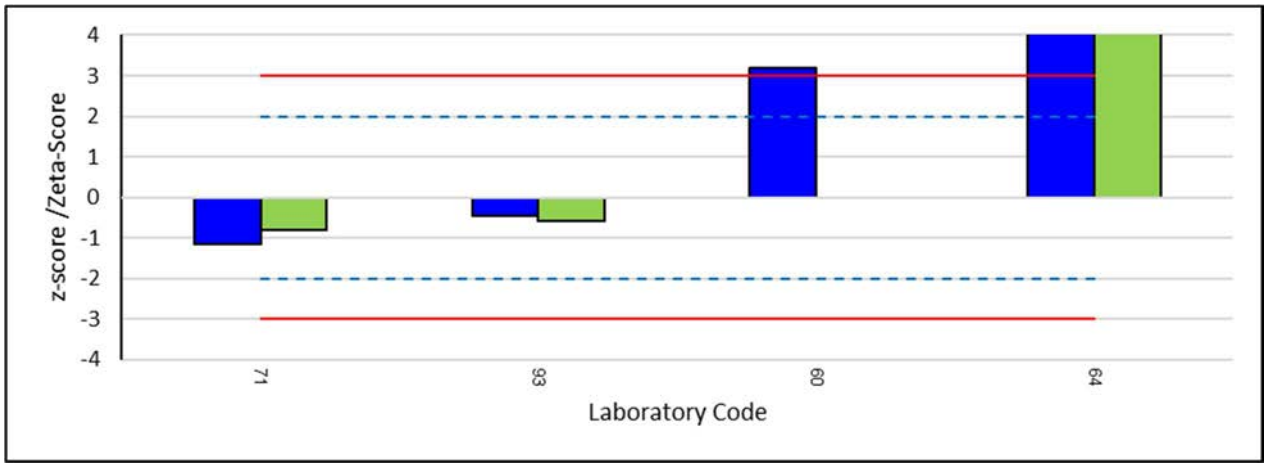
X_{ass}:	0.2 µg kg^{-1} as Hg
U_{ass} (k=2) :	0.038 µg kg^{-1} as Hg
$2\sigma_p$:	0.05 µg kg^{-1} as Hg
Number of results:	4
Number of method:	3

Reported results and expanded uncertainties:

— X_{ass} ; $X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

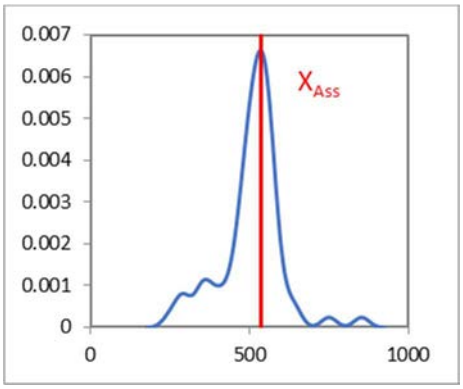


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Mn

Kernel density Plot



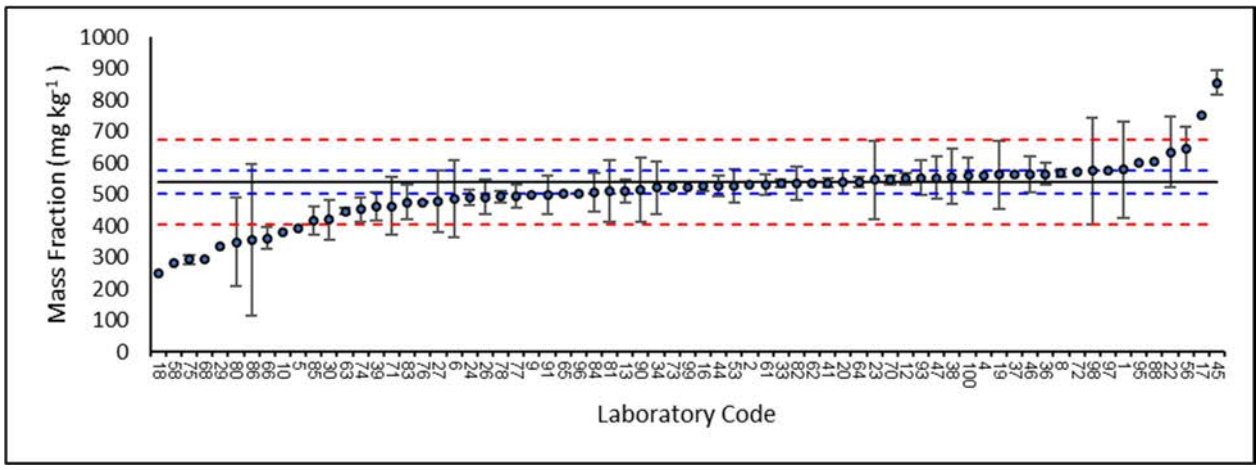
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	83%	9%	9%
Zeta-score	73%	12%	16%

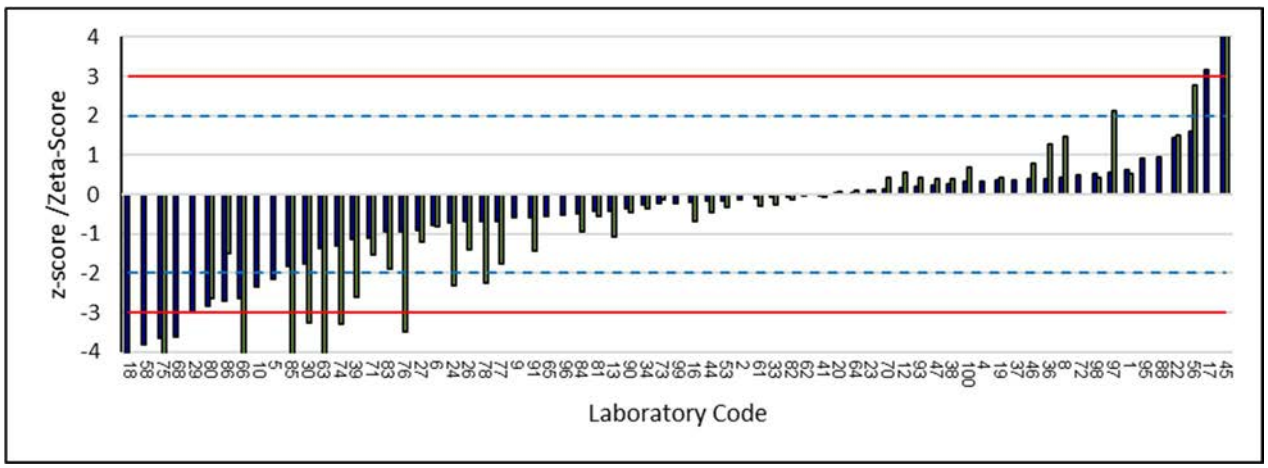
X_{ass}:	539 mg kg^{-1}
U_{ass} (k=2) :	36 mg kg^{-1}
$2\sigma_p$:	135 mg kg^{-1}
Number of results:	69
Number of method:	6

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

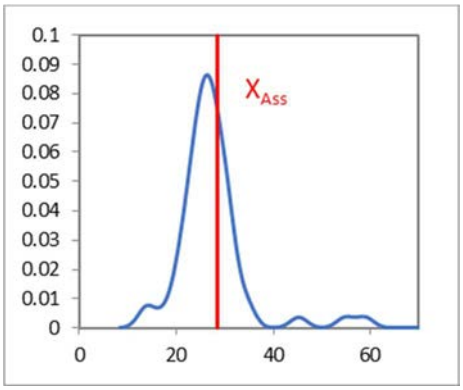


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Ni

Kernel density Plot



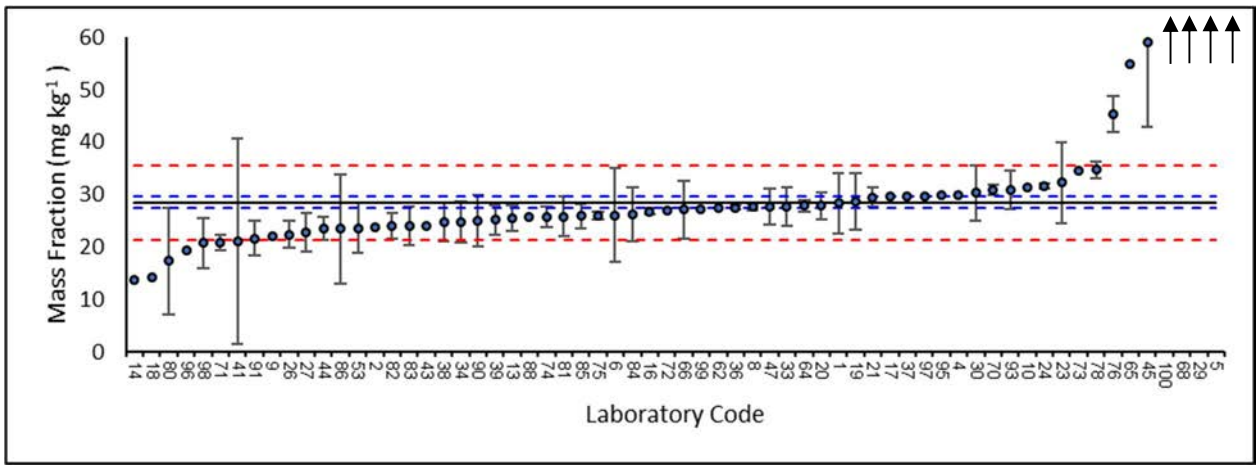
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	78%	6%	16%
Zeta-score	51%	18%	31%

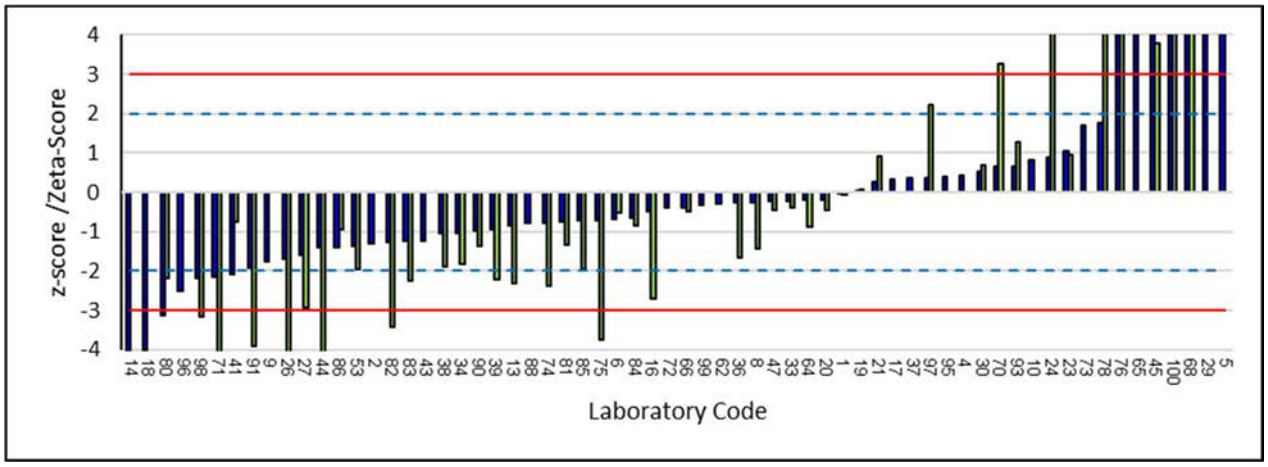
X_{ass}:	28.5 mg kg^{-1}
U_{ass} (k=2) :	1.1 mg kg^{-1}
$2\sigma_p$:	7.1 mg kg^{-1}
Number of results:	64
Number of method:	5

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

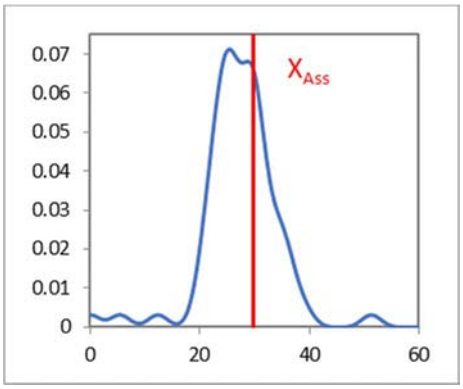


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Pb

Kernel density Plot



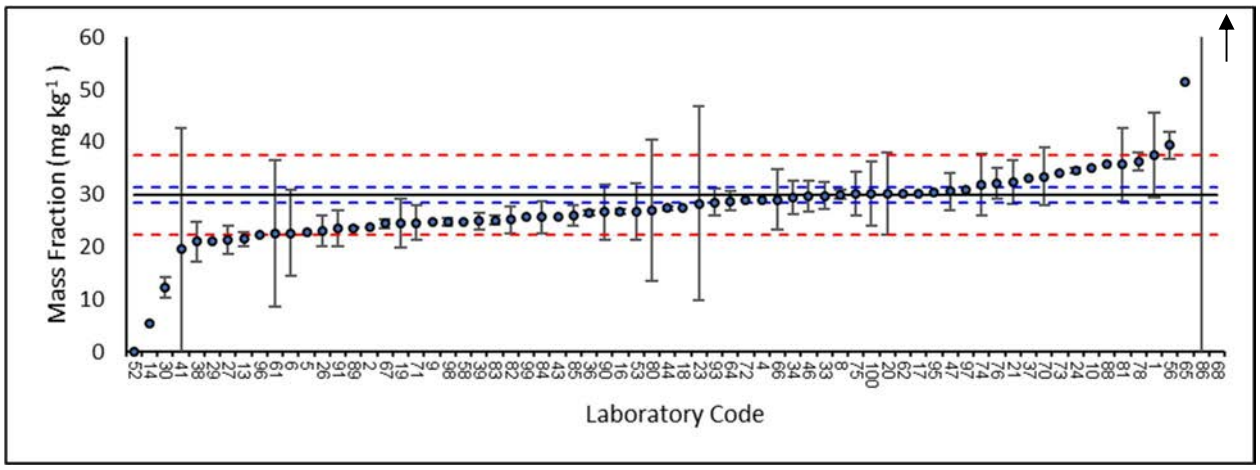
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	81%	10%	9%
Zeta-score	54%	6%	40%

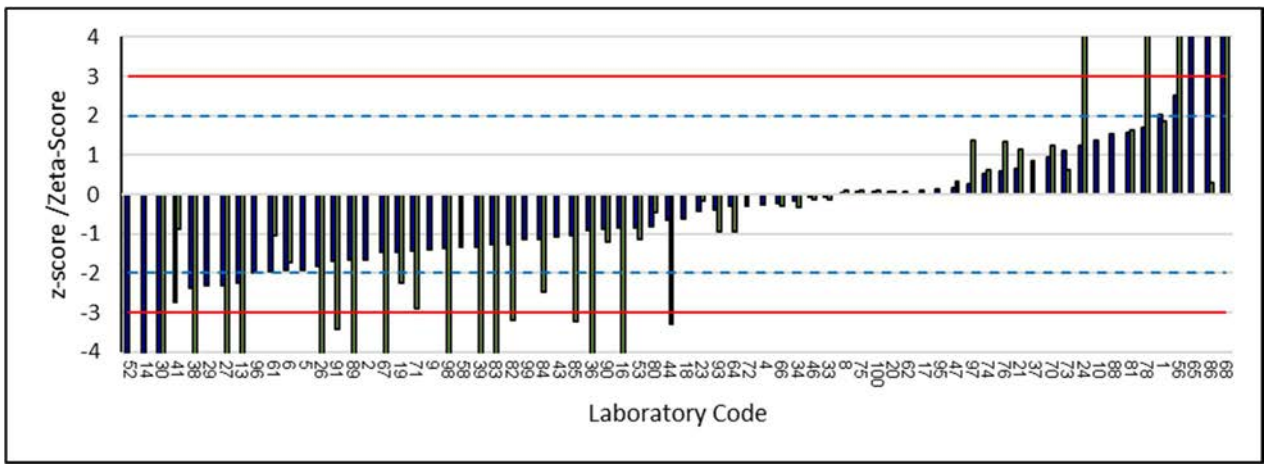
X_{ass}:	29.9 mg kg^{-1}
U_{ass} (k=2) :	1.4 mg kg^{-1}
$2\sigma_p$:	7.5 mg kg^{-1}
Number of results:	70
Number of method:	5

