Worldwide Open Proficiency Test for Nuclear and Related Analytical Techniques Laboratories

PTNATIAEA16

Determination of Major, Minor and Trace Elements in a Cereal Grain

CONTENTS

FOREWORD

The IAEA assists its Member States laboratories to continuously improve their analytical performance by producing reference materials, by developing standardized analytical methods, and by conducting inter-laboratory comparisons and proficiency tests. To ensure a reliable worldwide, rapid and consistent response, the IAEA Nuclear Science and Instrumentation Laboratory in Seibersdorf, Austria, coordinates proficiency tests for Member States laboratories.

This summary report presents the results of the worldwide proficiency test PTNATIAEA16 on the determination of major, minor and trace elements in a cereal grain. Methodologies, statistical analysis, and evaluation of results (for each element and for each laboratory) are also reported. The test was carried out within the IAEA project Nuclear Instrumentation, under the Accelerators and Nuclear Spectrometry Subprogram, Nuclear Science Program. The main objective of the project is to enhance capability of interested Member States in effective utilization of nuclear spectrometry and analytical services in industry, human health, agriculture, and in monitoring and evaluation of the environment.

This proficiency test was designed to identify potential analytical problems, to support IAEA Member States laboratories to improve the quality of their analytical results, to maintain their accreditation and to provide a regular forum for discussion and technology transfer in this topic.

The coordinator of the proficiency test and responsible for this publication was Mr. A. Migliori of the IAEA Nuclear Science and Instrumentation Laboratory, Seibersdorf (Austria).

1. INTRODUCTION

The PTNATIAEA16 proficiency test was aimed at nuclear and related analytical techniques laboratories. The participants were requested to use their established and proven analytical procedures for the determination of major, minor and trace elements in a cereal grain.

Cereal grain samples with established homogeneity and well characterized known target values of the mass fractions of analytes were distributed to participating laboratories. The laboratories were requested to analyze the samples using established techniques following their analytical procedures. Based on the results of the proficiency test presented in this report, each participating laboratory should assess its analytical performance by using the specified criteria and, if appropriate, to identify discrepancies, and to correct relevant analytical procedures.

The Proficiency Test was announced on March 4th, 2019. The air filters were distributed to the participating laboratories in March/April 2019. The deadline for submission of the results was July 26th, 2019 (the deadline was postponed almost one month due to problems faced in shipping the samples to part of the laboratories). The proficiency test was implemented exploiting a web based platform (www.pt-nsil.com) to facilitate and improve the processes and actions required for the organization and functionality of the exercise for the participants and the coordinator. Detailed instructions for analysts were also available on the website.

The submitted results were processed, grouped versus analytes/laboratories and compared with the analyte's assigned values. The values of *z*- and of *u*-scores were calculated for three fit-for-purpose levels. For the definitions of the *z*- and *u*-scores please see Section 3.2. The obtained results as well as the description of the data evaluation procedures are described in this report. Each laboratory was assigned a code, therefore full anonymity of the presented results is guaranteed. The link between the laboratory code and the laboratory name is known only to the organizers of the proficiency test and to the laboratory itself.

2. DESCRIPTION OF THE TEST SAMPLE

The test sample was a cereal grain prepared and tested by an external independent laboratory. The powdered, homogenized, and dried material was shipped to 75 laboratories in plastic bags, each containing around 10 g of the test sample. The participants were asked to conduct the determination of the mass fractions of chemical elements making up the sample according to their routine analytical procedures. They were also instructed to determine the moisture content of the material by using a separate sample and to report the results on a dry-weight basis. Only one result per element per analytical technique should be submitted. Each result should be accompanied by an estimate of its uncertainty expressed as one standard deviation. No restriction on the number of the reported elements was imposed.

3. DETAILS OF THE EXERCISE

3.1. ASSIGNED VALUE AND TARGET STANDARD DEVIATION

Assigned values X_A were defined in two steps. For a first evaluation, the reference values supplied by the provider of the material, established by independent inter-laboratory survey, were used as assigned values and the calculated *z*- and *u*-scores were promptly reported to the participants as a preliminary assessment included in the certificate of participation. This first evaluation was based on 24 certified values and on 5 indicative values.

After receiving the results from all participants, an evaluation of their density distribution was made. For those elements without well characterized values from the producer (including indicative values) but having more than 5 reported valid results and exhibiting a normal distribution (Figs 3-33), the mean or mode values were used as assigned values for a second evaluation[1].
The results for 55 analytes were submitted by participants of this proficiency test. The *z*- and *u*-scores were calculated for all the submitted results of all analytes (24 certified values and 5 consensus values after the second evaluation) except 26 elements, for which the assigned values were not available.
For each analyte a target value of the standard deviation has been assigned using a modified Horwitz function as proposed in the reference [1]:

$$H_A = \begin{cases} 0.22 X_A & X_A < 1.2 \cdot 10^{-7} \\ 0.02 \left(X_A\right)^{0.8495} & 1.2 \cdot 10^{-7} \le X_A \le 0.138 \\ 0.01 \sqrt{X_A} & X_A > 0.138 \end{cases} \quad (1)$$

In Eqn. (1) the assigned value of analyte, X_A, is expressed as a mass fraction. The target value of the standard deviation, σ_A is related to H_A by a factor *k*:

$$\sigma_A = kH_A, \quad k = 0.5, 1.0, 1.5 \quad (2)$$

Depending on the value of the factor *k* the target value of the standard deviation is recognized as fit-for-purpose at three levels of uncertainty: $k = 0.5$ - appropriate for high precision analysis; $k = 1.0$ - appropriate for well-established routine analysis; $k = 1.5$ - satisfactory for common analytical tasks. The relative value of the target standard deviation, *RSD*, expressed in per cent, is defined as follows:

$$RSD = \frac{\sigma_A}{X_A} \cdot 100\% \quad (3)$$

The relative value of the target standard deviation as a function of the assigned mass fraction of the analyte, X_A, is shown in Fig. 1 for the three different values of the *k* factor.

[1] Out of the 5 element with indicative values, only Sb was reported with more than 5 valid results and exhibited a normal distribution.

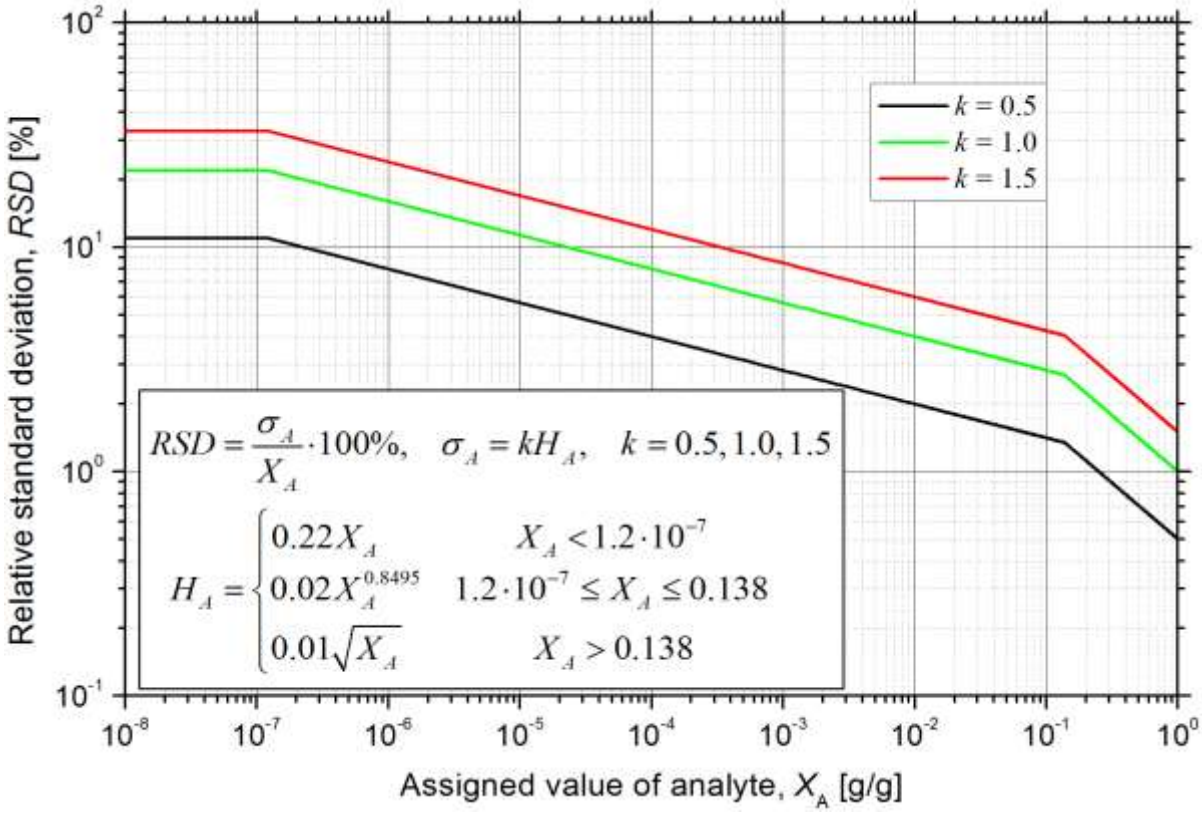

FIG. 1. Relative value of the target standard deviation, RSD, as a function of the assigned mass fraction of the analyte, X_A, calculated by using a modified Horwitz function, Eqn. (1).

3.2. *z*-SCORES AND *u*-SCORES

The reported concentrations of analytes were compared with the assigned values by using the *z*-score analysis. For every result a *z*-score was calculated:

$$z = \frac{x - X_A}{\sigma_A} \tag{4}$$

The term '*x*' denotes the reported mass fraction of analyte. Defined by different fit-for-purpose ranges of the target standard deviation, three different values of *z*-scores were calculated by combining Eqns. (2) and (4). Assuming that appropriate values for X_A and σ_A have been used and that the underlying distribution of analytical errors is normal, apart from outliers, in a well-behaved analytical system *z*-scores would be expected to fall outside the range $-2 \le z \le 2$ in about 4.6% of instances, and outside the range $-3 < z < 3$ only in about 0.3%. Therefore, based on the *z*-scores, the following decision limits were established:

$$\begin{aligned} |z| &\le 2 && \text{- a satisfactory result} \\ 2 < |z| &< 3 && \text{- the result is considered questionable} \\ |z| &\ge 3 && \text{- the result is considered unsatisfactory} \end{aligned} \tag{5}$$

The advice to the laboratory is that, independent of the fit-for-purpose range selected by the laboratory, any *z*-score for an element outside the range $-2 \le z \le 2$ should be examined by the analyst and all steps of the analytical procedure verified to identify the source(s) of the analytical bias.

For every participant the rescaled sum of *z*-scores, *RSZ*, as well as the sum of squared *z*-scores, *SSZ*, were calculated as defined by the following equations:

$$RSZ = \frac{\sum_{i=1}^{L} z_i}{\sqrt{L}} \tag{6}$$

$$SSZ = \sum_{i=1}^{L} (z_i)^2 \tag{7}$$

The symbol '*L*' denotes the number of results provided by the laboratory/participant for all the analytes determined. The summing up in Eqns. (6) and (7) takes into account all *z*-scores for all analytes with known assigned values reported by participant. The *RSZ* can be interpreted as a standardized normally distributed variable, with expected value equal to zero and unit variance. It is sensitive in detecting a small consistent bias in an analytical system, however, it is not sensitive in cases where there are even big errors but having opposite signs. The *SSZ* takes no account of the signs because it depends on the squared *z*-scores. It has a chi-squared (χ^2) distribution with *L* degrees of freedom. The *SSZ* can be regarded as complementary to *RSZ*, which means that if *RSZ* is well within the range $-3 < RSZ < 3$ and if at the same time the value of *SSZ* is above the $\chi^2_{critical}$ value the overall performance of the laboratory requires improvement.