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

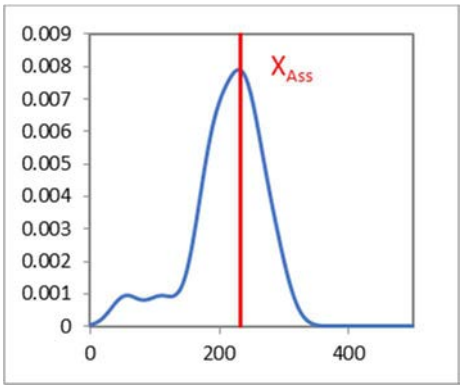


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Sr

Kernel density Plot



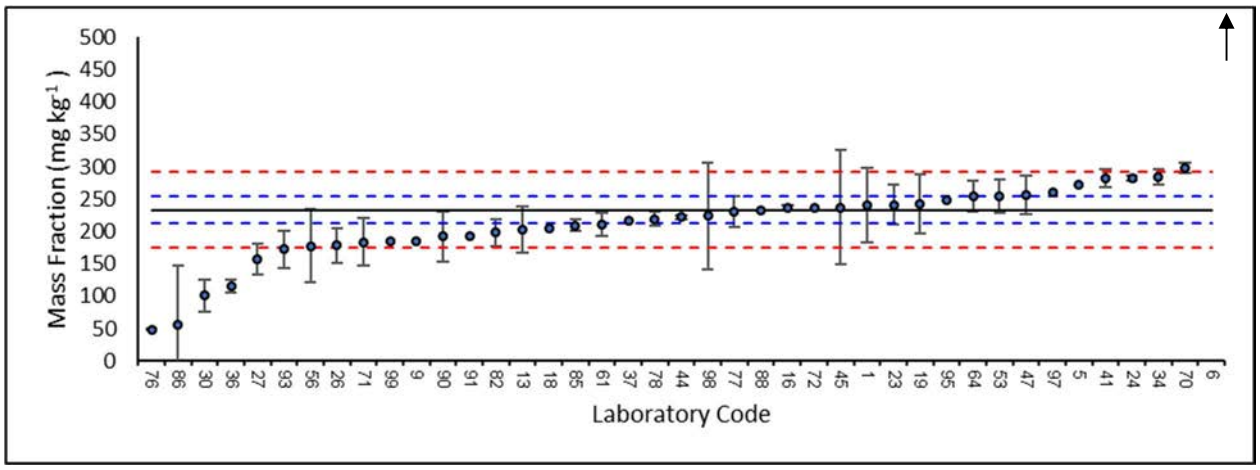
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	80%	7%	12%
Zeta-score	50%	13%	38%

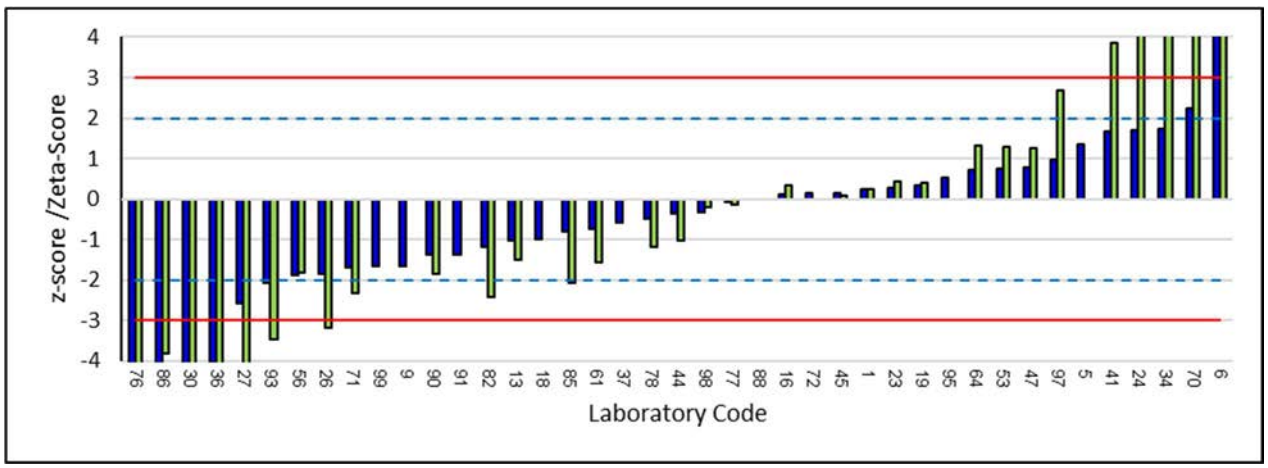
X_{ass}:	233 mg kg^{-1}
U_{ass} (k=2) :	21 mg kg^{-1}
$2\sigma_p$:	58 mg kg^{-1}
Number of results:	41
Number of method:	5

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$

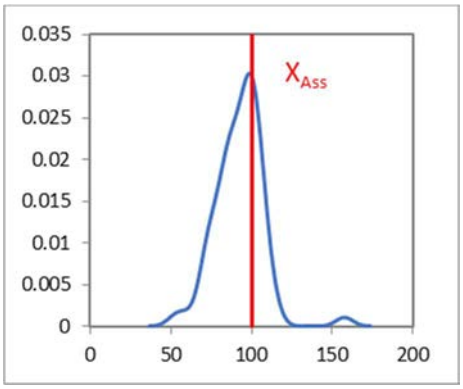


Performance evaluation: *z*-score Zeta-score



Evaluation of Reported data for Zn

Kernel density Plot



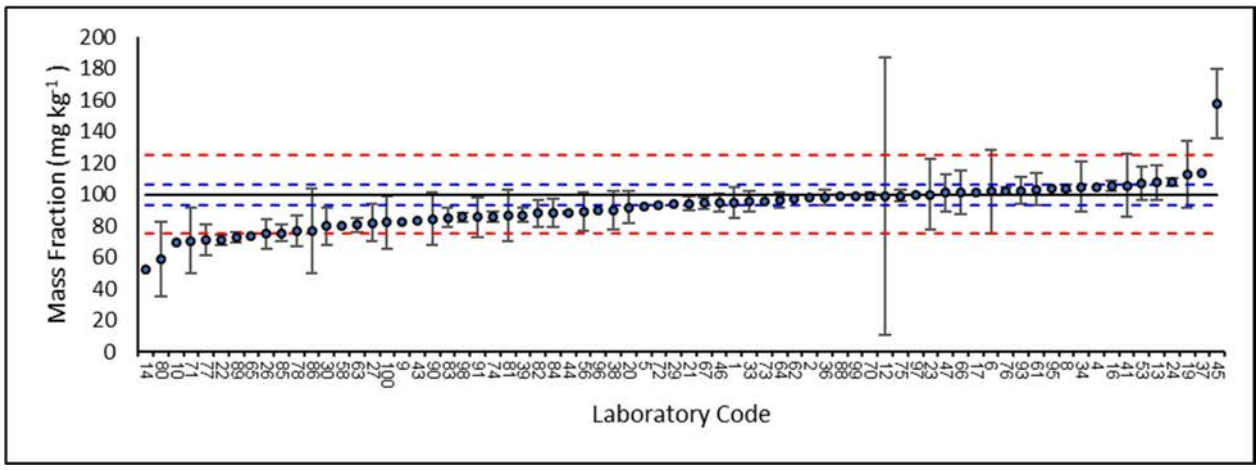
Summary of results:

	Satisfactory	Questionable	Unsatisfactory
z-score	88%	8%	4%
Zeta-score	59%	15%	26%

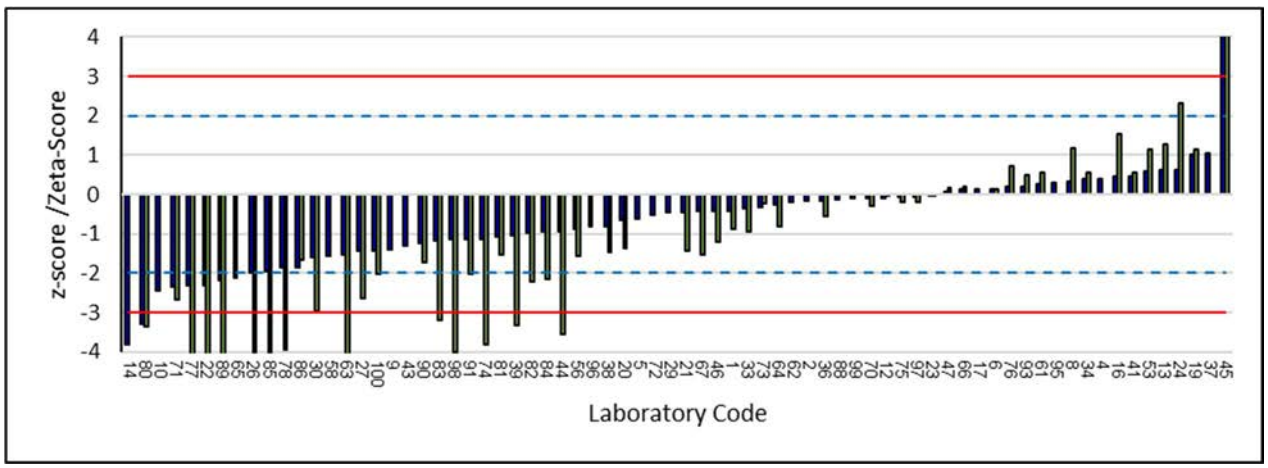
X_{ass}:	100 mg kg^{-1}
U_{ass} (k=2) :	6 mg kg^{-1}
$2\sigma_p$:	25 mg kg^{-1}
Number of results:	72
Number of method:	6

Reported results and expanded uncertainties:

— X_{ass} ; $\pm X_{lab} \pm U_{lab}$; ---- $X_{ass} \pm 2\sigma_p$; ---- $X_{ass} \pm U_{ass}(k=2)$



Performance evaluation: *z*-score Zeta-score



APPENDIX II

REPORTED RESULTS BY PARTICIPANTS

TABLE 5. REPORTED RESULTS BY PARTICPANTS

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
1	Ag	mg kg^{-1}	Yes	ICP-MS	0.250	0.050	2	n.a.	n.a.	SRM 2702
13	Ag	mg kg^{-1}	Yes	ICP-MS	0.380	0.080	2	n.a.	n.a.	MESS 3
17	Ag	mg kg^{-1}	Yes	ICP-MS	0.143			n.a.	n.a.	IAEA 458
18	Ag	mg kg^{-1}	No	ICP-MS	0.130			n.a.	n.a.	No QC reported
36	Ag	mg kg^{-1}	No Info	ICP-MS	0.135	0.030	3	n.a.	n.a.	MESS 3
37	Ag	mg kg^{-1}	Yes	ICP-MS	0.373			n.a.	n.a.	No QC reported
47	Ag	mg kg^{-1}	Yes	ICP-MS	0.087	0.014	2	n.a.	n.a.	No QC reported
53	Ag	mg kg^{-1}	Yes	ICP-MS	0.405	0.080	2	n.a.	n.a.	PACS 2
64	Ag	mg kg^{-1}	Yes	ICP-MS	0.111	0.013	2	n.a.	n.a.	IAEA 433
70	Ag	mg kg^{-1}	Yes	ET-AAS	0.063	0.022	2	n.a.	n.a.	IAEA 433
71	Ag	mg kg^{-1}	No	ICP-MS	0.061		2	n.a.	n.a.	No QC reported
72	Ag	mg kg^{-1}	Yes	ICP-MS	0.083			n.a.	n.a.	MESS 4
73	Ag	mg kg^{-1}	Yes	ET-AAS	0.227			n.a.	n.a.	MESS 3
80	Ag	mg kg^{-1}	No	ICP-MS	0.058	0.029	2	n.a.	n.a.	Oyster tissue
83	Ag	mg kg^{-1}	No	ICP-MS	0.055	0.002	1.96	n.a.	n.a.	No QC reported
84	Ag	mg kg^{-1}	No	ICP-MS	0.053	0.008	2	n.a.	n.a.	IAEA 407
95	Ag	mg kg^{-1}	Yes	ICP-MS	0.117			n.a.	n.a.	MESS 4
98	Ag	mg kg^{-1}	No	ICP-MS	0.183	0.020	2	n.a.	n.a.	IAEA 433
1	Al	g kg^{-1}	Yes	ICP-MS	64.9	9.7	2	-0.5	-0.7	SRM 2702
4	Al	g kg^{-1}	No	ICP-OES	62.1			-0.78		PACS 3

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
5	Al	g kg^{-1}	Yes	ICP-MS	36.0			-3.81		No QC reported
6	Al	g kg^{-1}	No	ICP-OES	77.2	13.9	2	1.0	1.1	No QC reported
8	Al	g kg^{-1}	Yes	ET-AAS	66.0	1.2	5.07	-0.3	-0.4	IAEA 433
9	Al	g kg^{-1}	No	ICP-MS	23100			2678.05		CANMET TILL1
12	Al	g kg^{-1}	No	NAA	69.4	0.8	2	0.1	0.2	IAEA 433
13	Al	g kg^{-1}	Yes	ICP-OES	70.3	3.8	2	0.2	0.4	MESS 3
16	Al	g kg^{-1}	No	ICP-OES	64.7	5.2	2	-0.5	-1.1	No QC reported
17	Al	g kg^{-1}	Yes	ICP-MS	45.0			-2.77		IAEA 458
18	Al	g kg^{-1}	No	ICP-MS	54.7			-1.64		No QC reported
20	Al	g kg^{-1}	Yes	F AAS	72.4	3.8	2	0.4	1.1	PACS 3
22	Al	g kg^{-1}	No	NAA	71492	5420	2	8305.0	26.4	IAEA SL1
23	Al	g kg^{-1}	No	XRF	75.3	19.0	2	0.8	0.7	MESS 4
24	Al	g kg^{-1}	Yes	ICP-MS	74.1	2.8	2.26	0.6	1.7	MESS 4
26	Al	g kg^{-1}	No	ICP-MS	25.7	3.7	2	-5.0	-12.7	CANMET TILL1
27	Al	g kg^{-1}	No	ICP-MS	27800	5100	2	3224.6	10.9	CANMET TILL1
29	Al	g kg^{-1}	Yes	F AAS	2.97			-7.65		IAEA 433
30	Al	g kg^{-1}	Yes	ICP-OES	14.1	1.0	2	-6.4	-19.2	No QC reported
36	Al	g kg^{-1}	No Info	ICP-MS	91.9	1.9	3	2.7	8.1	MESS 3
37	Al	g kg^{-1}	Yes	ICP-OES	45.6			-2.70		No QC reported
38	Al	g kg^{-1}	Yes	F AAS	68.7	9.9	2	0.0	0.0	WQB-1