The reported results were accompanied by the standard uncertainty estimate made by the participant. The values were used to calculate the *u*-scores:

$$u = \frac{|x - X_A|}{\sqrt{(\sigma_A)^2 + (\sigma_x)^2}} \tag{8}$$

The symbol 'σ_x' denotes the standard uncertainty of the submitted result *x*. If the assumptions about X_A and σ_A and about the normality of the underlying distributions are correct, and the laboratory estimate of σ_x takes into account all the significant sources of uncertainty, the *u*-scores would have a truncated normal distribution with unit variance. In a well-behaved analytical system only 0.1% of *u*-scores would fall outside the range $u < 3.29$. Therefore, the following decision limits for the *u*-scores were established:

$u \le 1.64$ - reported result does not differ from the assigned value
$1.64 < u \le 1.95$ - reported result probably does not differ from the assigned value
$1.95 < u \le 2.58$ - it is not clear whether the reported and assigned values differ (9)
$2.58 < u \le 3.29$ - reported result is probably different from the assigned value
$3.29 < u$ - reported result differs from the assigned value

The *u*-scores are especially useful for deciding whether the laboratory fit-for-purpose criteria are fulfilled. By comparing Eqn. (4) and Eqn. (8) one can notice that for corresponding values of *u*-score and *z*-score the following inequality is always fulfilled:

$$u \leq |z| \tag{10}$$

It implies that if the *u*-score is larger than 3.29 also the decision limit for the corresponding *z*-score is triggered and the laboratory has to check the analytical procedure as well as review the uncertainty budget estimation. If *u*-score stays below the value of 1.64 and at the same time the *z*-score decision limit is triggered ($|z| > 3$) the laboratory should reevaluate its fit-for-purpose status for that particular analyte.

3.3. CONSENSUS VALUES

To examine the overall performance of the participating laboratories the submitted results have been statistically processed and the consensus values were calculated. The results were tested for the presence of outliers using a set of seven outlier rejection tests, shown below:

Description of symbols:

$x_1 < ... < x_n$	- set of analytical results
$\bar{x}$	- mean value
s	- standard deviation

(11)

1. Coefficient of kurtosis [2], number of results: $5 \leq n \leq 100$, two-sided test, confidence level = 0.95:

$$b_2 = \frac{n\sum_{i=1}^{n}(\bar{x} - x_i)^4}{\left[\sum_{i=1}^{n}(\bar{x} - x_i)^2\right]^2} \tag{12}$$

   If b_2 > critical value then reject the result that is at the furthest distance from the mean, decrease *n*, repeat the procedure until $b_2 \leq$ critical value.

2. Coefficient of skewness [2], number of results, $5 \leq n \leq 60$, one-sided test, confidence level = 0.95:

$$\sqrt{b_1} = \frac{\sqrt{n}\sum_{i=1}^{n}(x_i - \bar{x})^3}{\left[\sum_{i=1}^{n}(x_i - \bar{x})^2\right]^{3/2}} \tag{13}$$

   If $\left|\sqrt{b_1}\right|$ > critical value then: if $\sqrt{b_1}$ is positive then reject x_n, otherwise reject x_1, decrease *n*, repeat the procedure until $\left|\sqrt{b_1}\right| \leq$ critical value.

3. Veglia's test [3,4], number of results: $4 \leq n \leq \infty$, two-sided test, confidence level = 0.95:

$$h = \sqrt{\frac{n}{n-1}}\,\frac{|x_k - \bar{x}_{n-1}|}{s_{n-1}} \tag{14}$$

where:

x_k , examined value, the result at the furthest distance from the mean

$\bar{x}_{n-1}$, the mean value of the population of the results with the examined result excluded

s_{n-1}, the standard deviation of the population of the results with the examined result excluded

If h > critical value then reject x_k otherwise temporarily exclude the x_k from the population of results and proceed with testing the next outlier candidate, if the following value of h > critical value then reject both results, decrease n respectively, repeat the procedure until $h \leq$ critical value.

4. Dixon's test [5], number of results: $3 \leq n \leq 25$, two-sided test, confidence level = 0.95:

If x_1 is at the furthest distance from the mean value, then calculate:

$$r = \begin{cases} (x_2 - x_1)/(x_n - x_1), & 3 \leq n \leq 7 \\ (x_2 - x_1)/(x_{n-1} - x_1), & 8 \leq n \leq 10 \\ (x_3 - x_1)/(x_{n-1} - x_1), & 11 \leq n \leq 13 \\ (x_3 - x_1)/(x_{n-2} - x_1), & 14 \leq n \leq 25 \end{cases} \tag{15a}$$

If x_n is at the furthest distance from the mean value then calculate:

$$r = \begin{cases} (x_n - x_{n-1})/(x_n - x_1), & 3 \leq n \leq 7 \\ (x_n - x_{n-1})/(x_n - x_2), & 8 \leq n \leq 10 \\ (x_n - x_{n-2})/(x_n - x_2), & 11 \leq n \leq 13 \\ (x_n - x_{n-2})/(x_n - x_3), & 14 \leq n \leq 25 \end{cases} \tag{15b}$$

If r > critical value then reject the tested result, decrease n, repeat the procedure until $r \leq$ critical value.

5. Outlier rejection test proposed in [2], number of results: $4 \leq n \leq 100$, two-sided test, confidence level = 0.95:

$$w/s = (x_n - x_1)/s \tag{16}$$

If w/s > critical value then: if $x_n - \bar{x} = \bar{x} - x_1$, reject both x_1 and x_n, otherwise reject x_k ($x_k = x_1$ *or* $x_k = x_n$), the result that is at the furthest distance from the mean, for the remaining population of results ($n' = n - 1$) calculate: $T_k = |\bar{x}' - x_k|/s'$, where: $\bar{x}'$ is the mean value and s' is the standard deviation of the population of the results excluding the rejected value x_k, if T_k > critical value then reject also the second extreme result, decrease n respectively, repeat the procedure until $w/s \leq$ critical value.

6. Outlier rejection test proposed in [6], number of results: $3 \le n < \infty$, two-sided test, confidence level = 0.95:

$$B_4 = \left| x_k - \bar{x} \right| / s \tag{17}$$

where:

x_k , examined value

If B_4 > critical value then reject the tested result, repeat the procedure until $B_4 \le$ critical value.

7. Outlier rejection test proposed in [7], number of results: $3 \le n \le 100$, two-sided test, confidence level = 0.95:

$$S_k^2 / S = \frac{\sum_{i=1, i \ne k}^{n} (x_i - \bar{x}')^2}{\sum_{i=1, i \ne k}^{n} (x_i - \bar{x})^2}, \quad k = 1 \, or \, k = n \tag{18}$$

where:

x_k , examined value, the result at the furthest distance from the mean

$\bar{x}'$, the mean value of the population of the results with the examined result x_k excluded

If S_k^2 / S > critical value then reject x_k , decrease *n*, repeat the procedure until $S_k^2 / S \le$ critical value.

The results which passed the outlier rejection procedures were used to calculate the consensus mean value of analyte, X_C, and corresponding consensus value of its standard deviation, σ_C:

$$X_C = \frac{\sum_{i=1}^{m} x_i}{m} \tag{19}$$

and

$$\sigma_C = \sqrt{\frac{\sum_{i=1}^{m} (x_i - X_C)^2}{m(m-1)}} \tag{20}$$

The term *m* denotes the number of reported values for a given analyte excluding the outliers rejected by at least one of the outlier rejections tests. The summing up in Eqn. (19) and (20) takes into account only the results which passed all the outlier rejection tests. The obtained consensus values were compared with the assigned values of the analytes.

4. RESULTS

The test samples were distributed to 75 laboratories for chemical composition analysis. Out of the 75 laboratories, 53 participated in the test submitting 741 individual results for 55 chemical elements. All submitted results have been evaluated. The list of the participating laboratories is presented at the end of this report.

The techniques used by the participants and their codes are listed in Table 1.

TABLE 1. THE CODING, DESCRIPTION AND THE ABBREVIATED NAMES OF THE ANALYTICAL TECHNIQUES USED BY PARTICIPANTS OF THE PROFICIENCY TEST EXERCISE

Technique Code	Description	Abbreviation
1.0	Energy dispersive X-ray fluorescence	EDXRF
1.1	EDXRF, radioisotope excitation	EDXRF-ISO
1.11	EDXRF, radioisotope excitation, 241Am	EDXRFISO-AM
1.13	EDXRF, radioisotope excitation, 109Cd	EDXRFISO-CD
1.14	EDXRF, radioisotope excitation, 238Pu	EDXRFISO-PU
1.2	EDXRF, X-ray tube excitation	EDXRFTUBE
1.21	EDXRF, X-ray tube direct excitation	EDXRFTUBE-DIRECT
1.22	EDXRF, X-ray tube and filter	EDXRFTUBE-FILTERS
1.23	EDXRF, X-ray tube and secondary targets	EDXRFTUBE-ST
1.24	Milli-XRF, x-ray tube and pin-hole collimator	m-XRF
1.3	Total reflection X-ray fluorescence	TXRF
1.32	TXRF with monochromator	TXRF-MON
1.4	EDXR, Synchrotron beam	SXRF
2.0	Wavelength dispersive X-ray fluorescence	WDXRF
4.2	Particle Induced X-ray Emission, vacuum chamber	PIXE-VAC
5.0	Neutron Activation Analysis	NAA
5.1	K0 Neutron Activation Analysis	K0 NAA
5.3	Radiochemical Neutron Activation Analysis	RNAA
5.4	Prompt Gamma Ray Activation Analysis	PGAA
6.0	Atomic absorption spectroscopy	AAS
7.1	ICP - optical emission spectrometry	ICP-OES
10	Other analytical technique	OTHER

In Table 2 a summary of the assigned analyte values, the target values of standard deviation (obtained by using modified Horwitz function), the consensus values and their standard deviations are shown. The elements for which the mean or mode values were considered as the assigned values in the second evaluation round are presented in italic. For 26 elements the assigned and target standard deviation values were not available. Elements for which indicative values were available but not enough results were submitted are presented in Table 2 in italic and with an asterisk symbol[2]. The consensus values (Eqn. 19) and corresponding standard deviations (Eqn. 20) were calculated based on 610 reported analytical results after excluding 131 results classified as outliers. The correlation between the assigned and the consensus values is shown in Fig. 2.

[2] The *z*- and *u*-scores for these elements are reported in Table 3 but they were not used to determined the *RSZ* and *SSZ* scores and they are not reported in the plots with the overall performance of the labs (Figs. 60-112).

TABLE 2. THE ASSIGNED VALUES OF ANALYTES, THE TARGET VALUES OF THE STANDARD DEVIATIONS AND THE CONSENSUS VALUES.