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
41	Al	g kg^{-1}	Yes	ICP-OES	71.9	10.1	2	0.4	0.5	IAEA 158
44	Al	g kg^{-1}	No	XRF	77.1	25.4	2	1.0	0.6	ISE983-WEPAL
45	Al	g kg^{-1}	No	XRF	56667	300	2	6581.1	377.3	IAEA 433
47	Al	g kg^{-1}	Yes	ICP-MS	69.3	8.4	2	0.1	0.1	MESS 3
53	Al	g kg^{-1}	No	NAA	85.5	17.0	2	1.9	1.9	SRM 2709a
56	Al	g kg^{-1}	No	NAA	68.5	3.1	2	0.0	-0.1	SRM 2711a
61	Al	g kg^{-1}	No	XRF	45433	15000	2	5274.9	6.1	IAEA 457
62	Al	g kg^{-1}	Yes	ICP-OES	66.4			-0.28		MESS 4
64	Al	g kg^{-1}	Yes	ICP-MS	67.7	3.0	2	-0.1	-0.4	IAEA 433
65	Al	g kg^{-1}	Yes	F AAS	45.9			-2.66		IAEA 457
70	Al	g kg^{-1}	Yes	ICP-OES	71.8	2.1	2	0.4	1.0	IAEA 433
71	Al	g kg^{-1}	No	ICP-MS	16333	3270	2	1891.2	9.9	No QC reported
72	Al	g kg^{-1}	Yes	ICP-MS	75.0			0.72		MESS 4
75	Al	g kg^{-1}	Yes	ET-AAS	70.7	3.6	2	0.2	0.6	IAEA 158
77	Al	g kg^{-1}	Yes	ICP-OES	72.2	3.6	2	0.4	1.0	GBW7312
81	Al	g kg^{-1}	Yes	ICP-OES	70.4	15.9	2	0.2	0.2	NWTH2
82	Al	g kg^{-1}	Yes	ICP-OES	76.5	7.7	2	0.9	1.6	No QC reported
83	Al	g kg^{-1}	No	ICP-MS	53.3	2.2	1.96	-1.8	-5.2	IAEA 359
84	Al	g kg^{-1}	No	ICP-MS	44.2	5.3	2	-2.9	-6.4	IAEA 461
85	Al	g kg^{-1}	No	XRF	47.8	1.1	2	-2.4	-7.4	IAEA 433

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
86	Al	g kg^{-1}	Yes	ICP-MS	6.42	1.84	2	-7.3	-21.2	MESS 3
88	Al	g kg^{-1}	Yes	ICP-OES	80.3			1.34		MESS 3
90	Al	g kg^{-1}	No	ICP-MS	25.5	5.1	2	-5.0	-11.5	No QC reported
91	Al	g kg^{-1}	No	ICP-MS	29.0	6.4	2	-4.6	-9.4	CRM 015
93	Al	g kg^{-1}	Yes	ICP-OES	51.0	9.4	2	-2.1	-3.2	IAEA 458
95	Al	g kg^{-1}	Yes	ICP-MS	82.6			1.60		MESS 4
96	Al	g kg^{-1}	No Info	XRF	71.1			0.27		MESS 3
97	Al	g kg^{-1}	Yes	ICP-MS	61.2			-0.9	-2.7	MESS 3
98	Al	g kg^{-1}	No	ICP-MS	54217	1824	2	6296.3	59.4	IAEA 433
99	Al	g kg^{-1}	Yes	ICP-OES	33.3			-4.13		No QC reported
100	Al	g kg^{-1}	Yes	F AAS	70265	11242	2	8162.4	12.5	IAEA 458
1	As	mg kg^{-1}	Yes	ICP-MS	13.7	3.0	2	0.7	0.7	ERM-CC141
2	As	mg kg^{-1}	No	ET-AAS	13.3			0.41		SETOC 721
4	As	mg kg^{-1}	No	ICP-OES	9.00			-2.29		PACS 3
5	As	mg kg^{-1}	Yes	ICP-MS	10.2			-1.53		No QC reported
6	As	mg kg^{-1}	No	ICP-OES	18.0	6.8	2	3.4	1.6	sdps 2
8	As	mg kg^{-1}	Yes	ET-AAS	10.8	1.7	0.7	-1.2	-2.0	BS-1TM
9	As	mg kg^{-1}	No	ICP-MS	10.7			-1.22		CANMET TILL1
12	As	mg kg^{-1}	No	NAA	12.9	8.2	2	0.2	0.1	IAEA 433
13	As	mg kg^{-1}	Yes	ICP-OES	11.1	1.2	2	-1.0	-2.2	MESS 3

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
16	As	mg kg^{-1}	No	ICP-MS	11.3	0.3	2	-0.8	-3.3	No QC reported
17	As	mg kg^{-1}	Yes	ICP-MS	13.8			0.74		IAEA 458
19	As	mg kg^{-1}	Yes	ICP-MS	15.6	3.0	2	1.9	2.0	IAEA SL1
23	As	mg kg^{-1}	No	XRF	16.6	6.0	2	2.5	1.3	MESS 4
24	As	mg kg^{-1}	No	Hyd-AAS	16.6	0.6	2.26	2.5	8.5	MESS 4
26	As	mg kg^{-1}	No	ICP-MS	10.8	1.2	2	-1.2	-2.7	CANMET TILL1
27	As	mg kg^{-1}	No	ICP-MS	10.7	1.8	2	-1.2	-1.9	CANMET TILL1
29	As	mg kg^{-1}	No Info	No info	1.54			-7.03		No QC reported
34	As	mg kg^{-1}	Yes	ICP-MS	12.8	1.0	2	0.1	0.3	MESS 3
36	As	mg kg^{-1}	No Info	ICP-MS	8.4	1.8	3	2.6	5.9	MESS 3
37	As	mg kg^{-1}	Yes	ICP-MS	11.9			-0.48		No QC reported
38	As	mg kg^{-1}	Yes	Hyd-AAS	10.3	1.6	2	-1.5	-2.6	WQB-1
39	As	mg kg^{-1}	No	ICP-MS	10.3	0.8	2	-1.4	-4.2	LGC 6187
41	As	mg kg^{-1}	Yes	F AAS	11.4	20.3	2	-0.8	-0.1	IAEA 158
43	As	mg kg^{-1}	No	ICP-MS	11.5			-0.71		No QC reported
44	As	mg kg^{-1}	No	XRF	11.5	0.4	2	-0.7	-2.6	ISE983-WEPAL
46	As	mg kg^{-1}	Yes	ICP-MS	10.0	1.5	2	-1.6	-3.1	M-2 BotSed
47	As	mg kg^{-1}	Yes	ICP-MS	12.8	1.6	2	0.1	0.2	MESS 3
52	As	mg kg^{-1}	No	ET-AAS	0.890			-7.44		No QC reported
53	As	mg kg^{-1}	No	NAA	12.3	2.4	2	-0.2	-0.3	SRM 2711a

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
56	As	mg kg^{-1}	No	NAA	11.7	1.4	2	-0.6	-1.2	SRM 2711a
62	As	mg kg^{-1}	Yes	ICP-MS	13.4			0.48		MESS 4
63	As	mg kg^{-1}	No	Hyd-AAS	11.4	0.4	2	-0.8	-2.9	RT 008
64	As	mg kg^{-1}	Yes	ICP-MS	10.3	0.6	2	-1.5	-4.9	IAEA 433
66	As	mg kg^{-1}	No	Hyd-AAS	13.1	2.6	2	0.3	0.4	IAEA 433
70	As	mg kg^{-1}	Yes	ICP-OES	16.3	3.0	2	2.3	2.4	IAEA 433
71	As	mg kg^{-1}	No	ICP-MS	10.8	1.3	2	-1.1	-2.4	No QC reported
72	As	mg kg^{-1}	Yes	ICP-MS	12.5			-0.10		MESS 4
73	As	mg kg^{-1}	Yes	Hyd-AAS	15.7			1.9	1.1	MESS 3
75	As	mg kg^{-1}	Yes	ET-AAS	11.1	0.8	2	-1.0	-2.8	IAEA 158
76	As	mg kg^{-1}	No	other	14.5	3.5	2	1.2	1.1	BS-1TM
78	As	mg kg^{-1}	No	ICP-MS	16.6	1.9	2	2.5	3.9	MESS 4
80	As	mg kg^{-1}	No	ICP-MS	8.65	3.44	2	-2.5	-2.3	Oyster Tissue
81	As	mg kg^{-1}	Yes	ICP-MS	12.2	3.8	2	-0.3	-0.2	NWTH2
82	As	mg kg^{-1}	No	ICP-OES	13.2	1.4	2	0.4	0.7	No QC reported
83	As	mg kg^{-1}	No	ICP-MS	12.7	1.3	1.96	0.0	0.1	IAEA 359
84	As	mg kg^{-1}	No	ICP-MS	11.3	1.4	2	-0.8	-1.7	IAEA 461
85	As	mg kg^{-1}	No	XRF	11.0	0.4	2	-1.0	-3.7	IAEA 433
86	As	mg kg^{-1}	Yes	ICP-MS	10.9	3.0	2	-1.1	-1.1	MESS 3
88	As	mg kg^{-1}	Yes	ICP-MS	10.1			-1.60		MESS 3

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
89	As	mg kg^{-1}	No	ICP-MS	10.6	1.2	2	-1.3	-2.8	PACS 1
90	As	mg kg^{-1}	No	ICP-MS	11.2	2.2	2	-0.9	-1.3	No QC reported
91	As	mg kg^{-1}	No	ICP-MS	9.75	1.48	2	-1.8	-3.5	CRM 015
92	As	mg kg^{-1}	No	NAA	13.1	1.6	2	0.3	0.6	Coal Fly Ash
93	As	mg kg^{-1}	Yes	ICP-OES	13.3	2.0	2	0.4	0.6	IAEA 458
95	As	mg kg^{-1}	Yes	ICP-MS	13.2			0.36		MESS 4
97	As	mg kg^{-1}	Yes	ICP-MS	12.6			0.0	0.1	MESS 3
98	As	mg kg^{-1}	No	ICP-MS	29.4	10.0	2	10.7	3.4	IAEA 433
1	Cd	mg kg^{-1}	Yes	ICP-MS	0.160	0.040	2	n.a.	n.a.	ERM-CC141
2	Cd	mg kg^{-1}	No	ET-AAS	0.042			n.a.	n.a.	IAEA 433
6	Cd	mg kg^{-1}	No	ET-AAS	0.044	0.044	2	n.a.	n.a.	sdps 2
8	Cd	mg kg^{-1}	Yes	ET-AAS	0.080	0.004	0.002	n.a.	n.a.	BS-1TM
9	Cd	mg kg^{-1}	No	ICP-MS	0.053			n.a.	n.a.	CANMET TILL1
10	Cd	mg kg^{-1}	No	ET-AAS	0.042			n.a.	n.a.	GSJ JLK-1
13	Cd	mg kg^{-1}	Yes	ICP-MS	0.044	0.044	2	n.a.	n.a.	MESS 3
14	Cd	mg kg^{-1}	No	ET-AAS	0.027			n.a.	n.a.	No QC reported
17	Cd	mg kg^{-1}	Yes	ICP-MS	0.090			n.a.	n.a.	IAEA 458
18	Cd	mg kg^{-1}	No	ICP-MS	0.390			n.a.	n.a.	No QC reported
19	Cd	mg kg^{-1}	Yes	ICP-MS	0.214	0.040	2	n.a.	n.a.	IAEA SL1
20	Cd	mg kg^{-1}	Yes	ET-AAS	0.155	0.040	2	n.a.	n.a.	PACS 3

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
21	Cd	mg kg^{-1}	No Info	No info	0.214	0.006	2	n.a.	n.a.	SRM 2702
24	Cd	mg kg^{-1}	Yes	ICP-MS	0.135	0.013	2.26	n.a.	n.a.	MESS 4
26	Cd	mg kg^{-1}	No	ICP-MS	0.057	0.008	2	n.a.	n.a.	CANMET TILL1
27	Cd	mg kg^{-1}	No	ICP-MS	0.052	0.012	2	n.a.	n.a.	CANMET TILL1
29	Cd	mg kg^{-1}	Yes	ET-AAS	0.135			n.a.	n.a.	IAEA 433
30	Cd	mg kg^{-1}	Yes	ICP-OES	0.268	0.084	2	n.a.	n.a.	No QC reported
33	Cd	mg kg^{-1}	Yes	ET-AAS	0.063	0.040	2	n.a.	n.a.	IAEA 433
34	Cd	mg kg^{-1}	Yes	ICP-MS	0.116	0.068	2	n.a.	n.a.	MESS 3
36	Cd	mg kg^{-1}	No Info	ICP-MS	0.117	0.018	3	n.a.	n.a.	MESS 3
37	Cd	mg kg^{-1}	Yes	ICP-MS	0.267			n.a.	n.a.	No QC reported
38	Cd	mg kg^{-1}	No	F AAS	0.151	0.035	2	n.a.	n.a.	WQB-1
41	Cd	mg kg^{-1}	Yes	ET-AAS	0.110	22.000	2	n.a.	n.a.	IAEA 158
47	Cd	mg kg^{-1}	Yes	ICP-MS	0.071	0.022	2	n.a.	n.a.	MESS 3
52	Cd	mg kg^{-1}	No	ET-AAS	0.035			n.a.	n.a.	No QC reported
53	Cd	mg kg^{-1}	Yes	ICP-MS	0.144	0.040	2	n.a.	n.a.	PACS 2
58	Cd	mg kg^{-1}	No	F AAS	1.72			n.a.	n.a.	No QC reported
62	Cd	mg kg^{-1}	Yes	ICP-MS	0.076			n.a.	n.a.	MESS 4
64	Cd	mg kg^{-1}	Yes	ICP-MS	0.099	0.010	2	n.a.	n.a.	IAEA 433
66	Cd	mg kg^{-1}	No	ET-AAS	0.120	0.020	2	n.a.	n.a.	IAEA 433
67	Cd	mg kg^{-1}	Yes	ET-AAS	0.067	0.004		n.a.	n.a.	IAEA 433

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
70	Cd	mg kg^{-1}	Yes	ET-AAS	0.064	0.010	2	n.a.	n.a.	IAEA 433
71	Cd	mg kg^{-1}	No	ICP-MS	0.079		2	n.a.	n.a.	No QC reported
72	Cd	mg kg^{-1}	Yes	ICP-MS	0.100			n.a.	n.a.	MESS 4
73	Cd	mg kg^{-1}	Yes	ET-AAS	0.019			n.a.	n.a.	MESS 3
78	Cd	mg kg^{-1}	No	ICP-MS	0.098	0.012	2	n.a.	n.a.	MESS 4
80	Cd	mg kg^{-1}	No	ICP-MS	0.057	0.023	2	n.a.	n.a.	Oyster Tissue
81	Cd	mg kg^{-1}	Yes	ICP-MS	0.115	9.710	2	n.a.	n.a.	NWTH2
83	Cd	mg kg^{-1}	No	ICP-MS	0.055	0.007	1.96	n.a.	n.a.	IAEA 359
84	Cd	mg kg^{-1}	No	ICP-MS	0.056	0.007	2	n.a.	n.a.	IAEA 407
85	Cd	mg kg^{-1}	No	XRF	0.073	0.006	2	n.a.	n.a.	IAEA 433
86	Cd	mg kg^{-1}	Yes	ICP-MS	0.059	0.020	2	n.a.	n.a.	MESS 3
89	Cd	mg kg^{-1}	No	ICP-MS	0.070	0.000	2	n.a.	n.a.	PACS 1
90	Cd	mg kg^{-1}	No	ICP-MS	0.055	0.011	2	n.a.	n.a.	No QC reported
91	Cd	mg kg^{-1}	No	ICP-MS	0.259	0.038	2	n.a.	n.a.	LGC 6187
95	Cd	mg kg^{-1}	Yes	ICP-MS	0.121			n.a.	n.a.	MESS 4
96	Cd	mg kg^{-1}	No Info	ET-AAS	0.024			n.a.	n.a.	PACS 2
97	Cd	mg kg^{-1}	Yes	ICP-MS	0.160			n.a.	n.a.	MESS 3
98	Cd	mg kg^{-1}	No	ICP-MS	0.141	0.060	2	n.a.	n.a.	IAEA 433
100	Cd	mg kg^{-1}	Yes	ET-AAS	0.049	0.015	2	n.a.	n.a.	IAEA 458
1	Co	mg kg^{-1}	Yes	ICP-MS	13.6	2.6	2	0.8	0.9	ERM-CC141