Analyte symbol	Assigned value of the analyte, X_A	Target value of standard deviation, σA			Consensus value of the analyte, X_C	Consensus value of the standard deviation, σ_C	Number of results	Number of outliers
		k = 0.5	k = 1.0	k = 1.5				
	[%]							
Ca	0.187	0.005	0.010	0.014	0.18	0.01	39	6
Cl	0.121	0.003	0.007	0.010	0.11	0.00	22	3
K	0.789	0.016	0.033	0.049	0.77	0.02	49	6
Mg	0.115	0.003	0.006	0.010	0.12	0.01	21	4
N	1.180	0.023	0.046	0.069	0.62	0.84	2	0
P	0.149	0.004	0.008	0.012	0.15	0.01	16	4
	[mg/kg]							
Al	*254.070*	*8.831*	*17.662*	*26.493*	279	15.51	18	6
*B**	*3.310*	*0.221*	*0.442*	*0.663*	2.80	0.10	1	0
Ba	3.510	0.232	0.465	0.697	5.92	0.86	8	0
Bi	-	-	-	-	3.39	1.60	4	0
Br	-	-	-	-	6.04	0.08	31	7
C	-	-	-	-	414700	6647	2	0
Ce	-	-	-	-	0.23	0.02	12	2
Cs	-	-	-	-	0.02	0.00	10	1
Cu	6.510	0.393	0.786	1.178	8.09	0.53	26	3
Eu	-	-	-	-	0.01	0.00	7	1
Fe	191.000	6.930	13.860	20.790	200	5.02	48	11
Ga	-	-	-	-	1.95	0.07	2	0
Hf	-	-	-	-	0.05	0.01	8	4
I	-	-	-	-	0.14	0.17	2	0
La	*0.106*	*0.012*	*0.023*	*0.035*	0.13	0.01	14	0
Lu	-	-	-	-	0.00	0.00	2	0
Mn	122.000	4.735	9.471	14.206	122	4.21	44	7
Na	103.000	4.101	8.202	12.303	137	2.33	26	7
Nb	-	-	-	-	16.21	7.38	3	0
Nd	-	-	-	-	0.17	0.02	1	0
Pd	-	-	-	-	6.98	1.73	1	0
Rb	3.250	0.218	0.435	0.653	3.24	0.11	35	5
S	935.000	26.712	53.424	80.136	1110	180	15	1
Sc	*0.022*	*0.002*	*0.005*	*0.007*	0.02	0.00	16	0
Si	-	-	-	-	3975	758	12	0
Sm	*0.016*	*0.002*	*0.004*	*0.005*	0.02	0.00	12	2

Analyte symbol	Assigned value of the analyte, X_A	Target value of standard deviation, σA			Consensus value of the analyte, X_C	Consensus value of the standard deviation, σ_C	Number of results	Number of outliers
		k = 0.5	k = 1.0	k = 1.5				
	[mg/kg]							
Sr	3.310	0.221	0.442	0.663	4.47	0.56	19	2
Ta	-	-	-	-	0.01	0.00	4	1
Tb	-	-	-	-	0.01	0.00	2	0
Th	-	-	-	-	0.03	0.00	8	2
Ti	-	-	-	-	14.39	3.35	13	3
Tl	-	-	-	-	0.90	0.40	1	0
U	-	-	-	-	0.02	0.01	3	1
W	-	-	-	-	10.67	10.62	4	1
Y	-	-	-	-	0.57	0.33	2	0
Yb	-	-	-	-	0.02	0.00	2	0
Zn	47.600	2.129	4.258	6.386	45.71	1.12	47	8
Zr	-	-	-	-	2.01	0.05	6	3
	[ug/kg]							
As	143.000	15.327	30.654	45.981	137	4.65	18	3
Cd	260.000	25.469	50.939	76.408	329	38.54	6	3
Co	81.400	8.954	17.908	26.862	84.34	4.21	19	4
Cr	454.000	40.895	81.790	123	537	39.56	15	6
Hg	5.400	0.594	1.188	1.782	31.75	13.85	4	0
Mo	170.000	17.753	35.506	53.258	123	61.82	5	2
Ni	522.000	46.043	92.085	138	508	53.31	12	8
Pb	921.000	74.583	149	224	1151	281	16	0
Sb	*34.867*	*3.835*	*7.671*	*11.506*	35.07	1.03	13	2
*Se**	*24.100*	*2.651*	*5.302*	*7.953*	28.96	15.50	5	1
V	402.000	36.880	73.760	111	441	28.87	8	1

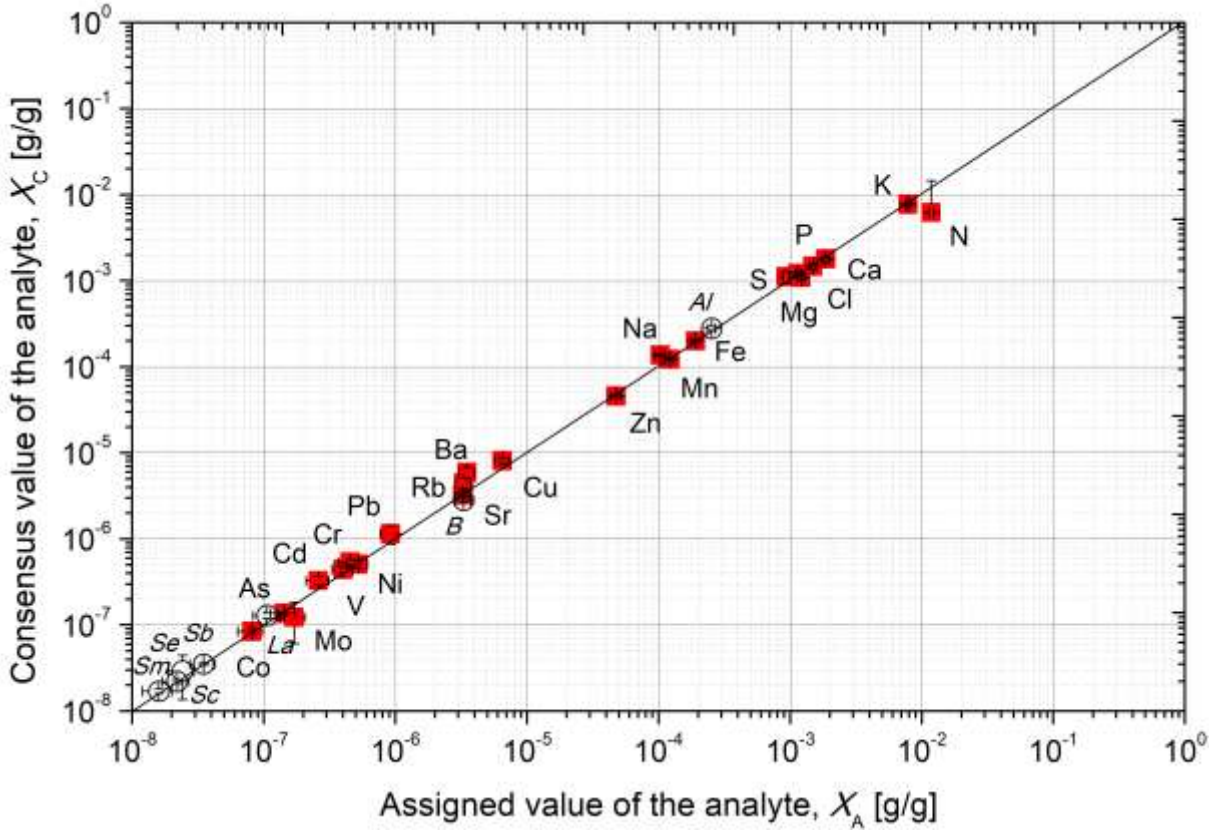

FIG. 2. Correlation between assigned, X_A, and consensus values of analytes, X_C[3].

Table 3 lists the values of the *z*- and *u*-scores for all submitted results. In brackets next to the element symbol the assigned values of element concentration and the target standard deviation for k = 1 are shown. The z- and *u*-scores were calculated for the three different fit-for-purpose ranges, as defined by Eqn. (2). The results rejected by the outliers rejection procedures were marked with "*" in the "Analyte concentration" column.

Table 4 shows the combined *z*-scores for the three different fit-for-purpose ranges, the *RSZ* and *SSZ* as defined in Eqns. (6) and (7), for the participating laboratories. The analytes without assigned values (even after the second evaluation) or with indicative values were not considered.

Figs. 3-33 and 34-59 present the distributions of the proficiency test results. In Figs 3-33 the individual results are marked with filled circles. The dotted lines show the range of the accepted results (these results were used to calculate the consensus values). The outliers are marked with arrows. Also shown are the estimated parameters of the distribution (after outlier rejection): mode, median, and the mean value. For few elements, the result of density distributions could

[3] The uncertainties of the assigned values were calculated according to Eqn. (2) with $k = 1$. The uncertainties of the consensus values were calculated according to Eqn. (20), except for the results reported by a single laboratory, in such a case the laboratory estimate of the uncertainty was shown in the plot. Solid red squares correspond to assigned values taken from the provider of the material. Hollow black circles correspond to the mode or mean values of the reported results used as assigned values after the second evaluation or to elements whose indicative value was known.

only be used as indicators of the trends observed in the reported data due to the limited number of results (only density distributions of analytes for which at least 5 results passed the outlier rejection tests are shown). All the populations of results, after outlier rejection, have passed a normality test (Kolmogorov-Smirnov). Please note that for some elements, especially in the case of Pb, two separate distribution differing by more than 3 orders of magnitude are noticeable. This is most likely related to a misunderstanding on the units to be used for reporting (mg/kg instead of ug/kg).
Figs. 34-59 show the bar chart distributions of the *z*-scores for the analytes with at least 6 submitted results. The results are sorted in ascending order versus laboratory/technique code. The bar charts show the distance between the reported and the assigned values of the analyte. The submitted results and their uncertainties are marked with filled squares accompanied by uncertainty bars. The horizontal lines show the admissible levels of z-score, $|z| < 2$, for three different ranges defined by factor k in Eqn. (2): $k = 0.5$ (solid black lines), $k = 1.0$ (solid green lines) and $k = 1.5$ (solid red lines).

For every participating laboratory its overall performance is presented in Figs. 60-112. The plots presented in this figure relate all the *u*-scores and *z*-scores calculated for a given laboratory. The hollow symbols denote the values calculated for specific fit-for-purpose levels as defined in Eqn. (2) with factor k, namely: $k = 0.5$ (black triangles), $k = 1.0$ (green circles), and $k = 1.5$ (red squares). The decision limits of unsatisfactory results were marked with black lines ($|z| > 3$, $u > 3.29$). They divide the plot area in four quadrants. Due to inequality (10) all the points accompanied by a laboratory estimate of the uncertainty fall always below the line $u = |z|$. The smaller the laboratory estimate of the uncertainty the closer the related point to the $u = |z|$ line. Points in the immediate proximity of the dashed diagonal line ($u = |z|$) have underestimated uncertainty values. The well performing laboratories would have more points located in the lower-left quadrant of the plot. If there are many points located in the upper-right quadrant it suggests that these results do not fall in the defined fit-for-purpose targets and that the laboratory provided too “narrow” uncertainty estimate.

Fig. 113 represents the proportion of results submitted according to the analytical techniques used. Most of the analyses were carried out either by neutron activation analysis (49.6%) or by energy dispersive X-ray fluorescence spectrometry (38.6%). PIXE results account for about 1.2% of the total and ICPMS for about 1.6%.

TABLE 3. SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
Ca (0.187 ± 0.010) [%]										
73	1.2	0.029*	0.001	3.45	-32.83	-16.41	-10.94	32.14	16.33	10.92
105	1.32	0.101	0.003	2.97	-17.87	-8.93	-5.96	15.16	8.53	5.83
39	1.24	0.112	0.009	8.04	-15.58	-7.79	-5.19	7.35	5.69	4.41
84	1.22	0.117	0.005	4.27	-14.54	-7.27	-4.85	10.09	6.45	4.58
64	1.14	0.13	0.03	23.08	-11.84	-5.92	-3.95	1.88	1.81	1.71
89	1	0.133	0.013	9.77	-11.22	-5.61	-3.74	3.9	3.34	2.78
127	1	0.139	0.004	2.88	-9.97	-4.99	-3.32	7.67	4.6	3.2
203	5.3	0.14	0.017	12.14	-9.76	-4.88	-3.25	2.66	2.41	2.11
183	5	0.15	0.005	3.33	-7.69	-3.84	-2.56	5.33	3.41	2.42
149	6	0.152	0.008	5.26	-7.27	-3.64	-2.42	3.75	2.8	2.12
169	5.1	0.157	0.01	6.37	-6.23	-3.12	-2.08	2.7	2.16	1.71
54	1.22	0.158	0.021	13.29	-6.03	-3.01	-2.01	1.35	1.26	1.14
199	5.1	0.158	0.021	13.29	-6.03	-3.01	-2.01	1.35	1.26	1.14
53	1.3	0.16	0.02	12.5	-5.61	-2.8	-1.87	1.31	1.22	1.09
79	1.13	0.168	0.002	1.19	-3.95	-1.97	-1.32	3.65	1.93	1.3
95	1.3	0.17	0.02	11.76	-3.53	-1.77	-1.18	0.83	0.77	0.69
69	1.1	0.175	0.029	16.57	-2.49	-1.25	-0.83	0.41	0.39	0.37
172	5.1	0.176	0.013	7.39	-2.29	-1.14	-0.76	0.79	0.68	0.57
152	5.3	0.177	0.009	5.08	-2.08	-1.04	-0.69	0.98	0.76	0.59
171	5.1	0.177	0.007	3.95	-2.08	-1.04	-0.69	1.18	0.84	0.62
176	5	0.185	0.004	2.16	-0.42	-0.21	-0.14	0.32	0.19	0.13
44	4.2	0.187	0.019	10.16	0	0	0	0	0	0
175	5.3	0.187	0.014	7.49	0	0	0	0	0	0
74	2	0.191	0.041	21.47	0.83	0.42	0.28	0.1	0.09	0.09
61	5	0.197	0.045	22.84	2.08	1.04	0.69	0.22	0.22	0.21
138	1.23	0.2	0.04	20	2.7	1.35	0.9	0.32	0.32	0.31
116	1.3	0.209	0.004	1.91	4.57	2.29	1.52	3.52	2.11	1.47
206	2	0.212	0.01	4.72	5.19	2.6	1.73	2.25	1.8	1.42
170	5	0.215	0.012	5.58	5.82	2.91	1.94	2.17	1.82	1.49
78	1	0.234	0.006	2.56	9.76	4.88	3.25	6.11	4.14	3.01
186	5.1	0.235	0.022	9.36	9.97	4.99	3.32	2.13	2	1.82
85	1.23	0.245	0.001	0.41	12.05	6.03	4.02	11.8	5.99	4.01
178	5.1	0.271	0.015	5.54	17.45	8.73	5.82	5.33	4.71	4.03
68	1.22	0.3	0.01	3.33	23.48	11.74	7.83	10.18	8.14	6.43
204	1.21	0.345*	0.01	2.9	32.83	16.41	10.94	14.24	11.38	9
5	1.22	0.36*	0.026	7.22	35.94	17.97	11.98	6.54	6.24	5.82
126	1.23	0.42*	0.002	0.48	48.41	24.2	16.14	44.7	23.7	15.98
96	1.13	0.518*	0.026	5.02	68.77	34.38	22.92	12.52	11.94	11.13
209	1.4	0.77*	0.15	19.48	121.13	60.56	40.38	3.88	3.88	3.87
Cl (0.121 ± 0.007) [%]										
204	1.21	0.071	0.004	5.63	-15.04	-7.52	-5.01	9.61	6.44	4.65
186	5.1	0.087	0.016	18.39	-10.22	-5.11	-3.41	2.08	1.96	1.8
105	1.32	0.091	0.001	1.1	-9.02	-4.51	-3.01	8.64	4.46	2.99
138	1.23	0.095	0.03	31.58	-7.82	-3.91	-2.61	0.86	0.85	0.82
69	1.1	0.097	0.016	16.49	-7.22	-3.61	-2.41	1.47	1.39	1.27

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
183	5.4	0.098	0.004	4.08	-6.92	-3.46	-2.31	4.42	2.96	2.14
68	1.22	0.1	0.001	1	-6.32	-3.16	-2.11	6.05	3.12	2.09
193	5	0.11	0.001	0.91	-3.31	-1.65	-1.1	3.17	1.64	1.1
191	5	0.11	0.005	4.55	-3.31	-1.65	-1.1	1.83	1.32	0.99
152	5.3	0.11	0.006	5.45	-3.31	-1.65	-1.1	1.6	1.23	0.94
44	4.2	0.115	0.012	10.43	-1.8	-0.9	-0.6	0.48	0.44	0.38
139	5	0.115	0.005	4.35	-1.8	-0.9	-0.6	1	0.72	0.54
176	5	0.116	0.002	1.72	-1.5	-0.75	-0.5	1.29	0.72	0.49
172	5.1	0.116	0.005	4.31	-1.5	-0.75	-0.5	0.83	0.6	0.45
175	5.3	0.116	0.015	12.93	-1.5	-0.75	-0.5	0.33	0.3	0.28
199	5.1	0.12	0.037	30.83	-0.3	-0.15	-0.1	0.03	0.03	0.03
178	5.1	0.134	0.005	3.73	3.91	1.95	1.3	2.16	1.56	1.17
170	5	0.136	0.007	5.15	4.51	2.26	1.5	1.94	1.55	1.23
53	2	0.14	0.01	7.14	5.71	2.86	1.9	1.8	1.58	1.35
126	1.23	0.18*	0.01	5.56	17.74	8.87	5.91	5.6	4.91	4.18
206	2	0.336*	0.02	5.95	64.66	32.33	21.55	10.6	10.2	9.62
5	1.22	0.74*	0.08	10.81	186.15	93.08	62.05	7.73	7.71	7.68
					K (0.789 ± 0.033) [%]					
72	1.3	0.025*	0.001	4	-46.72	-23.36	-15.57	46.64	23.35	15.57
73	1.2	0.108*	0.001	0.93	-41.65	-20.82	-13.88	41.57	20.81	13.88
207	7.1	0.429	0.002	0.47	-22.02	-11.01	-7.34	21.85	10.99	7.33
105	1.32	0.519	0.061	11.75	-16.51	-8.26	-5.5	4.28	3.9	3.45
84	1.22	0.523	0.008	1.53	-16.27	-8.13	-5.42	14.61	7.9	5.35
89	1	0.525	0.04	7.62	-16.14	-8.07	-5.38	6.11	5.11	4.17
85	1.23	0.576	0.042	7.29	-13.03	-6.51	-4.34	4.73	4	3.3
167	5	0.587	0.045	7.67	-12.35	-6.18	-4.12	4.22	3.63	3.03
54	1.22	0.623	0.075	12.04	-10.15	-5.08	-3.38	2.16	2.03	1.85
203	5.3	0.63	0.044	6.98	-9.72	-4.86	-3.24	3.39	2.9	2.41
152	5.3	0.656	0.033	5.03	-8.13	-4.07	-2.71	3.61	2.86	2.25
184	5	0.667	0.022	3.3	-7.46	-3.73	-2.49	4.45	3.1	2.27
183	5	0.672	0.014	2.08	-7.16	-3.58	-2.39	5.44	3.29	2.29
127	1	0.693	0.164	23.67	-5.87	-2.94	-1.96	0.58	0.57	0.56
61	5	0.73	0.17	23.29	-3.61	-1.8	-1.2	0.35	0.34	0.33
156	10	0.74	0.01	1.35	-3	-1.5	-1	2.56	1.43	0.98
191	5	0.76	0.005	0.66	-1.77	-0.89	-0.59	1.7	0.88	0.59
169	5.1	0.774	0.028	3.62	-0.92	-0.46	-0.31	0.46	0.35	0.27
172	5.1	0.775	0.014	1.81	-0.86	-0.43	-0.29	0.65	0.39	0.27
116	1.3	0.776	0.023	2.96	-0.8	-0.4	-0.27	0.46	0.33	0.24
79	1.13	0.781	0.02	2.56	-0.49	-0.24	-0.16	0.31	0.21	0.15
195	5	0.781	0.046	5.89	-0.49	-0.24	-0.16	0.16	0.14	0.12
171	5.1	0.785	0.012	1.53	-0.24	-0.12	-0.08	0.2	0.11	0.08
186	5.1	0.79	0.02	2.53	0.06	0.03	0.02	0.04	0.03	0.02
176	5	0.793	0.005	0.63	0.24	0.12	0.08	0.23	0.12	0.08
193	5	0.8	0.002	0.25	0.67	0.34	0.22	0.67	0.34	0.22
53	1.3	0.8	0.09	11.25	0.67	0.34	0.22	0.12	0.11	0.11
199	5.1	0.801	0.016	2	0.73	0.37	0.24	0.52	0.33	0.23
74	2	0.813	0.01	1.23	1.47	0.73	0.49	1.25	0.7	0.48
69	1.1	0.817	0.138	16.89	1.71	0.86	0.57	0.2	0.2	0.19
175	5.3	0.822	0.066	8.03	2.02	1.01	0.67	0.49	0.45	0.4

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
44	4.2	0.824	0.085	10.32	2.14	1.07	0.71	0.4	0.38	0.36
78	1	0.826	0.009	1.09	2.26	1.13	0.75	1.98	1.09	0.74
40	5.1	0.84	0.04	4.76	3.12	1.56	1.04	1.18	0.99	0.81
170	5	0.845	0.003	0.36	3.42	1.71	1.14	3.37	1.71	1.14
138	1.23	0.85	0.15	17.65	3.73	1.87	1.24	0.4	0.4	0.39
149	5	0.863	0.025	2.9	4.53	2.26	1.51	2.48	1.8	1.34
178	5.1	0.87	0.028	3.22	4.95	2.48	1.65	2.5	1.88	1.43
202	5.1	0.882	0.051	5.78	5.69	2.84	1.9	1.74	1.54	1.31
206	2	0.928	0.03	3.23	8.5	4.25	2.83	4.07	3.13	2.42
96	1.13	0.929	0.047	5.06	8.56	4.28	2.85	2.81	2.45	2.06
39	1.24	0.988	0.108	10.93	12.17	6.08	4.06	1.82	1.76	1.68
64	1.14	1	0.2	20	12.9	6.45	4.3	1.05	1.04	1.02
95	1.3	1.01	0.15	14.85	13.52	6.76	4.51	1.46	1.44	1.4
5	1.22	1.15	0.05	4.35	22.08	11.04	7.36	6.86	6.04	5.15
204	1.21	1.487*	0.076	5.11	42.69	21.34	14.23	8.98	8.44	7.72
126	1.23	1.54*	0.07	4.55	45.93	22.96	15.31	10.45	9.72	8.79
209	1.4	2.3*	0.2	8.7	92.41	46.2	30.8	7.53	7.46	7.34
68	1.22	2.92*	0.03	1.03	130.32	65.16	43.44	62.37	48.02	37.06
Mg (0.115 ± 0.006) [%]										
193	5	0.07	0.001	1.43	-14.13	-7.07	-4.71	13.48	6.98	4.68
186	5.1	0.087	0.016	18.39	-8.79	-4.4	-2.93	1.72	1.63	1.5
207	7.1	0.09	0.002	2.22	-7.85	-3.93	-2.62	6.65	3.74	2.56
191	5	0.096	0.008	8.33	-5.97	-2.98	-1.99	2.21	1.86	1.52
105	1.32	0.097	0.048	49.48	-5.65	-2.83	-1.88	0.37	0.37	0.37
139	5	0.105	0.005	4.76	-3.14	-1.57	-1.05	1.69	1.23	0.93
176	5	0.116	0.003	2.59	0.31	0.16	0.1	0.23	0.14	0.1
199	5.1	0.117	0.009	7.69	0.63	0.31	0.21	0.21	0.18	0.15
149	6	0.12	0.004	3.33	1.57	0.79	0.52	0.98	0.66	0.48
152	5.3	0.127	0.006	4.72	3.77	1.88	1.26	1.77	1.37	1.06
172	5.1	0.132	0.007	5.3	5.34	2.67	1.78	2.21	1.8	1.44
178	5.1	0.141	0.01	7.09	8.16	4.08	2.72	2.48	2.19	1.88
170	5	0.141	0.002	1.42	8.16	4.08	2.72	6.91	3.89	2.66
44	4.2	0.149	0.011	7.38	10.68	5.34	3.56	2.97	2.67	2.33
53	2	0.15	0.01	6.67	10.99	5.5	3.66	3.33	2.95	2.53
78	1	0.159	0.008	5.03	13.82	6.91	4.61	5.11	4.3	3.53
85	1.23	0.168	0.009	5.36	16.64	8.32	5.55	5.55	4.81	4.04
206	2	0.24*	0.01	4.17	39.25	19.63	13.08	11.91	10.54	9.04
126	1.23	0.307*	0.01	3.26	60.29	30.14	20.1	18.29	16.19	13.88
195	5	0.505*	0.081	16.04	122.46	61.23	40.82	4.81	4.8	4.78
204	1.21	0.578*	0.013	2.25	145.38	72.69	48.46	34.59	31.98	28.7
N (1.18 ± 0.046) [%]										
206	2	0.029	0.005	17.24	-50	-25	-16.67	48.87	24.86	16.62
156	10	1.21	0.09	7.44	1.3	0.65	0.43	0.32	0.3	0.26
P (0.149 ± 0.008) [%]										
138	1.23	0.1	0.05	50	-12.35	-6.17	-4.12	0.98	0.97	0.95
105	1.32	0.102	0.009	8.82	-11.84	-5.92	-3.95	4.78	3.92	3.15
69	1.1	0.127	0.022	17.32	-5.54	-2.77	-1.85	0.98	0.94	0.88