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
4	Co	mg kg^{-1}	No	ICP-OES	14.0			1.06		PACS 3
5	Co	mg kg^{-1}	Yes	ICP-MS	8.03			-2.80		No QC reported
6	Co	mg kg^{-1}	No	ICP-OES	13.6	3.8	2	0.8	0.7	sdps 2
8	Co	mg kg^{-1}	Yes	ET-AAS	11.7	0.7	0.29	-0.4	-1.4	IAEA 433
9	Co	mg kg^{-1}	No	ICP-MS	10.7			-1.07		CANMET TILL1
12	Co	mg kg^{-1}	No	NAA	11.9	0.6	2	-0.3	-1.1	IAEA 433
13	Co	mg kg^{-1}	Yes	ICP-OES	11.0	3.1	2	-0.9	-0.9	MESS 3
16	Co	mg kg^{-1}	No	ICP-MS	12.5	0.2	2	0.1	0.6	No QC reported
17	Co	mg kg^{-1}	Yes	ICP-MS	11.2			-0.74		IAEA 458
19	Co	mg kg^{-1}	Yes	ICP-MS	11.1	2.1	2	-0.8	-1.2	IAEA SL1
21	Co	mg kg^{-1}	No Info	No info	12.8	0.6	2	0.3	1.2	SRM 2702
22	Co	mg kg^{-1}	No	NAA	12.3	0.7	2	0.0	-0.2	IAEA SL1
24	Co	mg kg^{-1}	Yes	ICP-MS	13.9	0.3	2.26	1.0	5.2	MESS 4
26	Co	mg kg^{-1}	No	ICP-MS	10.2	1.4	2	-1.4	-2.8	CANMET TILL1
27	Co	mg kg^{-1}	No	ICP-MS	10.7	2.0	2	-1.1	-1.6	CANMET TILL1
29	Co	mg kg^{-1}	Yes	F AAS	12.5			0.10		IAEA 433
30	Co	mg kg^{-1}	Yes	ICP-OES	14.3	5.3	2	1.2	0.7	No QC reported
34	Co	mg kg^{-1}	Yes	ICP-MS	11.3	1.4	2	-0.7	-1.4	MESS 3
36	Co	mg kg^{-1}	No Info	ICP-MS	12.1	0.6	3	-0.1	-0.7	MESS 3
37	Co	mg kg^{-1}	Yes	ICP-MS	12.6			0.18		No QC reported

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
39	Co	mg kg^{-1}	No	ICP-MS	10.8	1.9	2	-1.0	-1.6	SRM 2702
43	Co	mg kg^{-1}	No	ICP-MS	11.0			-0.88		No QC reported
45	Co	mg kg^{-1}	No	XRF	118	47	2	68.2	4.5	IAEA 433
46	Co	mg kg^{-1}	No	NAA	12.4	0.7	2	0.0	0.2	INCT OBTL-5
47	Co	mg kg^{-1}	Yes	ICP-MS	12.2	1.4	2	-0.1	-0.2	No QC reported
53	Co	mg kg^{-1}	No	NAA	12.1	2.4	2	-0.2	-0.2	SRM 2709a
56	Co	mg kg^{-1}	No	NAA	12.2	1.1	2	-0.1	-0.2	SRM 2711a
62	Co	mg kg^{-1}	Yes	ICP-MS	12.6			0.13		MESS 4
64	Co	mg kg^{-1}	Yes	ICP-MS	11.9	0.4	2	-0.3	-1.3	IAEA 433
65	Co	mg kg^{-1}	Yes	F AAS	47.8			22.97		IAEA 457
66	Co	mg kg^{-1}	No	F AAS	12.4	2.5	2	0.1	0.1	IAEA 433
70	Co	mg kg^{-1}	Yes	F AAS	12.0	2.9	2	-0.2	-0.2	IAEA 433
71	Co	mg kg^{-1}	No	ICP-MS	10.6	0.7	2	-1.1	-3.8	No QC reported
72	Co	mg kg^{-1}	Yes	ICP-MS	11.6			-0.49		MESS 4
73	Co	mg kg^{-1}	Yes	ET-AAS	14.6			1.5	0.8	MESS 3
75	Co	mg kg^{-1}	Yes	ET-AAS	11.3	0.9	2	-0.7	-1.9	IAEA 158
76	Co	mg kg^{-1}	Yes	F AAS	17.0	6.0	2	3.0	1.5	BS-1TM
78	Co	mg kg^{-1}	No	ICP-MS	11.8	2.4	2	-0.4	-0.5	MESS 4
80	Co	mg kg^{-1}	No	ICP-MS	8.10	3.24	2	-2.8	-2.6	Oyster tissue
82	Co	mg kg^{-1}	Yes	ICP-OES	12.1	1.3	2	-0.2	-0.4	No QC reported

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
83	Co	mg kg^{-1}	No	ICP-MS	10.4	2.1	1.96	-1.2	-1.7	No QC reported
84	Co	mg kg^{-1}	No	ICP-MS	12.0	1.5	2	-0.2	-0.4	IAEA 461
85	Co	mg kg^{-1}	No	XRF	10.8	0.4	2	-1.0	-4.6	IAEA 433
86	Co	mg kg^{-1}	Yes	ICP-MS	9.52	4.34	2	-1.8	-1.3	MESS 3
88	Co	mg kg^{-1}	Yes	ICP-MS	12.8			0.31		MESS 3
89	Co	mg kg^{-1}	No	ICP-OES	10.9	0.3	2	-1.0	-5.0	PACS 1
90	Co	mg kg^{-1}	No	ICP-MS	11.2	2.2	2	-0.8	-1.1	No QC reported
91	Co	mg kg^{-1}	No	ICP-MS	10.5	1.6	2	-1.2	-2.2	CRM 015
92	Co	mg kg^{-1}	No	NAA	14.4	1.1	2	1.3	3.3	SRM 2711a
95	Co	mg kg^{-1}	Yes	ICP-MS	13.0			0.39		MESS 4
96	Co	mg kg^{-1}	No Info	F AAS	11.4			-0.63		PACS 2
97	Co	mg kg^{-1}	Yes	ICP-MS	12.6			0.1	0.8	MESS 3
98	Co	mg kg^{-1}	No	ICP-MS	11.5	2.0	2	-0.5	-0.8	IAEA 433
1	Cr	mg kg^{-1}	Yes	ICP-MS	71.1	16.9	2	0.6	0.6	SRM 2702
2	Cr	mg kg^{-1}	No	ET-AAS	47.3			-2.25		SETOC 721
4	Cr	mg kg^{-1}	No	ICP-OES	68.0			0.27		PACS 3
5	Cr	mg kg^{-1}	Yes	ICP-MS	53.7			-1.47		No QC reported
6	Cr	mg kg^{-1}	No	ICP-OES	53.7	31.2	2	-1.5	-0.8	sdps 2
8	Cr	mg kg^{-1}	Yes	ET-AAS	74.3	7.8	3.17	1.0	2.1	IAEA 433
9	Cr	mg kg^{-1}	No	ICP-MS	40.1			-3.12		CANMET TILL1

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
12	Cr	mg kg^{-1}	No	NAA	65.7	9.0	2	0.0	0.0	IAEA 433
13	Cr	mg kg^{-1}	Yes	ICP-OES	53.3	4.0	2	-1.5	-5.0	MESS 3
16	Cr	mg kg^{-1}	No	ICP-MS	74.1	1.7	2	1.0	5.0	No QC reported
17	Cr	mg kg^{-1}	No	ICP-MS	59.6			-0.75		IAEA 458
18	Cr	mg kg^{-1}	No	ICP-MS	26.9			-4.73		No QC reported
19	Cr	mg kg^{-1}	Yes	ICP-MS	55.3	10.5	2	-1.3	-1.9	IAEA SL1
23	Cr	mg kg^{-1}	No	XRF	64.0	32.0	2	-0.2	-0.1	MESS 4
24	Cr	mg kg^{-1}	Yes	ICP-MS	43.6	3.8	2.26	-2.7	-9.9	MESS 4
26	Cr	mg kg^{-1}	No	ICP-MS	41.6	5.2	2	-2.9	-8.1	CANMET TILL1
27	Cr	mg kg^{-1}	No	ICP-MS	42.1	7.9	2	-2.9	-5.6	CANMET TILL1
29	Cr	mg kg^{-1}	Yes	ET-AAS	16.6			-5.98		No QC reported
30	Cr	mg kg^{-1}	Yes	ICP-OES	37.4	7.1	2	-3.5	-7.4	No QC reported
33	Cr	mg kg^{-1}	Yes	ET-AAS	64.3	10.0	2	-0.2	-0.3	IAEA 433
34	Cr	mg kg^{-1}	Yes	ICP-MS	66.1	7.6	2	0.0	0.1	MESS 3
36	Cr	mg kg^{-1}	No Info	ICP-MS	62.4	1.7	3	-0.4	-2.2	MESS 3
37	Cr	mg kg^{-1}	Yes	ICP-MS	63.9			-0.23		No QC reported
38	Cr	mg kg^{-1}	Yes	F AAS	69.0	12.0	2	0.4	0.5	WQB-1
39	Cr	mg kg^{-1}	No	ICP-MS	54.9	8.2	2	-1.3	-2.5	LGC 6187
41	Cr	mg kg^{-1}	Yes	ICP-OES	64.0	16.4	2	-0.2	-0.2	IAEA 158
43	Cr	mg kg^{-1}	No	ICP-MS	44.0			-2.65		No QC reported

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
44	Cr	mg kg^{-1}	No	XRF	60.3	3.7	2	-0.7	-2.4	ISE983-WEPAL
45	Cr	mg kg^{-1}	No	XRF	117	21	2	6.3	4.9	IAEA 433
46	Cr	mg kg^{-1}	No	NAA	142	14	2	9.3	10.7	No QC reported
47	Cr	mg kg^{-1}	Yes	ICP-MS	63.4	7.6	2	-0.3	-0.6	MESS 3
53	Cr	mg kg^{-1}	No	NAA	50.9	10.2	2	-1.8	-2.8	IAEA SL1
56	Cr	mg kg^{-1}	No	NAA	56.8	5.1	2	-1.1	-3.1	SRM 2711a
61	Cr	mg kg^{-1}	No	XRF	82.3	16.0	2	2.0	2.0	IAEA 457
62	Cr	mg kg^{-1}	Yes	ICP-MS	64.5			-0.16		No QC reported
64	Cr	mg kg^{-1}	Yes	ICP-MS	66.4	1.6	2	0.1	0.4	IAEA 433
65	Cr	mg kg^{-1}	Yes	F AAS	145			9.60		IAEA 457
66	Cr	mg kg^{-1}	No	F AAS	95.7	18.5	2	3.6	3.2	No QC reported
67	Cr	mg kg^{-1}	Yes	F AAS	55.6	1.8		-1.2	-6.3	IAEA 433
70	Cr	mg kg^{-1}	Yes	ICP-OES	66.3	5.2	2	0.1	0.2	IAEA 433
71	Cr	mg kg^{-1}	No	ICP-MS	37.2	7.4	2	-3.5	-7.2	No QC reported
72	Cr	mg kg^{-1}	Yes	ICP-MS	61.8			-0.49		MESS 4
73	Cr	mg kg^{-1}	Yes	ET-AAS	68.7			0.4	0.2	MESS 3
74	Cr	mg kg^{-1}	No	F AAS	80.0	5.8	2	1.7	4.4	IAEA 405
75	Cr	mg kg^{-1}	Yes	ET-AAS	71.5	3.3	2	0.7	2.6	IAEA 158
76	Cr	mg kg^{-1}	Yes	F AAS	38.5			-3.32		BS-1TM
78	Cr	mg kg^{-1}	No	ICP-MS	66.7	10.8	2	0.1	0.2	MESS 4

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
80	Cr	mg kg^{-1}	No	ICP-MS	41.1	24.6	2	-3.0	-2.0	TORT 3
81	Cr	mg kg^{-1}	Yes	ICP-MS	59.1	4.1	2	-0.8	-2.7	NWTH2
82	Cr	mg kg^{-1}	Yes	ICP-OES	34.7	3.5	2	-3.8	-13.7	No QC reported
83	Cr	mg kg^{-1}	No	ICP-MS	51.3	2.8	1.96	-1.8	-7.1	IAEA 359
84	Cr	mg kg^{-1}	No	ICP-MS	51.4	10.3	2	-1.7	-2.7	IAEA 461
85	Cr	mg kg^{-1}	No	XRF	43.0	3.2	2	-2.8	-10.5	IAEA 433
86	Cr	mg kg^{-1}	Yes	ICP-MS	47.3	21.4	2	-2.3	-1.7	MESS 3
88	Cr	mg kg^{-1}	Yes	ICP-OES	60.0			-0.70		MESS 3
90	Cr	mg kg^{-1}	No	ICP-MS	44.4	8.9	2	-2.6	-4.6	No QC reported
91	Cr	mg kg^{-1}	No	ICP-MS	41.3	6.2	2	-3.0	-7.2	CRM 015
92	Cr	mg kg^{-1}	No	NAA	70.1	3.6	2	0.5	1.9	SRM 2711a
93	Cr	mg kg^{-1}	Yes	ICP-OES	64.4	8.0	2	-0.2	-0.3	IAEA 458
95	Cr	mg kg^{-1}	Yes	ICP-MS	72.1			0.78		MESS 4
97	Cr	mg kg^{-1}	Yes	ICP-MS	67.9			0.3	1.3	MESS 3
98	Cr	mg kg^{-1}	No	ICP-MS	54.0	3.6	2	-1.4	-5.1	IAEA 433
99	Cr	mg kg^{-1}	Yes	ICP-OES	58.0			-0.95		CRM 7002
100	Cr	mg kg^{-1}	Yes	ET-AAS	6.95	2.78	2	-7.2	-29.4	IAEA 458
1	Cu	mg kg^{-1}	Yes	ICP-MS	25.9	5.1	2	-0.5	-0.6	ERM-CC141
2	Cu	mg kg^{-1}	No	ET-AAS	24.9			-0.75		SETOC 721
4	Cu	mg kg^{-1}	No	ICP-OES	31.0			1.03		PACS 3

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
5	Cu	mg kg^{-1}	Yes	ICP-MS	17.0			-3.06		No QC reported
6	Cu	mg kg^{-1}	No	ICP-OES	25.4	7.6	2	-0.6	-0.5	sdps 2
8	Cu	mg kg^{-1}	Yes	ET-AAS	25.9	0.8	0.34	-0.4	-1.5	IAEA 433
9	Cu	mg kg^{-1}	No	ICP-MS	23.8			-1.07		CANMET TILL1
10	Cu	mg kg^{-1}	No	F AAS	23.8			-1.08		GSJ JLK-1
13	Cu	mg kg^{-1}	Yes	ICP-OES	24.4	2.3	2	-0.9	-2.0	MESS 3
16	Cu	mg kg^{-1}	No	ICP-MS	23.5	0.5	2	-1.2	-4.2	No QC reported
17	Cu	mg kg^{-1}	Yes	ICP-MS	26.6			-0.25		IAEA 458
18	Cu	mg kg^{-1}	No	ICP-MS	15.4			-3.52		No QC reported
19	Cu	mg kg^{-1}	Yes	ICP-MS	26.9	5.1	2	-0.2	-0.2	IAEA SL1
20	Cu	mg kg^{-1}	Yes	F AAS	30.4	2.4	2	0.9	1.9	PACS 3
21	Cu	mg kg^{-1}	No Info	No info	27.0	2.2	2	-0.1	-0.3	SRM 2702
23	Cu	mg kg^{-1}	No	XRF	28.3	8.5	2	0.2	0.2	MESS 4
24	Cu	mg kg^{-1}	Yes	ICP-MS	32.0	0.5	2.26	1.3	4.8	MESS 4
26	Cu	mg kg^{-1}	No	ICP-MS	23.9	3.0	2	-1.0	-2.0	CANMET TILL1
27	Cu	mg kg^{-1}	No	ICP-MS	23.7	3.8	2	-1.1	-1.8	CANMET TILL1
29	Cu	mg kg^{-1}	Yes	ET-AAS	27.1			-0.10		IAEA 433
30	Cu	mg kg^{-1}	Yes	ICP-OES	38.3	4.4	2	3.2	4.5	No QC reported
33	Cu	mg kg^{-1}	Yes	ET-AAS	26.8	3.4	2	-0.2	-0.3	IAEA 433
34	Cu	mg kg^{-1}	Yes	ICP-MS	26.9	5.2	2	-0.2	-0.2	MESS 3