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
53	1.3	0.13	0.01	7.69	-4.79	-2.39	-1.6	1.77	1.49	1.22
183	5.4	0.13	0.01	7.69	-4.79	-2.39	-1.6	1.77	1.49	1.22
116	1.3	0.149	0.004	2.68	0	0	0	0	0	0
74	2	0.154	0.001	0.65	1.26	0.63	0.42	1.22	0.63	0.42
73	1.2	0.161	0.015	9.32	3.02	1.51	1.01	0.77	0.71	0.63
204	1.21	0.163	0.011	6.75	3.53	1.76	1.18	1.2	1.03	0.86
78	1	0.173	0.002	1.16	6.05	3.02	2.02	5.4	2.93	1.99
44	4.2	0.185	0.013	7.03	9.07	4.54	3.02	2.65	2.36	2.04
85	1.23	0.191	0.003	1.57	10.58	5.29	3.53	8.44	4.95	3.42
126	1.23	0.318*	0.015	4.72	42.59	21.29	14.2	10.89	9.96	8.82
68	1.22	0.324*	0.01	3.09	44.1	22.05	14.7	16.27	13.71	11.26
206	2	0.568*	0.02	3.52	105.58	52.79	35.19	20.55	19.47	18
207	7.1	1.82*	0.002	0.11	421.07	210.54	140.36	376.02	204.15	138.42

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					k = 0.5	*k* = 1.0	*k* = 1.5	*k* = 0.5	*k* = 1.0	*k* = 1.5
				Al (254.07 ± 17.662) [mg/kg]						
207	7.1	1.475*	0.04	2.71	-28.6	-14.3	-9.53	28.6	14.3	9.53
139	5	203	11	5.42	-5.78	-2.89	-1.93	3.62	2.45	1.78
116	1.3	217.35	6.48	2.98	-4.16	-2.08	-1.39	3.35	1.95	1.35
172	5.1	238	15	6.3	-1.82	-0.91	-0.61	0.92	0.69	0.53
193	5	250	0.04	0.02	-0.46	-0.23	-0.15	0.46	0.23	0.15
195	5	253	60.47	23.9	-0.12	-0.06	-0.04	0.02	0.02	0.02
199	5.1	259.21	8.31	3.21	0.58	0.29	0.19	0.42	0.26	0.19
176	5	270	4	1.48	1.8	0.9	0.6	1.64	0.88	0.59
152	5.3	293	52	17.75	4.41	2.2	1.47	0.74	0.71	0.67
178	5.1	313	9.91	3.17	6.67	3.34	2.22	4.44	2.91	2.08
78	1	322	12	3.73	7.69	3.85	2.56	4.56	3.18	2.34
167	5	342.775	9.241	2.7	10.04	5.02	3.35	6.94	4.45	3.16
204	1.21	385	26	6.75	14.83	7.41	4.94	4.77	4.17	3.53
202	5.1	460*	35	7.61	23.32	11.66	7.77	5.7	5.25	4.69
206	2	560*	0.007	0	34.64	17.32	11.55	34.64	17.32	11.55
105	1.32	975*	764	78.36	81.64	40.82	27.21	0.94	0.94	0.94
69	1.1	2580*	469	18.18	263.38	131.69	87.79	4.96	4.96	4.95
183	5.4	5000*	200	4	537.42	268.71	179.14	23.71	23.64	23.52
				B (3.31 ± 0.442) [mg/kg]*						
183	5.4	2.8	0.1	3.57	-2.31	-1.15	-0.77	2.1	1.12	0.76
				Ba (3.51 ± 0.465) [mg/kg]						
69	1.1	1.95	0.28	14.36	-6.71	-3.36	-2.24	4.29	2.87	2.08
152	5.3	3.8	0.41	10.79	1.25	0.62	0.42	0.62	0.47	0.36
199	5.1	5.11	0.46	9	6.88	3.44	2.29	3.1	2.45	1.92
176	5	5.6	0.7	12.5	8.99	4.5	3	2.83	2.49	2.12
203	5.3	6.9	0.6	8.7	14.59	7.29	4.86	5.27	4.47	3.69
195	5	7.01	0.95	13.55	15.06	7.53	5.02	3.58	3.31	2.97
169	5.1	7.012	0.642	9.16	15.07	7.53	5.02	5.13	4.42	3.7
64	1.11	10	4	40	27.93	13.96	9.31	1.62	1.61	1.6
				Bi [mg/kg]						
69	1.1	0.76	0.19	25	-	-	-	-	-	-
126	1.23	1.2	0.6	50	-	-	-	-	-	-
68	1.22	3.9	1.2	30.77	-	-	-	-	-	-
206	2	7.7	0.009	0.12	-	-	-	-	-	-
				Br [mg/kg]						
152	5.3	3.2*	0.32	10	-	-	-	-	-	-
206	2	3.6*	0.009	0.25	-	-	-	-	-	-
69	1.1	4.8*	0.51	10.63	-	-	-	-	-	-
183	5	5.25	0.11	2.1	-	-	-	-	-	-
40	5.1	5.38	0.26	4.83	-	-	-	-	-	-
191	5	5.6	0.3	5.36	-	-	-	-	-	-
105	1.32	5.6	0.77	13.75	-	-	-	-	-	-
172	5.1	5.7	0.17	2.98	-	-	-	-	-	-
184	5	5.78	0.2	3.46	-	-	-	-	-	-

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
186	5.1	5.8	0.1	1.72	-	-	-	-	-	-
176	5	5.94	0.04	0.67	-	-	-	-	-	-
149	5	5.96	0.19	3.19	-	-	-	-	-	-
96	1.13	6	0.3	5	-	-	-	-	-	-
195	5	6.01	0.24	3.99	-	-	-	-	-	-
193	5	6.011	0.005	0.08	-	-	-	-	-	-
138	1.23	6.05	1.8	29.75	-	-	-	-	-	-
202	5.1	6.11	0.36	5.89	-	-	-	-	-	-
61	5.1	6.12	0.32	5.23	-	-	-	-	-	-
79	1.13	6.124	0.204	3.33	-	-	-	-	-	-
169	5.1	6.152	0.215	3.49	-	-	-	-	-	-
178	5.1	6.3	0.19	3.02	-	-	-	-	-	-
171	5.1	6.31	0.12	1.9	-	-	-	-	-	-
199	5.1	6.37	0.11	1.73	-	-	-	-	-	-
170	5	6.39	0.27	4.23	-	-	-	-	-	-
175	5.3	6.4	0.54	8.44	-	-	-	-	-	-
203	5.3	6.6	0.4	6.06	-	-	-	-	-	-
95	1.3	7	0.8	11.43	-	-	-	-	-	-
126	1.23	7.9*	2	25.32	-	-	-	-	-	-
64	1.11	15*	4	26.67	-	-	-	-	-	-
209	1.4	18.3*	1.2	6.56	-	-	-	-	-	-
204	1.21	31.5*	2.3	7.3	-	-	-	-	-	-
				C [mg/kg]						
183	5.4	410000	17000	4.15	-	-	-	-	-	-
206	2	419400	0.1	0	-	-	-	-	-	-
				Ce [mg/kg]						
152	5.3	0.158	0.016	10.13	-	-	-	-	-	-
203	5.3	0.16	0.017	10.63	-	-	-	-	-	-
171	5.1	0.187	0.036	19.25	-	-	-	-	-	-
196	5	0.196	0.01	5.1	-	-	-	-	-	-
40	5.1	0.2	0.03	15	-	-	-	-	-	-
175	5.3	0.23	0.05	21.74	-	-	-	-	-	-
193	5	0.26	0.003	1.15	-	-	-	-	-	-
176	5	0.305	0.02	6.56	-	-	-	-	-	-
199	5.1	0.31	0.07	22.58	-	-	-	-	-	-
183	5	0.34	0.01	2.94	-	-	-	-	-	-
202	5.1	0.48*	0.08	16.67	-	-	-	-	-	-
69	1.1	5.01*	0.56	11.18	-	-	-	-	-	-
				Cs [mg/kg]						
152	5.3	0.015	0.001	6.67	-	-	-	-	-	-
203	5.3	0.017	0.001	5.88	-	-	-	-	-	-
170	5	0.018	0.005	27.78	-	-	-	-	-	-
176	5	0.019	0.003	15.79	-	-	-	-	-	-
199	5.1	0.02	0.006	30	-	-	-	-	-	-
183	5	0.02	0.001	5	-	-	-	-	-	-
169	5.1	0.021	0.001	4.76	-	-	-	-	-	-
171	5.1	0.021	0.002	9.52	-	-	-	-	-	-

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
193	5	0.023	0.009	39.13	-	-	-	-	-	-
172	5.1	0.15*	0.019	12.67	-	-	-	-	-	-
				Cu (6.51 ± 0.786) [mg/kg]						
72	1.3	0.072*	0.011	15.28	-16.39	-8.2	-5.46	16.38	8.19	5.46
68	1.22	4.04	1.41	34.9	-6.29	-3.14	-2.1	1.69	1.53	1.34
193	5	5.13	0.02	0.39	-3.51	-1.76	-1.17	3.51	1.76	1.17
105	1.32	5.6	0.17	3.04	-2.32	-1.16	-0.77	2.13	1.13	0.76
53	1.3	6	0.7	11.67	-1.3	-0.65	-0.43	0.64	0.48	0.37
64	1.14	6	3	50	-1.3	-0.65	-0.43	0.17	0.16	0.16
108	1.3	6.02	0.49	8.14	-1.25	-0.62	-0.42	0.78	0.53	0.38
149	6	6.079	0.528	8.69	-1.1	-0.55	-0.37	0.65	0.46	0.33
85	1.23	6.21	0.07	1.13	-0.76	-0.38	-0.25	0.75	0.38	0.25
116	1.3	6.95	0.24	3.45	1.12	0.56	0.37	0.96	0.54	0.37
74	2	7.35	0.74	10.07	2.14	1.07	0.71	1	0.78	0.6
127	1	7.453	0.084	1.13	2.4	1.2	0.8	2.35	1.19	0.8
199	5.1	7.47	1.12	14.99	2.44	1.22	0.81	0.81	0.7	0.59
79	1.13	7.956	0.637	8.01	3.68	1.84	1.23	1.93	1.43	1.08
78	1.3	7.96	0.4	5.03	3.69	1.85	1.23	2.59	1.64	1.17
96	1.13	9	0.5	5.56	6.34	3.17	2.11	3.92	2.67	1.95
95	1.3	9.3	1.6	17.2	7.1	3.55	2.37	1.69	1.57	1.4
89	1	9.38	1.45	15.46	7.31	3.65	2.44	1.91	1.74	1.54
172	5.1	9.78	2.85	29.14	8.33	4.16	2.78	1.14	1.11	1.06
126	1.23	9.9	1	10.1	8.63	4.32	2.88	3.16	2.67	2.19
204	1.21	10.2	1.2	11.76	9.39	4.7	3.13	2.92	2.57	2.19
138	1.23	11	2.4	21.82	11.43	5.72	3.81	1.85	1.78	1.68
5	1.22	12.7	2.41	18.98	15.76	7.88	5.25	2.54	2.44	2.31
209	1.4	14.6	1.3	8.9	20.6	10.3	6.87	5.96	5.33	4.61
206	2	18.8*	0.001	0.01	31.29	15.65	10.43	31.29	15.65	10.43
69	1.1	29.5*	3.1	10.51	58.53	29.27	19.51	7.36	7.19	6.93
				Eu [mg/kg]						
152	5.3	0.002	0.001	50	-	-	-	-	-	-
199	5.1	0.005	0.001	20	-	-	-	-	-	-
176	5	0.006	0.001	16.67	-	-	-	-	-	-
183	5	0.01	0.001	10	-	-	-	-	-	-
195	5	0.012	0.004	33.33	-	-	-	-	-	-
202	5.1	0.02	0.003	15	-	-	-	-	-	-
172	5.1	0.053*	0.009	16.98	-	-	-	-	-	-
				Fe (191 ± 13.860) [mg/kg]						
207	7.1	1.912*	0.005	0.26	-27.29	-13.64	-9.1	27.29	13.64	9.1
72	1.3	3.299*	0.237	7.18	-27.08	-13.54	-9.03	27.07	13.54	9.03
73	1.2	78*	5	6.41	-16.31	-8.15	-5.44	13.22	7.67	5.28
84	1.22	82*	12	14.63	-15.73	-7.86	-5.24	7.87	5.95	4.54
85	1.23	131	5	3.82	-8.66	-4.33	-2.89	7.02	4.07	2.81
152	5.3	144	8	5.56	-6.78	-3.39	-2.26	4.44	2.94	2.11
89	1	158.33	12.63	7.98	-4.71	-2.36	-1.57	2.27	1.74	1.34
167	5	162.403	2.287	1.41	-4.13	-2.06	-1.38	3.92	2.04	1.37
68	1.22	167.31	28.79	17.21	-3.42	-1.71	-1.14	0.8	0.74	0.67