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
36	Cu	mg kg^{-1}	No Info	ICP-MS	27.1	1.5	3	-0.1	-0.3	MESS 3
37	Cu	mg kg^{-1}	Yes	ICP-MS	29.0			0.43		No QC reported
38	Cu	mg kg^{-1}	Yes	F AAS	27.9	3.2	2	0.1	0.2	WQB-1
39	Cu	mg kg^{-1}	No	ICP-MS	22.1	1.3	2	-1.6	-4.8	LGC 6187
41	Cu	mg kg^{-1}	Yes	ICP-OES	41.6	15.7	2	4.1	1.9	IAEA 158
43	Cu	mg kg^{-1}	No	ICP-MS	26.1			-0.40		No QC reported
44	Cu	mg kg^{-1}	No	XRF	20.3	0.6	2	-2.1	-7.4	ISE983-WEPAL
45	Cu	mg kg^{-1}	No	XRF	43.0	14.0	2	4.5	2.2	IAEA 433
46	Cu	mg kg^{-1}	Yes	ICP-MS	26.3	2.6	2	-0.4	-0.8	M-2 BotSed
47	Cu	mg kg^{-1}	Yes	ICP-MS	27.8	3.4	2	0.1	0.2	MESS 3
53	Cu	mg kg^{-1}	Yes	ICP-MS	27.5	5.4	2	0.0	0.0	PACS 2
56	Cu	mg kg^{-1}	No	F AAS	24.9	2.1	2	-0.8	-1.9	SRM 2711a
58	Cu	mg kg^{-1}	No	F AAS	23.9			-1.04		No QC reported
61	Cu	mg kg^{-1}	No	XRF	42.0	16.0	2	4.2	1.8	IAEA 457
62	Cu	mg kg^{-1}	Yes	ICP-MS	28.4			0.25		MESS 4
63	Cu	mg kg^{-1}	No	F AAS	26.4	2.8	2	-0.3	-0.6	RT 008
64	Cu	mg kg^{-1}	Yes	ICP-MS	26.8	1.4	2	-0.2	-0.6	IAEA 433
65	Cu	mg kg^{-1}	Yes	F AAS	22.4			-1.49		IAEA 457
66	Cu	mg kg^{-1}	No	F AAS	26.8	5.4	2	-0.2	-0.3	IAEA 433
67	Cu	mg kg^{-1}	Yes	F AAS	28.1	0.6		0.2	0.6	IAEA 433

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
68	Cu	mg kg^{-1}	No Info	F AAS	25.8	0.0	2	-0.5	-1.8	No QC reported
70	Cu	mg kg^{-1}	Yes	F AAS	27.8	2.1	2	0.1	0.3	IAEA 433
71	Cu	mg kg^{-1}	No	ICP-MS	26.4	5.4	2	-0.3	-0.4	No QC reported
72	Cu	mg kg^{-1}	Yes	ICP-MS	26.8			-0.19		MESS 4
73	Cu	mg kg^{-1}	Yes	ET-AAS	28.3			0.2	0.1	MESS 3
74	Cu	mg kg^{-1}	No	F AAS	129	8	2	29.5	24.6	IAEA 405
75	Cu	mg kg^{-1}	Yes	ET-AAS	26.6	1.0	2	-0.3	-0.9	IAEA 158
76	Cu	mg kg^{-1}	Yes	F AAS	27.8	2.7	2	0.1	0.2	BS-1TM
78	Cu	mg kg^{-1}	No	ICP-MS	26.1	2.7	2	-0.4	-0.9	MESS 4
80	Cu	mg kg^{-1}	No	ICP-MS	24.6	12.5	2	-0.8	-0.5	TORT 3
81	Cu	mg kg^{-1}	Yes	ICP-MS	25.9	4.8	2	-0.5	-0.6	NWTH2
82	Cu	mg kg^{-1}	Yes	ICP-OES	23.2	2.4	2	-1.2	-2.8	No QC reported
83	Cu	mg kg^{-1}	No	ICP-MS	23.2	1.4	1.96	-1.3	-3.7	IAEA 359
84	Cu	mg kg^{-1}	No	ICP-MS	25.7	2.6	2	-0.5	-1.1	IAEA 461
85	Cu	mg kg^{-1}	No	XRF	23.1	2.3	2	-1.3	-3.0	IAEA 433
86	Cu	mg kg^{-1}	Yes	ICP-MS	22.0	8.4	2	-1.6	-1.3	MESS 3
88	Cu	mg kg^{-1}	Yes	ICP-OES	27.0			-0.14		MESS 3
89	Cu	mg kg^{-1}	No	ICP-OES	21.8	1.1	2	-1.6	-5.3	PACS 2
90	Cu	mg kg^{-1}	No	ICP-MS	27.2	5.4	2	-0.1	-0.1	No QC reported
91	Cu	mg kg^{-1}	No	ICP-MS	22.8	3.4	2	-1.4	-2.4	CRM 015

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
93	Cu	mg kg^{-1}	Yes	ICP-OES	29.8	4.2	2	0.7	1.0	IAEA 458
95	Cu	mg kg^{-1}	Yes	ICP-MS	29.0			0.46		MESS 4
96	Cu	mg kg^{-1}	No Info	F AAS	22.9			-1.34		PACS 2
97	Cu	mg kg^{-1}	Yes	ICP-MS	29.2			0.5	1.8	MESS 3
98	Cu	mg kg^{-1}	No	ICP-MS	24.0	4.6	2	-1.0	-1.4	IAEA 433
99	Cu	mg kg^{-1}	Yes	ICP-OES	25.7			-0.53		CRM 7002
100	Cu	mg kg^{-1}	Yes	F AAS	27.6	5.5	2	0.0	0.0	IAEA 458
1	Fe	g kg^{-1}	Yes	ICP-MS	32.9	1.6	2	-0.3	-1.0	SRM 2702
2	Fe	g kg^{-1}	No	F AAS	32.4			0.41		IAEA 433
4	Fe	g kg^{-1}	No	ICP-OES	32.2			-0.45		PACS 3
5	Fe	g kg^{-1}	Yes	ICP-MS	36.2			0.49		No QC reported
6	Fe	g kg^{-1}	No	ICP-OES	37.5	7.5	2	0.8	0.9	No QC reported
8	Fe	g kg^{-1}	Yes	ET-AAS	34.8	0.7	0.29	0.2	0.7	BS-1TM
9	Fe	g kg^{-1}	No	ICP-MS	27800			6503.26		CANMET TILL1
12	Fe	g kg^{-1}	No	NAA	34.4	1.0	2	0.0	0.2	IAEA 433
13	Fe	g kg^{-1}	Yes	ICP-OES	33.8	1.7	2	-0.1	-0.3	MESS 3
16	Fe	g kg^{-1}	No	ICP-OES	31.9	3.5	2	-0.5	-1.2	No QC reported
17	Fe	g kg^{-1}	Yes	ICP-MS	33.7			-0.11		IAEA 458
18	Fe	g kg^{-1}	No	ICP-MS	32.4			-0.41		No QC reported
19	Fe	g kg^{-1}	Yes	ICP-MS	34138	6486	2	7987.8	10.5	IAEA SL1

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
20	Fe	g kg^{-1}	Yes	F AAS	34.7	3.0	2	0.1	0.3	PACS 3
22	Fe	g kg^{-1}	No	NAA	29757	1865	2	6961.5	31.7	IAEA SL1
23	Fe	g kg^{-1}	No	XRF	34.1	4.5	2	0.0	0.0	MESS 4
24	Fe	g kg^{-1}	Yes	ICP-MS	38.6	0.4	2.26	1.0	4.6	MESS 4
26	Fe	g kg^{-1}	No	ICP-MS	28.2	3.6	2	-1.4	-2.9	CANMET TILL1
27	Fe	g kg^{-1}	No	ICP-MS	28333	5300	2	6628.2	10.7	CANMET TILL1
29	Fe	g kg^{-1}	Yes	F AAS	177			33.36		No QC reported
30	Fe	g kg^{-1}	Yes	ICP-OES	24.4	3.9	2	-2.3	-4.6	No QC reported
33	Fe	g kg^{-1}	Yes	F AAS	34.3	0.6	2	0.0	0.1	IAEA 433
34	Fe	g kg^{-1}	Yes	ICP-MS	36.0	4.1	2	0.4	0.8	MESS 3
36	Fe	g kg^{-1}	No Info	ICP-MS	35.1	1.8	3	0.2	0.9	MESS 3
37	Fe	g kg^{-1}	Yes	ICP-OES	33.9			-0.06		No QC reported
38	Fe	g kg^{-1}	Yes	F AAS	38.4	4.8	2	1.0	1.6	WQB-1
39	Fe	g kg^{-1}	No	ICP-MS	30.8	3.4	2	-0.8	-1.7	LGC 6187
41	Fe	g kg^{-1}	Yes	ICP-OES	35.9	12.4	2	0.4	0.3	IAEA 158
44	Fe	g kg^{-1}	No	XRF	33.0	2.8	2	-0.3	-0.7	ISE983-WEPAL
45	Fe	g kg^{-1}	No	XRF	49267	426	2	11531.1	231.1	IAEA 433
46	Fe	g kg^{-1}	No	NAA	3.34	0.20	2	-7.2	-32.2	INCT OBTL-5
47	Fe	g kg^{-1}	Yes	ICP-MS	34.1	4.0	2	0.0	0.0	MESS 3
53	Fe	g kg^{-1}	No	NAA	31.5	6.2	2	-0.6	-0.8	IAEA SL1

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
56	Fe	g kg^{-1}	No	NAA	33.7	0.9	2	-0.1	-0.4	SRM 2711a
58	Fe	g kg^{-1}	No	F AAS	26.8			-1.72		No QC reported
61	Fe	g kg^{-1}	No	XRF	33700	1100	2	7885.1	60.1	IAEA 457
62	Fe	g kg^{-1}	Yes	ICP-OES	32.3			-0.44		MESS 4
63	Fe	g kg^{-1}	No	F AAS	27.8	2.2	2	-1.5	-4.3	RT 008
64	Fe	g kg^{-1}	Yes	ICP-MS	33.0	1.2	2	-0.3	-1.1	IAEA 433
65	Fe	g kg^{-1}	Yes	F AAS	45.6			2.69		IAEA 457
66	Fe	g kg^{-1}	No	F AAS	34.6	6.9	2	0.1	0.1	IAEA 433
70	Fe	g kg^{-1}	Yes	ICP-OES	35.8	2.0	2	0.4	1.2	IAEA 433
71	Fe	g kg^{-1}	No	ICP-MS	22700	4540	2	5308.8	10.0	No QC reported
72	Fe	g kg^{-1}	Yes	ICP-MS	36.1			0.45		MESS 4
73	Fe	g kg^{-1}	Yes	F AAS	28779			6732.6	5.0	No QC reported
74	Fe	g kg^{-1}	No	F AAS	28467	1534	2	6659.4	37.1	IAEA 405
75	Fe	g kg^{-1}	Yes	ET-AAS	39.1	1.8	2	1.2	3.7	IAEA 158
76	Fe	g kg^{-1}	Yes	F AAS	34.5	2.7	2	0.1	0.2	BS-1TM
77	Fe	g kg^{-1}	Yes	ICP-OES	37.2	3.9	2	0.7	1.4	GBW7312
78	Fe	g kg^{-1}	No	ICP-MS	33133	3070	2	7752.4	21.6	MESS 4
80	Fe	g kg^{-1}	No	ICP-MS	24.3	12.0	2	-2.3	-1.6	TORT 3
81	Fe	g kg^{-1}	Yes	ICP-OES	37.7	12.7	2	0.8	0.6	NWTH2
82	Fe	g kg^{-1}	Yes	ICP-OES	35.4	3.6	2	0.3	0.6	No QC reported

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
83	Fe	g kg^{-1}	No	ICP-MS	29.5	5.0	1.96	-1.1	-1.7	IAEA 359
84	Fe	g kg^{-1}	No	ICP-MS	31.0	3.1	2	-0.7	-1.8	IAEA 461
85	Fe	g kg^{-1}	No	XRF	26.7	2.8	2	-1.7	-4.4	IAEA 433
86	Fe	g kg^{-1}	Yes	ICP-MS	2.91	0.92	2	-7.3	-29.5	MESS 3
88	Fe	g kg^{-1}	Yes	ICP-OES	37.0			0.66		MESS 3
90	Fe	g kg^{-1}	No	ICP-OES	32.1	6.4	2	-0.5	-0.6	No QC reported
91	Fe	g kg^{-1}	No	ICP-MS	42.9	8.1	2	2.1	2.1	LGC 6187
92	Fe	g kg^{-1}	No	NAA	38.7	2.7	2	1.1	2.8	SRM 2711a
93	Fe	g kg^{-1}	Yes	ICP-OES	34.5	8.2	2	0.1	0.1	IAEA 458
95	Fe	g kg^{-1}	Yes	ICP-MS	37.2			0.71		MESS 4
96	Fe	g kg^{-1}	No Info	XRF	36.9			0.65		MESS 3
97	Fe	g kg^{-1}	Yes	ICP-MS	33.6			-0.1	-0.5	MESS 3
98	Fe	g kg^{-1}	No	ICP-MS	30579	1468	2	7154.2	41.6	IAEA 433
99	Fe	g kg^{-1}	Yes	ICP-OES	33.5			-0.14		No QC reported
100	Fe	g kg^{-1}	Yes	F AAS	35427	3543	2	8289.5	20.0	IAEA 458
1	Hg	mg kg^{-1}	No	Solid-AAS	0.025	0.006	2	-1.2	-1.5	ERM-CC141
2	Hg	mg kg^{-1}	No	Solid-AAS	0.028			-0.59		SETOC 722
4	Hg	mg kg^{-1}	No	Solid-AAS	0.025			-1.30		PACS 3
6	Hg	mg kg^{-1}	No	Solid-AAS	0.029	0.013	2	-0.3	-0.2	sdps 1
8	Hg	mg kg^{-1}	No	CV -AAS	0.063	0.008	0.003	9.0	8.6	BS-1TM

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
9	Hg	mg kg^{-1}	No	CV-AFS	0.032			0.68		CANMET TILL1
10	Hg	mg kg^{-1}	No	ET-AAS	4.79			1274.77		GSJ JLk-1
11	Hg	mg kg^{-1}	No Info	No info	0.029	0.002	2	-0.3	-0.8	MESS 4
13	Hg	mg kg^{-1}	No	Hyd-AAS	0.037	0.007	2	2.0	1.8	MESS 3
16	Hg	mg kg^{-1}	No	CV -AAS	0.027	0.009	2	-0.9	-0.8	No QC reported
17	Hg	mg kg^{-1}	Yes	ICP-MS	0.100			18.78		IAEA 458
18	Hg	mg kg^{-1}	No	ICP-MS	0.190			42.89		No QC reported
20	Hg	mg kg^{-1}	No	CV -AAS	0.036	0.008	2	1.6	1.5	PACS 3
23	Hg	mg kg^{-1}	No	Solid-AAS	0.024	0.005	2.09	-1.7	-2.7	IAEA 457
24	Hg	mg kg^{-1}	Yes	CV-AFS	0.034	0.006	2.26	1.2	2.1	MESS 4
26	Hg	mg kg^{-1}	No	CV -AAS	0.035	0.005	2	1.2	2.2	CANMET TILL1
27	Hg	mg kg^{-1}	No	CV -AAS	0.026	0.009	2	-1.1	-0.9	CANMET TILL1
29	Hg	mg kg^{-1}	No Info	No info	0.359			88.06		No QC reported
30	Hg	mg kg^{-1}	Yes	ICP-OES	0.122	0.029	2	24.8	6.6	No QC reported
36	Hg	mg kg^{-1}	No Info	Solid-AAS	0.021	0.002	3	-2.4	-8.1	IAEA 405
37	Hg	mg kg^{-1}	No	Solid-AAS	0.027			-0.86		No QC reported
38	Hg	mg kg^{-1}	No	Solid-AAS	0.028	0.006	2	-0.6	-0.7	DC75301
40	Hg	mg kg^{-1}	No	CV -AAS	0.038			2.3	2.1	BRC-277R
41	Hg	mg kg^{-1}	No	Solid-AAS	0.028	22.000	2	-0.4	0.0	IAEA 158
47	Hg	mg kg^{-1}	No	ICP-MS	0.036	0.010	2	1.6	1.2	No QC reported

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
51	Hg	mg kg^{-1}	No	Solid-AAS	0.020			-2.62		IAEA 457
56	Hg	mg kg^{-1}	No	NAA	3.27	0.35	2	868.7	18.0	SRM 2711a
59	Hg	mg kg^{-1}	No	Solid-AAS	0.026	0.004	2	-0.9	-1.6	IAEA 461
60	Hg	mg kg^{-1}	No	CV -AAS	0.029			-0.32		IAEA 158
62	Hg	mg kg^{-1}	No	Solid-AAS	0.027			-0.68		MESS 3
64	Hg	mg kg^{-1}	No	Solid-AAS	0.026	0.004	2	-1.0	-1.8	IAEA 433
66	Hg	mg kg^{-1}	No	CV -AAS	0.060	0.020	2	8.1	3.0	IAEA 433
67	Hg	mg kg^{-1}	Yes	CV -AAS	0.025	0.001		-1.2	-4.8	IAEA 433
70	Hg	mg kg^{-1}	No	Solid-AAS	0.032	0.002	2	0.6	1.6	IAEA 433
71	Hg	mg kg^{-1}	No	CV-AFS	0.030	0.004	2	-0.1	-0.1	No QC reported
72	Hg	mg kg^{-1}	No	Solid-AAS	0.031			0.30		MESS 4
73	Hg	mg kg^{-1}	No	No info	0.026			-1.1	-0.8	MESS 3
78	Hg	mg kg^{-1}	No	CV-AFS	0.033	0.005	2	0.7	1.1	MESS 4
80	Hg	mg kg^{-1}	No	ICP-MS	0.155	0.080	2	33.6	3.1	TORT 3
84	Hg	mg kg^{-1}	No	Solid-AAS	0.028	0.009	2	-0.5	-0.4	IAEA 452
86	Hg	mg kg^{-1}	No	Solid-AAS	0.029	0.006	2	-0.3	-0.4	MESS 3
89	Hg	mg kg^{-1}	No	Solid-AAS	0.030			0.03		DOLT5
90	Hg	mg kg^{-1}	No	CV-AFS	0.015	0.003	2	-4.1	-9.4	No QC reported
91	Hg	mg kg^{-1}	No	ICP-MS	0.126	0.025	2	25.8	7.7	CRM 015
93	Hg	mg kg^{-1}	No	Solid-AAS	0.027	0.001	2	-0.8	-3.8	IAEA 458

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
95	Hg	mg kg^{-1}	No	Solid-AAS	0.030			0.10		MESS 4
98	Hg	mg kg^{-1}	No	ICP-MS	0.223	0.040	2	51.6	9.6	IAEA 433
99	Hg	mg kg^{-1}	No	Solid-AAS	0.028			-0.41		Metranal 32
100	Hg	mg kg^{-1}	No	CV-AFS	0.033	0.004	2	0.8	1.4	IAEA 458
4	Li	mg kg^{-1}	No	ICP-OES	68.0			5.50		PACS 3
5	Li	mg kg^{-1}	Yes	ICP-MS	48.2			1.56		No QC reported
6	Li	mg kg^{-1}	No	ICP-OES	81.0	32.0	2	8.1	2.5	sdps 2
9	Li	mg kg^{-1}	No	ICP-MS	25.1			-3.02		CANMET TILL1
13	Li	mg kg^{-1}	Yes	ICP-OES	41.1	2.8	2	0.2	0.3	MESS 3
16	Li	mg kg^{-1}	No	ICP-MS	30.9	1.5	2	-1.9	-6.1	No QC reported
18	Li	mg kg^{-1}	No	ICP-MS	19.2			-4.19		No QC reported
24	Li	mg kg^{-1}	Yes	ICP-MS	42.7	0.9	2.26	0.5	1.7	MESS 4
26	Li	mg kg^{-1}	No	ICP-MS	25.4	5.7	2	-3.0	-4.7	CANMET TILL1
27	Li	mg kg^{-1}	No	ICP-MS	22.9	3.8	2	-3.5	-7.5	CANMET TILL1
30	Li	mg kg^{-1}	Yes	ICP-OES	28.5	7.1	2	-2.3	-3.1	No QC reported
33	Li	mg kg^{-1}	Yes	F AAS	41.5	3.8	2	0.2	0.5	IAEA 433
36	Li	mg kg^{-1}		No Info	41.9	2.2	3	0.32	1.1	MESS-3
37	Li	mg kg^{-1}	Yes	ICP-MS	41.9			0.32		No QC reported
38	Li	mg kg^{-1}	Yes	F AAS	39.2	7.4	2	-0.2	-0.3	WQB-1
41	Li	mg kg^{-1}	Yes	ICP-OES	99.0	18.0	2	11.7	6.5	IAEA 158

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
47	Li	mg kg^{-1}	Yes	ICP-MS	37.6	4.6	2	-0.5	-1.0	No QC reported
53	Li	mg kg^{-1}	Yes	ICP-MS	24.3	5.0	2	-3.2	-5.6	PACS 2
62	Li	mg kg^{-1}	Yes	ICP-MS	40.3			0.00		MESS 4
63	Li	mg kg^{-1}	No	F AAS	36.4	7.9	2	-0.8	-0.9	No QC reported
64	Li	mg kg^{-1}	Yes	ICP-MS	40.9	5.0	2	0.1	0.2	IAEA 433
65	Li	mg kg^{-1}	Yes	F AAS	26.8			-2.69		IAEA 457
72	Li	mg kg^{-1}	Yes	ICP-MS	38.2			-0.42		MESS 4
78	Li	mg kg^{-1}	No	ICP-MS	44.0	11.2	2	0.7	0.6	MESS 4
81	Li	mg kg^{-1}	Yes	ICP-MS	38.4	11.5	2	-0.4	-0.3	NWTH2
82	Li	mg kg^{-1}	Yes	ICP-OES	38.0	3.8	2	-0.5	-1.0	No QC reported
86	Li	mg kg^{-1}	Yes	ICP-MS	36.0	9.0	2	-0.9	-0.9	MESS 3
88	Li	mg kg^{-1}	Yes	ICP-OES	39.7			-0.13		MESS 3
90	Li	mg kg^{-1}	No	ICP-MS	28.1	5.6	2	-2.4	-3.9	No QC reported
91	Li	mg kg^{-1}	No	ICP-MS	24.3			-3.17		No QC reported
93	Li	mg kg^{-1}	Yes	ICP-OES	27.5	4.4	2	-2.5	-5.0	IAEA 458
95	Li	mg kg^{-1}	Yes	ICP-MS	45.7			1.06		MESS 4
97	Li	mg kg^{-1}	Yes	ICP-MS	44.9			0.9	3.4	MESS 3
98	Li	mg kg^{-1}	No	ICP-MS	39.6	1.8	2	-0.1	-0.4	IAEA 433
99	Li	mg kg^{-1}	Yes	ICP-OES	63.0			4.51		No QC reported
60	MeHg	µg kg^{-1} as Hg	No	GC-ECD	0.280			3.20		IAEA 158

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
64	MeHg	µg kg^{-1} as Hg	No	ID GC ICP-MS	1.85	0.14	2	65.9	22.7	ERM CC580
71	MeHg	µg kg^{-1} as Hg	No	GC-AFS	0.171	0.061	2	-1.1	-0.8	No QC reported
93	MeHg	µg kg^{-1} as Hg	No	ID GC ICP-MS	0.189	0.008	2	-0.5	-0.6	IAEA 158
1	Mn	mg kg^{-1}	Yes	ICP-MS	580	153	2	0.6	0.5	ERM-CC141
2	Mn	mg kg^{-1}	No	F AAS	530			-0.14		IAEA 433
4	Mn	mg kg^{-1}	No	ICP-OES	562			0.34		PACS 3
5	Mn	mg kg^{-1}	Yes	ICP-MS	393			-2.16		No QC reported
6	Mn	mg kg^{-1}	No	ICP-OES	487	122	2	-0.8	-0.8	No QC reported
8	Mn	mg kg^{-1}	Yes	ET-AAS	567	12	4.9	0.4	1.5	BS-1TM
9	Mn	mg kg^{-1}	No	ICP-MS	500			-0.58		CANMET TILL1
10	Mn	mg kg^{-1}	No	F AAS	381			-2.34		GSJ JLK-1
12	Mn	mg kg^{-1}	No	NAA	550	17	2	0.2	0.6	IAEA 433
13	Mn	mg kg^{-1}	Yes	ICP-OES	511	38	2	-0.4	-1.1	MESS 3
16	Mn	mg kg^{-1}	No	ICP-MS	526	13	2	-0.2	-0.7	No QC reported
17	Mn	mg kg^{-1}	Yes	ICP-MS	752			3.16		No QC reported
18	Mn	mg kg^{-1}	No	ICP-MS	249			-4.30		No QC reported
19	Mn	mg kg^{-1}	Yes	ICP-MS	563	107	2	0.4	0.4	IAEA SL1
20	Mn	mg kg^{-1}	Yes	F AAS	540	36	2	0.0	0.1	PACS 3
22	Mn	mg kg^{-1}	No	NAA	635	112	2	1.4	1.5	IAEA SL1
23	Mn	mg kg^{-1}	No	XRF	546	125	2	0.1	0.1	MESS 4

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
24	Mn	mg kg^{-1}	Yes	ICP-MS	491	24	2.26	-0.7	-2.3	MESS 4
26	Mn	mg kg^{-1}	No	ICP-MS	492	56	2	-0.7	-1.4	CANMET TILL1
27	Mn	mg kg^{-1}	No	ICP-MS	477	98	2	-0.9	-1.2	CANMET TILL1
29	Mn	mg kg^{-1}	Yes	F AAS	337			-2.99		IAEA 433
30	Mn	mg kg^{-1}	Yes	ICP-OES	420	64	2	-1.8	-3.2	No QC reported
33	Mn	mg kg^{-1}	Yes	F AAS	534	12	2	-0.1	-0.2	IAEA 433
34	Mn	mg kg^{-1}	Yes	ICP-MS	522	84	2	-0.3	-0.4	MESS 3
36	Mn	mg kg^{-1}	No Info	ICP-MS	566	33	3	0.4	1.3	MESS 3
37	Mn	mg kg^{-1}	Yes	ICP-OES	564			0.38		No QC reported
38	Mn	mg kg^{-1}	Yes	F AAS	557	87	2	0.3	0.4	WQB-1
39	Mn	mg kg^{-1}	No	ICP-MS	463	46	2	-1.1	-2.6	LGC 6187
41	Mn	mg kg^{-1}	Yes	ICP-OES	538	16	2	0.0	-0.1	IAEA 158
44	Mn	mg kg^{-1}	No	XRF	528	34	2	-0.2	-0.5	ISE983-WEPAL
45	Mn	mg kg^{-1}	No	XRF	855	40	2	4.7	11.7	IAEA 433
46	Mn	mg kg^{-1}	Yes	ICP-MS	565	57	2	0.4	0.8	M-2 BotSed
47	Mn	mg kg^{-1}	Yes	ICP-MS	554	66	2	0.2	0.4	No QC reported
53	Mn	mg kg^{-1}	No	NAA	528	53	2	-0.2	-0.3	IAEA SL1
56	Mn	mg kg^{-1}	No	NAA	647	69	2	1.6	2.8	SRM 2711a
58	Mn	mg kg^{-1}	No	F AAS	282			-3.81		No QC reported
61	Mn	mg kg^{-1}	No	XRF	532	34	2	-0.1	-0.3	IAEA 457

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
62	Mn	mg kg^{-1}	Yes	ICP-MS	537			-0.03		MESS 4
63	Mn	mg kg^{-1}	No	F AAS	447	10	2	-1.4	-4.9	RT 008
64	Mn	mg kg^{-1}	Yes	ICP-MS	541	16	2	0.0	0.1	IAEA 433
65	Mn	mg kg^{-1}	Yes	F AAS	502			-0.54		IAEA 457
66	Mn	mg kg^{-1}	No	F AAS	362	36	2	-2.6	-7.0	IAEA 433
68	Mn	mg kg^{-1}	No Info	F AAS	295			-3.63		No QC reported
70	Mn	mg kg^{-1}	Yes	F AAS	547	14	2	0.1	0.4	IAEA 433
71	Mn	mg kg^{-1}	No	ICP-MS	464	92	2	-1.1	-1.5	No QC reported
72	Mn	mg kg^{-1}	Yes	ICP-MS	573			0.51		MESS 4
73	Mn	mg kg^{-1}	Yes	F AAS	524			-0.2	-0.1	MESS 3
74	Mn	mg kg^{-1}	No	F AAS	452	38	2	-1.3	-3.3	IAEA 405
75	Mn	mg kg^{-1}	Yes	ET-AAS	294	13	2	-3.6	-12.8	IAEA 158
76	Mn	mg kg^{-1}	Yes	F AAS	476	0	2	-0.9	-3.5	BS-1TM
77	Mn	mg kg^{-1}	Yes	ICP-OES	494	36	2	-0.7	-1.8	GBW7312
78	Mn	mg kg^{-1}	No	ICP-MS	494	18	2	-0.7	-2.3	MESS 4
80	Mn	mg kg^{-1}	No	ICP-MS	349	140	2	-2.8	-2.6	Oyster Tissue
81	Mn	mg kg^{-1}	Yes	ICP-MS	511	97	2	-0.4	-0.5	NWTH2
82	Mn	mg kg^{-1}	Yes	ICP-OES	535	54	2	-0.1	-0.1	No QC reported
83	Mn	mg kg^{-1}	No	ICP-MS	476	55	1.96	-0.9	-1.9	IAEA 359
84	Mn	mg kg^{-1}	No	ICP-MS	506	61	2	-0.5	-0.9	IAEA 461

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
85	Mn	mg kg^{-1}	No	XRF	416	44	2	-1.8	-4.3	IAEA 433
86	Mn	mg kg^{-1}	Yes	ICP-MS	357	240	2	-2.7	-1.5	MESS 3
88	Mn	mg kg^{-1}	Yes	ICP-OES	604			0.96		No QC reported
90	Mn	mg kg^{-1}	No	ICP-MS	515	103	2	-0.4	-0.4	No QC reported
91	Mn	mg kg^{-1}	No	ICP-MS	500	61	2	-0.6	-1.4	LGC 6187
93	Mn	mg kg^{-1}	Yes	ICP-OES	553	56	2	0.2	0.4	IAEA 458
95	Mn	mg kg^{-1}	Yes	ICP-MS	601			0.92		MESS 4
96	Mn	mg kg^{-1}	No Info	XRF	503			-0.53		MESS 3
97	Mn	mg kg^{-1}	Yes	ICP-MS	577			0.6	2.1	MESS 3
98	Mn	mg kg^{-1}	No	ICP-MS	575	168	2	0.5	0.4	IAEA 433
99	Mn	mg kg^{-1}	Yes	ICP-OES	524			-0.22		CRM 7002
100	Mn	mg kg^{-1}	Yes	F AAS	562	56	2	0.3	0.7	IAEA 458
1	Ni	mg kg^{-1}	Yes	ICP-MS	28.4	5.8	2	0.0	-0.1	ERM-cc141
2	Ni	mg kg^{-1}	No	ET-AAS	23.8			-1.32		SETOC 721
4	Ni	mg kg^{-1}	No	ICP-OES	30.0			0.41		PACS 3
5	Ni	mg kg^{-1}	Yes	ICP-MS	203			49.03		No QC reported
6	Ni	mg kg^{-1}	No	ICP-OES	26.1	8.9	2	-0.7	-0.5	sdps 2
8	Ni	mg kg^{-1}	Yes	ET-AAS	27.6	0.6	0.24	-0.2	-1.4	BS-1TM
9	Ni	mg kg^{-1}	No	ICP-MS	22.2			-1.77		CANMET TILL1
10	Ni	mg kg^{-1}	No	F AAS	31.5			0.82		GSJ JLK-1