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
69	1.1	170	17.4	10.24	-3.03	-1.52	-1.01	1.12	0.94	0.77
95	1.3	170.8	4.8	2.81	-2.91	-1.46	-0.97	2.4	1.38	0.95
105	1.32	179	79	44.13	-1.73	-0.87	-0.58	0.15	0.15	0.15
183	5	180	4	2.22	-1.59	-0.79	-0.53	1.37	0.76	0.52
96	1.13	182	9	4.95	-1.3	-0.65	-0.43	0.79	0.54	0.4
53	1.3	184	20	10.87	-1.01	-0.51	-0.34	0.33	0.29	0.24
54	1.22	185	18	9.73	-0.87	-0.43	-0.29	0.31	0.26	0.22
199	5.1	186.645	6.564	3.52	-0.63	-0.31	-0.21	0.46	0.28	0.2
108	1.3	188	7	3.72	-0.43	-0.22	-0.14	0.3	0.19	0.14
149	5	189.77	7.154	3.77	-0.18	-0.09	-0.06	0.12	0.08	0.06
40	5.1	190	10	5.26	-0.14	-0.07	-0.05	0.08	0.06	0.04
171	5.1	197	4	2.03	0.87	0.43	0.29	0.75	0.42	0.28
44	4.2	199.6	45	22.55	1.24	0.62	0.41	0.19	0.18	0.17
193	5	200	0.005	0	1.3	0.65	0.43	1.3	0.65	0.43
138	1.23	205	45	21.95	2.02	1.01	0.67	0.31	0.3	0.28
170	5	205.4	1.9	0.93	2.08	1.04	0.69	2	1.03	0.69
196	5	210	10	4.76	2.74	1.37	0.91	1.56	1.11	0.82
186	5.1	210	8	3.81	2.74	1.37	0.91	1.8	1.19	0.85
176	5	210	4	1.9	2.74	1.37	0.91	2.37	1.32	0.9
178	5.1	211	23.2	11	2.89	1.44	0.96	0.83	0.74	0.64
169	5.1	215	9	4.19	3.46	1.73	1.15	2.11	1.45	1.06
116	1.3	216.43	9.45	4.37	3.67	1.83	1.22	2.17	1.52	1.11
74	2	219.629	109.925	50.05	4.13	2.07	1.38	0.26	0.26	0.26
172	5.1	221	21	9.5	4.33	2.16	1.44	1.36	1.19	1.02
195	5	225	10.9	4.84	4.91	2.45	1.64	2.63	1.93	1.45
39	1.24	225	18	8	4.91	2.45	1.64	1.76	1.5	1.24
127	1	228.746	5.769	2.52	5.45	2.72	1.82	4.19	2.51	1.75
184	5	230	27	11.74	5.63	2.81	1.88	1.4	1.29	1.14
202	5.1	234	11	4.7	6.2	3.1	2.07	3.31	2.43	1.83
79	1.13	238.2	2.775	1.16	6.81	3.41	2.27	6.32	3.34	2.25
203	5.3	247	9	3.64	8.08	4.04	2.69	4.93	3.39	2.47
78	1.3	288.76	4.39	1.52	14.11	7.05	4.7	11.92	6.72	4.6
64	1.14	300*	8	2.67	15.73	7.86	5.24	10.3	6.81	4.89
206	2	310*	0.005	0	17.17	8.59	5.72	17.17	8.59	5.72
175	5.3	324*	80	24.69	19.19	9.6	6.4	1.66	1.64	1.61
126	1.23	342*	17	4.97	21.79	10.89	7.26	8.23	6.88	5.62
5	1.22	509.8*	57.12	11.2	46	23	15.33	5.54	5.42	5.24
209	1.4	708*	97	13.7	74.6	37.3	24.87	5.32	5.28	5.21
204	1.21	738*	11	1.49	78.93	39.47	26.31	42.07	30.91	23.26
					Ga [mg/kg]					
69	1.1	1.9	0.27	14.21	-	-	-	-	-	-
206	2	2	0.004	0.2	-	-	-	-	-	-
					Hf [mg/kg]					
183	5	0.02	0.001	5	-	-	-	-	-	-
199	5.1	0.033	0.006	18.18	-	-	-	-	-	-
152	5.3	0.054	0.005	9.26	-	-	-	-	-	-
172	5.1	0.073	0.019	26.03	-	-	-	-	-	-
184	5	0.13*	0.03	23.08	-	-	-	-	-	-

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
202	5.1	0.14*	0.01	7.14	-	-	-	-	-	-
178	5.1	0.467*	0.046	9.85	-	-	-	-	-	-
126	1.23	3*	1	33.33	-	-	-	-	-	-
				I [mg/kg]						
186	5.1	0.015	0.003	20	-	-	-	-	-	-
172	5.1	0.261	0.104	39.85	-	-	-	-	-	-
				La (0.106 ± 0.023) [mg/kg]						
203	5.3	0.081	0.004	4.94	-2.14	-1.07	-0.71	2.03	1.06	0.71
152	5.3	0.097	0.01	10.31	-0.77	-0.39	-0.26	0.59	0.35	0.25
199	5.1	0.101	0.1	99.01	-0.43	-0.21	-0.14	0.05	0.05	0.05
171	5.1	0.102	0.013	12.75	-0.34	-0.17	-0.11	0.23	0.15	0.11
40	5.1	0.106	0.006	5.66	0	0	0	0	0	0
184	5	0.11	0.02	18.18	0.34	0.17	0.11	0.17	0.13	0.1
172	5.1	0.11	0.008	7.27	0.34	0.17	0.11	0.28	0.16	0.11
178	5.1	0.123	0.009	7.32	1.46	0.73	0.49	1.15	0.68	0.47
204	1.21	0.14	0.05	35.71	2.92	1.46	0.97	0.66	0.62	0.56
175	5.3	0.14	0.02	14.29	2.92	1.46	0.97	1.47	1.11	0.84
183	5	0.15	0.01	6.67	3.77	1.89	1.26	2.86	1.73	1.21
193	5	0.17	0.003	1.76	5.49	2.74	1.83	5.32	2.72	1.82
139	5	0.187	0.019	10.16	6.95	3.47	2.32	3.63	2.69	2.03
176	5	0.195	0.003	1.54	7.63	3.82	2.54	7.39	3.79	2.54
				Lu [mg/kg]						
199	5.1	0.004	0.001	25	-	-	-	-	-	-
152	5.3	0.005	0.001	20	-	-	-	-	-	-
				Mn (122 ± 9.471) [mg/kg]						
193	5	0.013*	0.002	15.38	-25.76	-12.88	-8.59	25.76	12.88	8.59
207	7.1	0.92*	0.004	0.43	-25.57	-12.78	-8.52	25.57	12.78	8.52
72	1.3	2.477*	0.008	0.32	-25.24	-12.62	-8.41	25.24	12.62	8.41
149	6	22.4*	1.229	5.49	-21.03	-10.52	-7.01	20.36	10.43	6.98
96	1.13	56	3	5.36	-13.94	-6.97	-4.65	11.77	6.64	4.55
84	1.22	58	10	17.24	-13.52	-6.76	-4.51	5.78	4.65	3.68
39	1.24	74.1	8.9	12.01	-10.12	-5.06	-3.37	4.75	3.69	2.86
85	1.23	95.1	5.5	5.78	-5.68	-2.84	-1.89	3.71	2.46	1.77
69	1.1	98.9	10.3	10.41	-4.88	-2.44	-1.63	2.04	1.65	1.32
64	1.14	100	10	10	-4.65	-2.32	-1.55	1.99	1.6	1.27
54	1.22	100	18	18	-4.65	-2.32	-1.55	1.18	1.08	0.96
89	1	102.2	8.43	8.25	-4.18	-2.09	-1.39	2.05	1.56	1.2
108	1.3	108	4	3.7	-2.96	-1.48	-0.99	2.26	1.36	0.95
167	5	109.738	0.692	0.63	-2.59	-1.29	-0.86	2.56	1.29	0.86
68	1.22	110.16	28.74	26.09	-2.5	-1.25	-0.83	0.41	0.39	0.37
191	5	113	12	10.62	-1.9	-0.95	-0.63	0.7	0.59	0.48
175	5.3	119.6	2.6	2.17	-0.51	-0.25	-0.17	0.44	0.24	0.17
139	5	120	7	5.83	-0.42	-0.21	-0.14	0.24	0.17	0.13
172	5.1	120	4	3.33	-0.42	-0.21	-0.14	0.32	0.19	0.14
53	1.3	120	13	10.83	-0.42	-0.21	-0.14	0.14	0.12	0.1
195	5	122	3.69	3.02	0	0	0	0	0	0

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
199	5.1	124.53	2.59	2.08	0.53	0.27	0.18	0.47	0.26	0.18
183	5.4	125	6	4.8	0.63	0.32	0.21	0.39	0.27	0.19
176	5	127.4	2	1.57	1.14	0.57	0.38	1.05	0.56	0.38
152	5.3	128	7	5.47	1.27	0.63	0.42	0.71	0.51	0.38
202	5.1	129	5	3.88	1.48	0.74	0.49	1.02	0.65	0.46
186	5.1	130	3.7	2.85	1.69	0.84	0.56	1.33	0.79	0.54
116	1.3	132.77	3.9	2.94	2.27	1.14	0.76	1.76	1.05	0.73
127	1	133.156	7.187	5.4	2.36	1.18	0.79	1.3	0.94	0.7
44	4.2	133.7	24.7	18.47	2.47	1.24	0.82	0.47	0.44	0.41
170	5	135	4	2.96	2.75	1.37	0.92	2.1	1.26	0.88
169	5.1	136	5	3.68	2.96	1.48	0.99	2.03	1.31	0.93
74	2	137.208	26.178	19.08	3.21	1.61	1.07	0.57	0.55	0.51
178	5.1	140	4.25	3.04	3.8	1.9	1.27	2.83	1.73	1.21
5	1.22	143.99	24.41	16.95	4.64	2.32	1.55	0.88	0.84	0.78
78	1.3	144.11	2.93	2.03	4.67	2.33	1.56	3.97	2.23	1.52
95	1.3	145.9	22.3	15.28	5.05	2.52	1.68	1.05	0.99	0.9
79	1.13	149	1.414	0.95	5.7	2.85	1.9	5.46	2.82	1.89
138	1.23	160	29	18.13	8.02	4.01	2.67	1.29	1.25	1.18
105	1.32	168	12	7.14	9.71	4.86	3.24	3.57	3.01	2.47
204	1.21	170	15	8.82	10.14	5.07	3.38	3.05	2.71	2.32
206	2	200*	0.004	0	16.47	8.24	5.49	16.47	8.24	5.49
126	1.23	238*	12	5.04	24.5	12.25	8.17	8.99	7.59	6.24
209	1.4	347*	44	12.68	47.51	23.76	15.84	5.08	5	4.87
Na (103 ± 8.202) [mg/kg]										
186	5.1	12*	3.6	30	-22.19	-11.09	-7.4	16.68	10.16	7.1
149	5	43.62*	1.905	4.37	-14.48	-7.24	-4.83	13.13	7.05	4.77
152	5.3	112	6	5.36	2.19	1.1	0.73	1.24	0.89	0.66
167	5	125.518	2.37	1.89	5.49	2.75	1.83	4.75	2.64	1.8
195	5	126	9.27	7.36	5.61	2.8	1.87	2.27	1.86	1.49
191	5	127	5	3.94	5.85	2.93	1.95	3.71	2.5	1.81
184	5	129	4	3.1	6.34	3.17	2.11	4.54	2.85	2.01
193	5	130.6	0.017	0.01	6.73	3.36	2.24	6.73	3.36	2.24
171	5.1	135	3	2.22	7.8	3.9	2.6	6.3	3.66	2.53
176	5	137.6	1	0.73	8.44	4.22	2.81	8.2	4.19	2.8
203	5.3	138	3.8	2.75	8.53	4.27	2.84	6.26	3.87	2.72
40	5.1	138	7	5.07	8.53	4.27	2.84	4.31	3.25	2.47
183	5.4	140	8	5.71	9.02	4.51	3.01	4.12	3.23	2.52
139	5	141	15	10.64	9.27	4.63	3.09	2.44	2.22	1.96
170	5	141.5	3.2	2.26	9.39	4.69	3.13	7.4	4.37	3.03
202	5.1	142	4	2.82	9.51	4.75	3.17	6.81	4.27	3.01
199	5.1	143.84	3.3	2.29	9.96	4.98	3.32	7.76	4.62	3.21
61	5	147	11	7.48	10.73	5.36	3.58	3.75	3.21	2.67
175	5.3	148	11	7.43	10.97	5.49	3.66	3.83	3.28	2.73
172	5.1	150	8	5.33	11.46	5.73	3.82	5.23	4.1	3.2
169	5.1	153	10	6.54	12.19	6.1	4.06	4.63	3.87	3.15
178	5.1	168*	8.38	4.99	15.85	7.92	5.28	6.97	5.54	4.37
204	1.21	196*	15	7.65	22.68	11.34	7.56	5.98	5.44	4.79
206	2	380*	0.006	0	67.54	33.77	22.51	67.54	33.77	22.51
156	10	2780*	385	13.85	652.74	326.37	217.58	6.95	6.95	6.95

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
126	1.23	6860*	1400	20.41	1647.59	823.79	549.2	4.83	4.83	4.83
					Nb [mg/kg]					
96	1.13	1.6	0.1	6.25	-	-	-	-	-	-
68	1.22	21.62	1	4.63	-	-	-	-	-	-
204	1.21	25.4	2.2	8.66	-	-	-	-	-	-
					Nd [mg/kg]					
152	5.3	0.165	0.021	12.73	-	-	-	-	-	-
					Pd [mg/kg]					
68	1.22	6.98	1.73	24.79	-	-	-	-	-	-
					Rb (3.25 ± 0.435) [mg/kg]					
79	1.13	1.808	0.064	3.54	-6.62	-3.31	-2.21	6.36	3.28	2.2
206	2	2	0.009	0.45	-5.74	-2.87	-1.91	5.74	2.87	1.91
152	5.3	2.3	0.23	10	-4.36	-2.18	-1.45	3	1.93	1.37
108	1.3	2.36	0.16	6.78	-4.09	-2.04	-1.36	3.29	1.92	1.32
105	1.32	2.6	0.4	15.38	-2.99	-1.49	-1	1.43	1.1	0.85
69	1.1	2.85	0.32	11.23	-1.84	-0.92	-0.61	1.03	0.74	0.55
53	1.3	2.9	0.3	10.34	-1.61	-0.8	-0.54	0.94	0.66	0.49
126	1.23	3.1	1	32.26	-0.69	-0.34	-0.23	0.15	0.14	0.13
184	5	3.1	0.6	19.35	-0.69	-0.34	-0.23	0.24	0.2	0.17
203	5.3	3.13	0.31	9.9	-0.55	-0.28	-0.18	0.32	0.22	0.17
78	1.3	3.15	0.16	5.08	-0.46	-0.23	-0.15	0.37	0.22	0.15
116	1.3	3.15	0.31	9.84	-0.46	-0.23	-0.15	0.26	0.19	0.14
183	5	3.2	0.12	3.75	-0.23	-0.11	-0.08	0.2	0.11	0.08
40	5.1	3.2	0.17	5.31	-0.23	-0.11	-0.08	0.18	0.11	0.07
85	1.23	3.24	0.12	3.7	-0.05	-0.02	-0.02	0.04	0.02	0.02
199	5.1	3.345	0.195	5.83	0.44	0.22	0.15	0.33	0.2	0.14
169	5.1	3.42	0.16	4.68	0.78	0.39	0.26	0.63	0.37	0.25
196	5	3.46	0.03	0.87	0.96	0.48	0.32	0.96	0.48	0.32
175	5.3	3.51	0.46	13.11	1.19	0.6	0.4	0.51	0.41	0.33
195	5	3.55	0.05	1.41	1.38	0.69	0.46	1.34	0.68	0.46
170	5	3.57	0.11	3.08	1.47	0.73	0.49	1.31	0.71	0.48
138	1.23	3.6	1.1	30.56	1.61	0.8	0.54	0.31	0.3	0.27
186	5.1	3.6	0.14	3.89	1.61	0.8	0.54	1.35	0.77	0.52
95	1.3	3.6	0.3	8.33	1.61	0.8	0.54	0.94	0.66	0.49
171	5.1	3.64	0.14	3.85	1.79	0.9	0.6	1.51	0.85	0.58
61	5.1	3.7	0.33	8.92	2.07	1.03	0.69	1.14	0.82	0.61
125	2	3.8	0.16	4.21	2.53	1.26	0.84	2.04	1.19	0.82
176	5	3.9	0.15	3.85	2.99	1.49	1	2.46	1.41	0.97
193	5	4	0.01	0.25	3.45	1.72	1.15	3.44	1.72	1.15
202	5.1	4.56	0.57	12.5	6.02	3.01	2.01	2.15	1.83	1.51
68	1.22	5.98*	0.77	12.88	12.54	6.27	4.18	3.41	3.09	2.7
96	1.13	7*	0.4	5.71	17.23	8.61	5.74	8.23	6.34	4.9
209	1.4	7.2*	0.2	2.78	18.14	9.07	6.05	13.36	8.24	5.78
204	1.21	9.5*	1.2	12.63	28.71	14.36	9.57	5.12	4.9	4.57
5	1.22	11.5*	2.1	18.26	37.9	18.95	12.63	3.91	3.85	3.75

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
S (935 ± 53.424) [mg/kg]										
72	1.3	15.833	0.366	2.31	-34.41	-17.21	-11.47	34.41	17.2	11.47
138	1.23	670	120	17.91	-9.92	-4.96	-3.31	2.16	2.02	1.84
105	1.32	736	83	11.28	-7.45	-3.72	-2.48	2.28	2.02	1.72
183	5.4	760	40	5.26	-6.55	-3.28	-2.18	3.64	2.62	1.95
69	1.1	767	132	17.21	-6.29	-3.14	-2.1	1.25	1.18	1.09
53	1.3	837	92	10.99	-3.67	-1.83	-1.22	1.02	0.92	0.8
116	1.3	883.57	16.19	1.83	-1.93	-0.96	-0.64	1.65	0.92	0.63
44	4.2	939.7	60.8	6.47	0.18	0.09	0.06	0.07	0.06	0.05
78	1	951	13	1.37	0.6	0.3	0.2	0.54	0.29	0.2
204	1.21	985	26	2.64	1.87	0.94	0.62	1.34	0.84	0.59
73	1.2	1336	67	5.01	15.01	7.51	5	5.56	4.68	3.84
126	1.23	1852	100	5.4	34.33	17.16	11.44	8.86	8.09	7.16
5	1.22	2300	400	17.39	51.1	25.55	17.03	3.4	3.38	3.35
206	2	2500	0.01	0	58.59	29.29	19.53	58.59	29.29	19.53
68	1.22	5326.12*	77.78	1.46	164.39	82.19	54.8	53.39	46.54	39.32
Sc (0.022 ± 0.005) [mg/kg]										
167	5	0.015	0.001	6.67	-2.89	-1.45	-0.96	2.67	1.42	0.96
152	5.3	0.016	0.002	12.5	-2.48	-1.24	-0.83	1.91	1.15	0.8
171	5.1	0.02	0.001	5	-0.83	-0.41	-0.28	0.76	0.4	0.27
183	5	0.02	0.001	5	-0.83	-0.41	-0.28	0.76	0.4	0.27
40	5.1	0.02	0.001	5	-0.83	-0.41	-0.28	0.76	0.4	0.27
184	5	0.02	0.002	10	-0.83	-0.41	-0.28	0.64	0.38	0.27
193	5	0.021	0.002	9.52	-0.41	-0.21	-0.14	0.32	0.19	0.13
172	5.1	0.022	0.002	9.09	0	0	0	0	0	0
203	5.3	0.022	0.001	4.55	0	0	0	0	0	0
199	5.1	0.022	0.001	4.55	0	0	0	0	0	0
195	5	0.023	0.002	8.7	0.41	0.21	0.14	0.32	0.19	0.13
202	5.1	0.023	0.001	4.35	0.41	0.21	0.14	0.38	0.2	0.14
169	5.1	0.024	0.001	4.17	0.83	0.41	0.28	0.76	0.4	0.27
178	5.1	0.024	0.003	12.5	0.83	0.41	0.28	0.52	0.35	0.25
175	5.3	0.026	0.002	7.69	1.65	0.83	0.55	1.27	0.76	0.53
176	5	0.029	0.001	3.45	2.89	1.45	0.96	2.67	1.42	0.96
Si [mg/kg]										
207	7.1	5.648	0.007	0.12	-	-	-	-	-	-
68	1.22	268.93	1.42	0.53	-	-	-	-	-	-
138	1.23	1130	370	32.74	-	-	-	-	-	-
53	2	3240	324	10	-	-	-	-	-	-
69	1.1	3600	616	17.11	-	-	-	-	-	-
44	4.2	3601.6	585.4	16.25	-	-	-	-	-	-
78	1	3863	54	1.4	-	-	-	-	-	-
204	1.21	4093	834	20.38	-	-	-	-	-	-
126	1.23	6261	1000	15.97	-	-	-	-	-	-
183	5.4	6600	300	4.55	-	-	-	-	-	-
74	2	7231.683	1179.808	16.31	-	-	-	-	-	-
206	2	7810	0.03	0	-	-	-	-	-	-