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
13	Ni	mg kg^{-1}	Yes	ICP-OES	25.5	2.4	2	-0.9	-2.3	MESS 3
14	Ni	mg kg^{-1}	No	F AAS	13.7			-4.16		No QC reported
16	Ni	mg kg^{-1}	No	ICP-MS	26.8	0.6	2	-0.5	-2.7	No QC reported
17	Ni	mg kg^{-1}	Yes	ICP-MS	29.7			0.34		IAEA 458
18	Ni	mg kg^{-1}	No	ICP-MS	14.2			-4.02		No QC reported
19	Ni	mg kg^{-1}	Yes	ICP-MS	28.7	5.4	2	0.0	0.1	IAEA SL1
20	Ni	mg kg^{-1}	Yes	ET-AAS	27.9	2.6	2	-0.2	-0.5	PACS 3
21	Ni	mg kg^{-1}	No Info	No info	29.5	1.8	2	0.3	0.9	SRM 2702
23	Ni	mg kg^{-1}	No	XRF	32.3	7.8	2	1.0	1.0	MESS 4
24	Ni	mg kg^{-1}	No	ICP-MS	31.7	0.5	2.26	0.9	5.2	MESS 4
26	Ni	mg kg^{-1}	No	ICP-MS	22.4	2.6	2	-1.7	-4.3	CANMET TILL1
27	Ni	mg kg^{-1}	No	ICP-MS	22.8	3.7	2	-1.6	-2.9	CANMET TILL1
29	Ni	mg kg^{-1}	Yes	ET-AAS	201			48.51		IAEA 433
30	Ni	mg kg^{-1}	Yes	ICP-OES	30.4	5.3	2	0.5	0.7	No QC reported
33	Ni	mg kg^{-1}	Yes	ET-AAS	27.8	3.6	2	-0.2	-0.4	IAEA 433
34	Ni	mg kg^{-1}	Yes	ICP-MS	24.9	3.9	2	-1.0	-1.8	MESS 3
36	Ni	mg kg^{-1}	No Info	ICP-MS	27.6	0.4	3	-0.3	-1.7	MESS 3
37	Ni	mg kg^{-1}	Yes	ICP-MS	29.8			0.35		No QC reported
38	Ni	mg kg^{-1}	No	F AAS	24.8	3.7	2	-1.0	-1.9	WQB-1
39	Ni	mg kg^{-1}	No	ICP-MS	25.2	2.8	2	-0.9	-2.2	SRM 2702

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
41	Ni	mg kg^{-1}	Yes	ICP-OES	21.1	19.6	2	-2.1	-0.8	IAEA 158
43	Ni	mg kg^{-1}	No	ICP-MS	24.2			-1.22		No QC reported
44	Ni	mg kg^{-1}	No	XRF	23.5	2.2	2	-1.4	-4.1	ISE983-WEPAL
45	Ni	mg kg^{-1}	No	XRF	59.0	16.0	2	8.5	3.8	IAEA 433
47	Ni	mg kg^{-1}	Yes	ICP-MS	27.7	3.4	2	-0.2	-0.5	MESS 3
53	Ni	mg kg^{-1}	Yes	ICP-MS	23.7	4.8	2	-1.4	-2.0	PACS 2
62	Ni	mg kg^{-1}	Yes	ICP-MS	27.5			-0.29		MESS 4
64	Ni	mg kg^{-1}	Yes	ICP-MS	27.9	1.0	2	-0.2	-0.9	IAEA 433
65	Ni	mg kg^{-1}	Yes	F AAS	54.9			7.41		IAEA 457
66	Ni	mg kg^{-1}	No	F AAS	27.1	5.4	2	-0.4	-0.5	IAEA 433
68	Ni	mg kg^{-1}	No Info	F AAS	154	0	2	35.2	225.3	No QC reported
70	Ni	mg kg^{-1}	Yes	ICP-OES	30.9	0.9	2	0.7	3.2	IAEA 433
71	Ni	mg kg^{-1}	No	ICP-MS	20.9	1.4	2	-2.1	-8.4	No QC reported
72	Ni	mg kg^{-1}	Yes	ICP-MS	27.1			-0.39		MESS 4
73	Ni	mg kg^{-1}	Yes	ET-AAS	34.6			1.70		MESS 3
74	Ni	mg kg^{-1}	No	F AAS	25.8	2.0	2	-0.8	-2.4	IAEA 405
75	Ni	mg kg^{-1}	Yes	ET-AAS	26.0	0.8	2	-0.7	-3.7	IAEA 158
76	Ni	mg kg^{-1}	Yes	F AAS	45.3	3.4	2	4.7	9.4	BS-1TM
78	Ni	mg kg^{-1}	No	ICP-MS	34.8	1.6	2	1.8	6.4	MESS 4
80	Ni	mg kg^{-1}	No	ICP-MS	17.4	10.2	2	-3.1	-2.2	Oyster Tissue

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
81	Ni	mg kg^{-1}	Yes	ICP-MS	25.9	3.8	2	-0.7	-1.3	NWTH2
82	Ni	mg kg^{-1}	Yes	No info	24.0	2.4	2	-1.3	-3.4	No QC reported
83	Ni	mg kg^{-1}	No	ICP-MS	24.1	3.7	1.96	-1.2	-2.3	IAEA 359
84	Ni	mg kg^{-1}	No	ICP-MS	26.3	5.3	2	-0.6	-0.8	IAEA 461
85	Ni	mg kg^{-1}	No	XRF	25.9	2.4	2	-0.7	-1.9	IAEA 433
86	Ni	mg kg^{-1}	Yes	ICP-MS	23.6	10.4	2	-1.4	-0.9	MESS 3
88	Ni	mg kg^{-1}	Yes	No info	25.7			-0.78		MESS 3
90	Ni	mg kg^{-1}	No	ICP-MS	25.1	5.0	2	-1.0	-1.4	No QC reported
91	Ni	mg kg^{-1}	No	ICP-MS	21.7	3.3	2	-1.9	-3.9	CRM 015
93	Ni	mg kg^{-1}	Yes	ICP-OES	30.9	3.6	2	0.7	1.3	IAEA 458
95	Ni	mg kg^{-1}	Yes	ICP-MS	30.0			0.40		MESS 4
96	Ni	mg kg^{-1}	No Info	F AAS	19.5			-2.52		PACS 2
97	Ni	mg kg^{-1}	Yes	ICP-MS	29.8			0.4	2.2	MESS 3
98	Ni	mg kg^{-1}	No	ICP-MS	20.8	4.8	2	-2.2	-3.1	IAEA 433
99	Ni	mg kg^{-1}	Yes	ICP-OES	27.3			-0.33		CRM 7002
100	Ni	mg kg^{-1}	No	F AAS	120	36	2	25.7	5.1	IAEA 458
1	Pb	mg kg^{-1}	Yes	ICP-MS	37.5	8.0	2	2.0	1.9	SRM 2702
2	Pb	mg kg^{-1}	No	ET-AAS	23.8			-1.65		SETOC 721
4	Pb	mg kg^{-1}	No	ICP-OES	29.0			-0.25		PACS 3
5	Pb	mg kg^{-1}	Yes	ICP-MS	22.8			-1.91		No QC reported

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
6	Pb	mg kg^{-1}	No	ICP-OES	22.7	8.2	2	-1.9	-1.7	sdps 2
8	Pb	mg kg^{-1}	Yes	ET-AAS	30.0	0.9	0.38	0.0	0.1	BS-1TM
9	Pb	mg kg^{-1}	No	ICP-MS	24.7			-1.40		CANMET TILL1
10	Pb	mg kg^{-1}	No	F AAS	35.1			1.38		GSJ JLk-1
13	Pb	mg kg^{-1}	Yes	ICP-OES	21.6	1.4	2	-2.2	-8.3	MESS 3
14	Pb	mg kg^{-1}	No	ET-AAS	5.52			-6.52		No QC reported
16	Pb	mg kg^{-1}	No	ICP-MS	26.8	0.5	2	-0.8	-4.1	No QC reported
17	Pb	mg kg^{-1}	Yes	ICP-MS	30.3			0.10		IAEA 458
18	Pb	mg kg^{-1}	No	ICP-MS	27.6			-0.63		No QC reported
19	Pb	mg kg^{-1}	Yes	ICP-MS	24.5	4.6	2	-1.5	-2.2	IAEA SL1
20	Pb	mg kg^{-1}	Yes	F AAS	30.2	7.8	2	0.1	0.1	PACS 3
21	Pb	mg kg^{-1}	No Info	No info	32.4	4.1	2	0.7	1.1	SRM 2702
23	Pb	mg kg^{-1}	No	XRF	28.3	18.5	2	-0.4	-0.2	MESS 4
24	Pb	mg kg^{-1}	Yes	ICP-MS	34.6	0.6	2.26	1.2	6.1	MESS 4
26	Pb	mg kg^{-1}	No	ICP-MS	23.1	3.0	2	-1.8	-4.1	CANMET TILL1
27	Pb	mg kg^{-1}	No	ICP-MS	21.3	2.7	2	-2.3	-5.6	CANMET TILL1
29	Pb	mg kg^{-1}	Yes	ET-AAS	21.2			-2.33		IAEA 433
30	Pb	mg kg^{-1}	Yes	ICP-OES	12.4	2.0	2	-4.7	-14.4	No QC reported
33	Pb	mg kg^{-1}	Yes	ET-AAS	29.8	2.6	2	0.0	-0.1	IAEA 433
34	Pb	mg kg^{-1}	Yes	ICP-MS	29.4	3.2	2	-0.2	-0.3	MESS 3

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
36	Pb	mg kg^{-1}	No Info	ICP-MS	26.5	0.6	3	-0.9	-4.5	MESS 3
37	Pb	mg kg^{-1}	Yes	ICP-MS	33.2			0.86		No QC reported
38	Pb	mg kg^{-1}	No	F AAS	21.1	3.8	2	-2.4	-4.3	WQB-1
39	Pb	mg kg^{-1}	No	ICP-MS	24.9	1.5	2	-1.3	-4.8	LGC 6187
41	Pb	mg kg^{-1}	Yes	ET-AAS	19.7	23.0	2	-2.7	-0.9	IAEA 158
43	Pb	mg kg^{-1}	No	ICP-MS	25.9			-1.08		No QC reported
44	Pb	mg kg^{-1}	No	XRF	27.5	0.4	2	-0.7	-3.3	ISE983-WEPAL
46	Pb	mg kg^{-1}	Yes	ICP-MS	29.7	3.0	2	-0.1	-0.1	M-2 BotSed
47	Pb	mg kg^{-1}	Yes	ICP-MS	30.6	3.6	2	0.2	0.3	MESS 3
52	Pb	mg kg^{-1}	No	ET-AAS	0.046			-7.99		No QC reported
53	Pb	mg kg^{-1}	Yes	ICP-MS	26.8	5.4	2	-0.8	-1.1	PACS 2
56	Pb	mg kg^{-1}	No	XRF	39.4	2.6	2	2.5	6.5	SRM 2711a
58	Pb	mg kg^{-1}	No	F AAS	24.9			-1.35		No QC reported
61	Pb	mg kg^{-1}	No	XRF	22.7	14.0	2	-1.9	-1.0	IAEA 457
62	Pb	mg kg^{-1}	Yes	ICP-MS	30.3			0.08		MESS 4
64	Pb	mg kg^{-1}	Yes	ICP-MS	28.8	1.8	2	-0.3	-1.0	IAEA 433
65	Pb	mg kg^{-1}	Yes	F AAS	51.4			5.72		IAEA 457
66	Pb	mg kg^{-1}	No	F AAS	29.1	5.8	2	-0.2	-0.3	IAEA 433
67	Pb	mg kg^{-1}	Yes	F AAS	24.5	0.8		-1.5	-6.9	IAEA 433
68	Pb	mg kg^{-1}	No Info	F AAS	164	0	2	35.7	183.8	No QC reported

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
70	Pb	mg kg^{-1}	Yes	ICP-OES	33.4	5.5	2	0.9	1.2	IAEA 433
71	Pb	mg kg^{-1}	No	ICP-MS	24.6	3.4	2	-1.4	-2.9	No QC reported
72	Pb	mg kg^{-1}	Yes	ICP-MS	28.8			-0.29		MESS 4
73	Pb	mg kg^{-1}	Yes	ET-AAS	34.1			1.1	0.6	MESS 3
74	Pb	mg kg^{-1}	No	F AAS	31.9	5.9	2	0.5	0.6	IAEA 405
75	Pb	mg kg^{-1}	Yes	ET-AAS	30.2	4.2	2	0.1	0.1	IAEA 158
76	Pb	mg kg^{-1}	Yes	F AAS	32.2	3.0	2	0.6	1.3	BS-1TM
78	Pb	mg kg^{-1}	No	ICP-MS	36.3	1.6	2	1.7	5.9	MESS 4
80	Pb	mg kg^{-1}	No	ICP-MS	27.0	13.5	2	-0.8	-0.4	Oyster Tissue
81	Pb	mg kg^{-1}	Yes	ICP-MS	35.8	7.0	2	1.6	1.6	NWTH2
82	Pb	mg kg^{-1}	Yes	ICP-OES	25.2	2.6	2	-1.3	-3.2	No QC reported
83	Pb	mg kg^{-1}	No	ICP-MS	25.2	0.9	1.96	-1.3	-5.6	IAEA 359
84	Pb	mg kg^{-1}	No	ICP-MS	25.7	3.1	2	-1.1	-2.5	IAEA 461
85	Pb	mg kg^{-1}	No	XRF	26.1	1.9	2	-1.0	-3.2	IAEA 433
86	Pb	mg kg^{-1}	Yes	ICP-MS	105	514	2	20.0	0.3	MESS 3
88	Pb	mg kg^{-1}	Yes	ICP-MS	35.7			1.54		MESS 3
89	Pb	mg kg^{-1}	No	ICP-OES	23.7	0.2	2	-1.7	-8.5	PACS 1
90	Pb	mg kg^{-1}	No	ICP-MS	26.7	5.3	2	-0.9	-1.2	No QC reported
91	Pb	mg kg^{-1}	No	ICP-MS	23.6	3.5	2	-1.7	-3.4	CRM 015
93	Pb	mg kg^{-1}	Yes	ICP-OES	28.5	2.6	2	-0.4	-0.9	IAEA 458

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
95	Pb	mg kg^{-1}	Yes	ICP-MS	30.5			0.14		MESS 4
96	Pb	mg kg^{-1}	No Info	F AAS	22.5			-2.00		PACS 2
97	Pb	mg kg^{-1}	Yes	ICP-MS	31.0			0.3	1.4	MESS 3
98	Pb	mg kg^{-1}	No	ICP-MS	24.8	0.7	2	-1.4	-6.4	IAEA 433
99	Pb	mg kg^{-1}	Yes	ICP-OES	25.7			-1.14		CRM 7002
100	Pb	mg kg^{-1}	Yes	ET-AAS	30.2	6.0	2	0.1	0.1	IAEA 458
1	Sr	mg kg^{-1}	Yes	ICP-MS	240	58	2	0.2	0.2	SRM 2702
5	Sr	mg kg^{-1}	Yes	ICP-MS	272			1.35		No QC reported
6	Sr	mg kg^{-1}	No	ICP-OES	811	81	2	19.8	13.8	sdps 2
9	Sr	mg kg^{-1}	No	ICP-MS	185			-1.65		CANMET TILL1
13	Sr	mg kg^{-1}	Yes	ICP-OES	203	35	2	-1.0	-1.5	MESS 3
16	Sr	mg kg^{-1}	No	ICP-MS	237	4	2	0.1	0.3	No QC reported
18	Sr	mg kg^{-1}	No	ICP-MS	204			-1.00		No QC reported
19	Sr	mg kg^{-1}	Yes	ICP-MS	243	46	2	0.3	0.4	IAEA SL1
23	Sr	mg kg^{-1}	No	XRF	241	31	2	0.3	0.4	MESS 4
24	Sr	mg kg^{-1}	Yes	ICP-MS	282	3	2.26	1.7	4.6	MESS 4
26	Sr	mg kg^{-1}	No	ICP-MS	179	27	2	-1.9	-3.2	CANMET TILL1
27	Sr	mg kg^{-1}	No	ICP-MS	158	24	2	-2.6	-4.7	CANMET TILL1
30	Sr	mg kg^{-1}	Yes	ICP-OES	101	25	2	-4.5	-8.0	No QC reported
34	Sr	mg kg^{-1}	Yes	ICP-MS	283	12	2	1.7	4.2	MESS 3

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
36	Sr	mg kg^{-1}	No Info	ICP-MS	116	9	3	-4.0	-10.7	MESS 3
37	Sr	mg kg^{-1}	Yes	ICP-MS	216			-0.58		No QC reported
41	Sr	mg kg^{-1}	Yes	No info	282	14	2	1.7	3.9	IAEA 158
44	Sr	mg kg^{-1}	No	XRF	222	3	2	-0.4	-1.0	ISE983-WEPAL
45	Sr	mg kg^{-1}	No	XRF	237	88	2	0.1	0.1	IAEA 433
47	Sr	mg kg^{-1}	Yes	ICP-MS	256	30	2	0.8	1.3	No QC reported
53	Sr	mg kg^{-1}	Yes	ICP-MS	254	26	2	0.7	1.3	PACS 2
56	Sr	mg kg^{-1}	No	NAA	178	56	2	-1.9	-1.8	SRM 2711a
61	Sr	mg kg^{-1}	No	XRF	211	18	2	-0.7	-1.6	IAEA 457
64	Sr	mg kg^{-1}	Yes	ICP-MS	254	24	2	0.7	1.3	IAEA 433
70	Sr	mg kg^{-1}	Yes	ICP-OES	298	9	2	2.2	5.7	IAEA 433
71	Sr	mg kg^{-1}	No	ICP-MS	184	37	2	-1.7	-2.3	No QC reported
72	Sr	mg kg^{-1}	Yes	ICP-MS	237			0.13		MESS 4
76	Sr	mg kg^{-1}	Yes	F AAS	49.2	1.8	2	-6.3	-17.4	BS-1TM
77	Sr	mg kg^{-1}	Yes	ICP-OES	231	24	2	-0.1	-0.1	GBW7312
78	Sr	mg kg^{-1}	No	ICP-MS	219	11	2	-0.5	-1.2	MESS 4
82	Sr	mg kg^{-1}	Yes	ICP-OES	198	20	2	-1.2	-2.4	No QC reported
85	Sr	mg kg^{-1}	No	XRF	209	9	2	-0.8	-2.1	IAEA 433
86	Sr	mg kg^{-1}	Yes	ICP-MS	57.0	90.0	2	-6.0	-3.8	MESS 3
88	Sr	mg kg^{-1}	Yes	ICP-OES	233			0.00		MESS 3

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
90	Sr	mg kg^{-1}	No	ICP-MS	193	39	2	-1.4	-1.8	No QC reported
91	Sr	mg kg^{-1}	No	ICP-MS	193			-1.37		No QC reported
93	Sr	mg kg^{-1}	Yes	ICP-OES	172	28	2	-2.1	-3.5	IAEA 458
95	Sr	mg kg^{-1}	Yes	ICP-MS	248			0.53		MESS 4
97	Sr	mg kg^{-1}	Yes	ICP-MS	261			1.0	2.7	MESS 3
98	Sr	mg kg^{-1}	No	ICP-MS	224	83	2	-0.3	-0.2	IAEA 433
99	Sr	mg kg^{-1}	Yes	ICP-OES	184			-1.67		No QC reported
1	Zn	mg kg^{-1}	Yes	ICP-MS	94.9	9.6	2	-0.4	-0.9	ERM-CC141
2	Zn	mg kg^{-1}	No	F AAS	98.0			-0.16		IAEA 433
4	Zn	mg kg^{-1}	No	ICP-OES	105			0.39		PACS 3
5	Zn	mg kg^{-1}	Yes	ICP-MS	92.5			-0.60		No QC reported
6	Zn	mg kg^{-1}	No	ICP-OES	102	27	2	0.1	0.1	sdps 2
8	Zn	mg kg^{-1}	Yes	ET-AAS	104	2	0.82	0.3	1.2	BS-1TM
9	Zn	mg kg^{-1}	No	ICP-MS	82.5			-1.40		CANMET TILL1
10	Zn	mg kg^{-1}	No	F AAS	69.7			-2.43		GSJ JLk-1
12	Zn	mg kg^{-1}	No	NAA	99.1	88.2	2	-0.1	0.0	IAEA 433
13	Zn	mg kg^{-1}	Yes	ICP-MS	108	11	2	0.6	1.3	MESS 3
14	Zn	mg kg^{-1}	No	F AAS	52.4			-3.81		No QC reported
16	Zn	mg kg^{-1}	No	ICP-MS	106	4	2	0.4	1.5	No QC reported
17	Zn	mg kg^{-1}	Yes	ICP-MS	102			0.13		IAEA 458

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
19	Zn	mg kg^{-1}	Yes	ICP-MS	113	21	2	1.0	1.1	IAEA SL1
20	Zn	mg kg^{-1}	Yes	F AAS	92.0	10.0	2	-0.6	-1.4	PACS 3
21	Zn	mg kg^{-1}	No Info	No info	94.5	4.4	2	-0.4	-1.4	SRM 2702
22	Zn	mg kg^{-1}	No	NAA	71.2	3.0	2	-2.3	-8.1	IAEA SL1
23	Zn	mg kg^{-1}	No	XRF	100	23	2	0.0	0.0	MESS 4
24	Zn	mg kg^{-1}	Yes	ICP-MS	108	3	2.26	0.6	2.3	MESS 4
26	Zn	mg kg^{-1}	No	ICP-MS	75.2	9.3	2	-2.0	-4.4	CANMET TILL1
27	Zn	mg kg^{-1}	No	ICP-MS	82.1	12.0	2	-1.4	-2.6	CANMET TILL1
29	Zn	mg kg^{-1}	Yes	F AAS	94.4			-0.45		IAEA 433
30	Zn	mg kg^{-1}	Yes	ICP-OES	80.2	11.8	2	-1.6	-3.0	No QC reported
33	Zn	mg kg^{-1}	Yes	F AAS	95.7	6.8	2	-0.4	-0.9	IAEA 433
34	Zn	mg kg^{-1}	Yes	ICP-MS	105	16	2	0.4	0.6	MESS 3
36	Zn	mg kg^{-1}	No Info	ICP-MS	98.1	4.6	3	-0.2	-0.5	MESS 3
37	Zn	mg kg^{-1}	Yes	ICP-MS	113			1.06		No QC reported
38	Zn	mg kg^{-1}	Yes	F AAS	90.0	12.0	2	-0.8	-1.5	WQB-1
39	Zn	mg kg^{-1}	No	ICP-MS	87.1	4.4	2	-1.0	-3.3	SRM 2702
41	Zn	mg kg^{-1}	Yes	ICP-OES	106	20	2	0.5	0.6	IAEA 158
43	Zn	mg kg^{-1}	No	ICP-MS	83.9			-1.29		No QC reported
44	Zn	mg kg^{-1}	No	XRF	88.4	1.0	2	-0.9	-3.6	ISE983-WEPAL
45	Zn	mg kg^{-1}	No	XRF	157	22	2	4.6	5.0	IAEA 433

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
46	Zn	mg kg^{-1}	No	NAA	94.9	5.7	2	-0.4	-1.2	INCT OBTL-5
47	Zn	mg kg^{-1}	Yes	ICP-MS	101	12	2	0.1	0.2	MESS 3
53	Zn	mg kg^{-1}	No	NAA	107	11	2	0.6	1.2	SRM 2709a
56	Zn	mg kg^{-1}	No	NAA	89.2	12.3	2	-0.9	-1.6	SRM 2711a
58	Zn	mg kg^{-1}	No	F AAS	80.6			-1.56		No QC reported
61	Zn	mg kg^{-1}	No	XRF	103	10	2	0.3	0.5	IAEA 457
62	Zn	mg kg^{-1}	Yes	ICP-MS	97.7			-0.19		MESS 4
63	Zn	mg kg^{-1}	No	F AAS	80.8	4.4	2	-1.5	-4.9	RT 008
64	Zn	mg kg^{-1}	Yes	ICP-MS	96.8	5.0	2	-0.3	-0.8	IAEA 433
65	Zn	mg kg^{-1}	Yes	F AAS	73.5			-2.12		IAEA 457
66	Zn	mg kg^{-1}	No	F AAS	102	14	2	0.1	0.2	IAEA 433
67	Zn	mg kg^{-1}	Yes	F AAS	94.6	3.6		-0.4	-1.5	IAEA 433
70	Zn	mg kg^{-1}	Yes	ICP-OES	99.1	2.7	2	-0.1	-0.3	IAEA 433
71	Zn	mg kg^{-1}	No	ICP-MS	70.8	20.8	2	-2.3	-2.7	No QC reported
72	Zn	mg kg^{-1}	Yes	ICP-MS	93.5			-0.52		MESS 4
73	Zn	mg kg^{-1}	Yes	F AAS	95.9			-0.3	-0.2	MESS 3
74	Zn	mg kg^{-1}	No	F AAS	86.0	3.5	2	-1.1	-3.8	IAEA 405
75	Zn	mg kg^{-1}	Yes	ET-AAS	99.3	3.6	2	-0.1	-0.2	IAEA 158
76	Zn	mg kg^{-1}	Yes	F AAS	103	2	2	0.2	0.7	BS-1TM
77	Zn	mg kg^{-1}	Yes	ICP-OES	71.1	9.6	2	-2.3	-5.0	GBW7312

TABLE 5. REPORTED RESULTS BY PARTICPANT (cont.)

lab code	Analyte	Unit	HF	Instrumental Method	Lab Mean	Lab U	*k*	*z*-score	Zeta score	QC
78	Zn	mg kg^{-1}	No	ICP-MS	76.8	9.8	2	-1.9	-4.0	MESS 4
80	Zn	mg kg^{-1}	No	ICP-MS	59.0	23.6	2	-3.3	-3.4	TORT 3
81	Zn	mg kg^{-1}	Yes	ICP-MS	86.7	16.4	2	-1.1	-1.5	NWTH2
82	Zn	mg kg^{-1}	Yes	ICP-OES	88.0	8.8	2	-1.0	-2.2	No QC reported
83	Zn	mg kg^{-1}	No	ICP-MS	85.5	6.4	1.96	-1.2	-3.2	IAEA 359
84	Zn	mg kg^{-1}	No	ICP-MS	88.4	8.8	2	-0.9	-2.1	IAEA 407
85	Zn	mg kg^{-1}	No	XRF	75.7	5.3	2	-1.9	-5.8	IAEA 433
86	Zn	mg kg^{-1}	Yes	ICP-MS	77.0	26.8	2	-1.8	-1.7	MESS 3
88	Zn	mg kg^{-1}	Yes	ICP-OES	98.7			-0.11		MESS 3
89	Zn	mg kg^{-1}	No	ICP-OES	72.9	3.2	2	-2.2	-7.5	PACS 2
90	Zn	mg kg^{-1}	No	ICP-MS	84.5	16.9	2	-1.2	-1.7	No QC reported
91	Zn	mg kg^{-1}	No	ICP-MS	85.9	12.6	2	-1.1	-2.0	CRM 015
93	Zn	mg kg^{-1}	Yes	ICP-OES	103	8	2	0.2	0.5	IAEA 458
95	Zn	mg kg^{-1}	Yes	ICP-MS	104			0.29		MESS 4
96	Zn	mg kg^{-1}	No Info	F AAS	90.0			-0.81		PACS 2
97	Zn	mg kg^{-1}	Yes	ICP-MS	99.4			-0.1	-0.2	MESS 3
98	Zn	mg kg^{-1}	No	ICP-MS	85.8	2.9	2	-1.1	-4.0	IAEA 433
99	Zn	mg kg^{-1}	Yes	ICP-OES	99.0			-0.08		CRM 7002
100	Zn	mg kg^{-1}	Yes	F AAS	82.3	16.5	2	-1.4	-2.0	IAEA 458

REFERENCES

[1] CARVALHO, F.P., The inter-agency programme on marine pollution, IAEA Bulletin, **40**, 3 (1998) 7–10.

[2] COQUERY, M., et al., The IAEA worldwide intercomparison exercises (1990-1997): determination of trace elements in marine sediments and biological samples, Sci Total Environ., **30** (1999) 237–238, 501–8.

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Worldwide and regional laboratory Comparison on the Determination of Organochlorine Compounds, Polybrominated Diphenyl Ethers and Petroleum Hydrocarbons in IAEA 451 clam (grafrarium tumidum) sample, IAEA Analytical Quality in Nuclear Applications Series No. 28 (IAEA/AQ/28), IAEA, Vienna (2013)

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Worldwide Interlaboratory Comparison on the Determination of Trace Elements in Fish Sample IAEA-MESL-ILC-TE-BIOTA-2017, IAEA Analytical Quality in Nuclear Applications Series No. 55 (IAEA/AQ/55), IAEA, Vienna (2018).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Worldwide Interlaboratory Comparison on the Determination of Trace Elements in IAEA 457 Marine Sediment Sample, IAEA Analytical Quality in Nuclear Applications Series No. 46 (IAEA/AQ/46), IAEA, Vienna (2016).

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Certification of Trace Elements Mass Fractions in Marine Sediment IAEA 475, IAEA Analytical Quality in Nuclear Applications Series No. XX (IAEA/AQ/XX), IAEA, Vienna (2019). *under preparation*

[7] INTERNATIONAL ORGANISATION FOR STANDARDISATION, Guide 13528 2005, Statistical Methods for Use in Proficiency Testing by Interlaboratory Comparisons, ISO, Geneva (2005).

[8] ROYAL SOCIETY OF CHEMISTRY, Statistical Subcommittee of the Analytical Methods Committee (AMC), AMC Technical Brief: Representing data distributions with Kernel density estimates" 2006, www.rsc.org/amc.

[9] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, Reference materials — Guidance for characterization and assessment of homogeneity and stability, ISO Guide 35:2017, ISO, Geneva (2017)

[10] INTERNATIONAL ORGANISATION FOR STANDARDISATION, ISO/IEC 17043:2010(E), Conformity assessment — General requirements for proficiency testing ISO, Geneva (2010).

[11] VASSILEVA, E., QUÉTEL, C.R., Influence of the correction for moisture/water content on the quality of the certification of cadmium, copper and lead mass fractions in rice, Food Chem., **106** (2008) 1485–1490.

[12] INTERNATIONAL ORGANISATION FOR STANDARDISATION, ISO/IEC 17025:2017. General requirements for the competence of testing and calibration laboratories, ISO, Geneva (2017).

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INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA
ISSN 2074–7659