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					k = 0.5	k = 1.0	k = 1.5	k = 0.5	k = 1.0	k = 1.5
				Sm (0.016 ± 0.004) [mg/kg]						
203	5.3	0.01	0.001	10	-3.41	-1.7	-1.14	2.96	1.64	1.12
40	5.1	0.012	0.001	8.33	-2.27	-1.14	-0.76	1.98	1.09	0.74
152	5.3	0.015	0.002	13.33	-0.57	-0.28	-0.19	0.38	0.25	0.18
171	5.1	0.015	0.002	13.33	-0.57	-0.28	-0.19	0.38	0.25	0.18
199	5.1	0.016	0.002	12.5	0	0	0	0	0	0
172	5.1	0.017	0.002	11.76	0.57	0.28	0.19	0.38	0.25	0.18
193	5	0.017	0.001	5.88	0.57	0.28	0.19	0.49	0.27	0.19
183	5	0.02	0.002	10	2.27	1.14	0.76	1.5	0.99	0.71
178	5.1	0.021	0.002	9.52	2.84	1.42	0.95	1.88	1.24	0.89
176	5	0.023	0.001	4.35	3.98	1.99	1.33	3.46	1.91	1.3
139	5	0.03*	0.003	10	7.95	3.98	2.65	4.03	3.03	2.31
202	5.1	0.064*	0.007	10.94	27.27	13.64	9.09	6.65	6.13	5.47
				Sr (3.31 ± 0.442) [mg/kg]						
79	1.13	0.466	0.104	22.32	-12.86	-6.43	-4.29	11.64	6.26	4.24
206	2	1.9	0.009	0.47	-6.38	-3.19	-2.13	6.37	3.19	2.13
105	1.32	2.3	0.12	5.22	-4.57	-2.28	-1.52	4.01	2.2	1.5
108	1.3	2.61	0.28	10.73	-3.17	-1.58	-1.06	1.96	1.34	0.97
53	1.3	3	0.3	10	-1.4	-0.7	-0.47	0.83	0.58	0.43
116	1.3	3.49	0.24	6.88	0.81	0.41	0.27	0.55	0.36	0.26
78	1.3	3.68	0.16	4.35	1.67	0.84	0.56	1.36	0.79	0.54
96	1.13	4	0.2	5	3.12	1.56	1.04	2.31	1.42	1
203	5.3	4.1	0.3	7.32	3.57	1.79	1.19	2.12	1.48	1.09
69	1.1	4.1	0.43	10.49	3.57	1.79	1.19	1.63	1.28	1
85	1.23	4.46	0.75	16.82	5.2	2.6	1.73	1.47	1.32	1.15
125	2	4.56	0.24	5.26	5.65	2.83	1.88	3.83	2.48	1.77
193	5	6	0.02	0.33	12.17	6.08	4.06	12.12	6.08	4.05
64	1.11	7	3	42.86	16.69	8.34	5.56	1.23	1.22	1.2
209	1.4	7.4	0.1	1.35	18.5	9.25	6.17	16.85	9.02	6.1
95	1.3	7.7	0.4	5.19	19.86	9.93	6.62	9.61	7.36	5.67
68	1.22	9.21	0.84	9.12	26.68	13.34	8.89	6.79	6.22	5.51
5	1.22	12.95*	3.192	24.65	43.6	21.8	14.53	3.01	2.99	2.96
204	1.21	28.2*	1.8	6.38	112.57	56.29	37.52	13.72	13.43	12.97
				Ta [mg/kg]						
203	5.3	0.004	0.001	25	-	-	-	-	-	-
152	5.3	0.006	0.001	16.67	-	-	-	-	-	-
199	5.1	0.009	0.002	22.22	-	-	-	-	-	-
126	1.23	1.7*	1	58.82	-	-	-	-	-	-
				Tb [mg/kg]						
152	5.3	0.002	0.001	50	-	-	-	-	-	-
199	5.1	0.008	0.001	12.5	-	-	-	-	-	-
				Th [mg/kg]						
152	5.3	0.022	0.001	4.55	-	-	-	-	-	-
203	5.3	0.025	0.002	8	-	-	-	-	-	-
193	5	0.03	0.002	6.67	-	-	-	-	-	-

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
199	5.1	0.036	0.006	16.67	-	-	-	-	-	-
183	5	0.04	0.001	2.5	-	-	-	-	-	-
169	5.1	0.052	0.003	5.77	-	-	-	-	-	-
126	1.23	0.8*	0.4	50	-	-	-	-	-	-
125	2	1.1*	0.1	9.09	-	-	-	-	-	-
				Ti [mg/kg]						
72	1.3	1.291	0.004	0.31	-	-	-	-	-	-
105	1.32	3.5	2.7	77.14	-	-	-	-	-	-
78	1.3	7.53	0.36	4.78	-	-	-	-	-	-
138	1.23	8.55	1.7	19.88	-	-	-	-	-	-
69	1.1	8.9	1.6	17.98	-	-	-	-	-	-
204	1.21	10.8	2.2	20.37	-	-	-	-	-	-
199	5.1	20.26	3.41	16.83	-	-	-	-	-	-
126	1.23	23.5	1.2	5.11	-	-	-	-	-	-
172	5.1	28.9	13.1	45.33	-	-	-	-	-	-
68	1.22	30.67	8.8	28.69	-	-	-	-	-	-
152	5.3	50*	5.6	11.2	-	-	-	-	-	-
209	1.4	57*	39	68.42	-	-	-	-	-	-
96	1.13	197*	10	5.08	-	-	-	-	-	-
				Tl [mg/kg]						
126	1.23	0.9	0.4	44.44	-	-	-	-	-	-
				U [mg/kg]						
203	5.3	0.014	0.002	14.29	-	-	-	-	-	-
152	5.3	0.022	0.002	9.09	-	-	-	-	-	-
126	1.23	0.9*	0.4	44.44	-	-	-	-	-	-
				W [mg/kg]						
172	5.1	0.038	0.009	23.68	-	-	-	-	-	-
199	5.1	0.057	0.017	29.82	-	-	-	-	-	-
204	1.21	31.9	3.2	10.03	-	-	-	-	-	-
68	1.22	99.37*	16.16	16.26	-	-	-	-	-	-
				Y [mg/kg]						
69	1.1	0.34	0.094	27.65	-	-	-	-	-	-
126	1.23	0.8	0.2	25	-	-	-	-	-	-
				Yb [mg/kg]						
152	5.3	0.014	0.001	7.14	-	-	-	-	-	-
199	5.1	0.021	0.006	28.57	-	-	-	-	-	-
				Zn (47.6 ± 4.258) [mg/kg]						
207	7.1	0.318*	0.004	1.26	-22.21	-11.11	-7.4	22.21	11.11	7.4
72	1.3	1.042*	0.069	6.62	-21.87	-10.94	-7.29	21.86	10.93	7.29
39	1.24	22.4*	4.7	20.98	-11.84	-5.92	-3.95	4.88	3.97	3.18
206	2	30	0.002	0.01	-8.27	-4.13	-2.76	8.27	4.13	2.76
152	5.3	33	1.7	5.15	-6.86	-3.43	-2.29	5.36	3.18	2.21
68	1.22	34.23	2.46	7.19	-6.28	-3.14	-2.09	4.11	2.72	1.95

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
167	5	35.309	2.711	7.68	-5.77	-2.89	-1.92	3.57	2.44	1.77
196	5	36.9	3	8.13	-5.03	-2.51	-1.68	2.91	2.05	1.52
69	1.1	39.4	4.04	10.25	-3.85	-1.93	-1.28	1.8	1.4	1.09
64	1.14	40	4	10	-3.57	-1.79	-1.19	1.68	1.3	1.01
193	5	40	0.001	0	-3.57	-1.79	-1.19	3.57	1.79	1.19
105	1.32	41	1.8	4.39	-3.1	-1.55	-1.03	2.37	1.43	0.99
184	5	41.2	2.3	5.58	-3.01	-1.5	-1	2.04	1.32	0.94
54	1.22	41.8	5.4	12.92	-2.72	-1.36	-0.91	1	0.84	0.69
96	1.13	42	2	4.76	-2.63	-1.32	-0.88	1.92	1.19	0.84
195	5	42.6	6.7	15.73	-2.35	-1.17	-0.78	0.71	0.63	0.54
183	5	42.9	0.8	1.86	-2.21	-1.1	-0.74	2.07	1.08	0.73
40	5.1	45	2	4.44	-1.22	-0.61	-0.41	0.89	0.55	0.39
191	5	45	3	6.67	-1.22	-0.61	-0.41	0.71	0.5	0.37
176	5	45.1	0.7	1.55	-1.17	-0.59	-0.39	1.12	0.58	0.39
199	5.1	45.527	1.168	2.57	-0.97	-0.49	-0.32	0.85	0.47	0.32
203	5.3	46	1.1	2.39	-0.75	-0.38	-0.25	0.67	0.36	0.25
170	5	46.2	2.6	5.63	-0.66	-0.33	-0.22	0.42	0.28	0.2
171	5.1	46.6	1.3	2.79	-0.47	-0.23	-0.16	0.4	0.22	0.15
127	1	46.619	2.685	5.76	-0.46	-0.23	-0.15	0.29	0.19	0.14
89	1	46.77	3.37	7.21	-0.39	-0.19	-0.13	0.21	0.15	0.11
175	5.3	46.8	3.3	7.05	-0.38	-0.19	-0.13	0.2	0.15	0.11
53	1.3	47	5	10.64	-0.28	-0.14	-0.09	0.11	0.09	0.07
108	1.3	47	2	4.26	-0.28	-0.14	-0.09	0.21	0.13	0.09
61	5	48.4	3.3	6.82	0.38	0.19	0.13	0.2	0.15	0.11
74	2	48.82	0.17	0.35	0.57	0.29	0.19	0.57	0.29	0.19
202	5.1	49.5	1.8	3.64	0.89	0.45	0.3	0.68	0.41	0.29
116	1.3	49.73	1.91	3.84	1	0.5	0.33	0.74	0.46	0.32
186	5.1	50.1	2.1	4.19	1.17	0.59	0.39	0.84	0.53	0.37
95	1.3	50.6	5.1	10.08	1.41	0.7	0.47	0.54	0.45	0.37
149	5	51.97	1.132	2.18	2.05	1.03	0.68	1.81	0.99	0.67
169	5.1	52	2	3.85	2.07	1.03	0.69	1.51	0.94	0.66
79	1.13	52.72	0.725	1.38	2.41	1.2	0.8	2.28	1.19	0.8
138	1.23	56.5	12	21.24	4.18	2.09	1.39	0.73	0.7	0.65
85	1.23	57.2	1	1.75	4.51	2.25	1.5	4.08	2.2	1.49
78	1.3	59.25	3.52	5.94	5.47	2.74	1.82	2.83	2.11	1.6
73	1.2	62	5	8.06	6.76	3.38	2.25	2.65	2.19	1.78
126	1.23	73*	7	9.59	11.93	5.97	3.98	3.47	3.1	2.68
178	5.1	85*	3.21	3.78	17.57	8.78	5.86	9.71	7.01	5.23
204	1.21	85.3*	5.7	6.68	17.71	8.85	5.9	6.2	5.3	4.4
5	1.22	94.53*	26	27.5	22.05	11.02	7.35	1.8	1.78	1.75
209	1.4	106*	13	12.26	27.43	13.72	9.14	4.43	4.27	4.03
					Zr [mg/kg]					
152	5.3	1.24*	0.12	9.68	-	-	-	-	-	-
69	1.1	1.92	0.22	11.46	-	-	-	-	-	-
96	1.13	2	0.1	5	-	-	-	-	-	-
204	1.21	2.1	0.3	14.29	-	-	-	-	-	-
126	1.23	3.7*	1	27.03	-	-	-	-	-	-
68	1.22	23.9*	1.02	4.27	-	-	-	-	-	-

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
As (143 ± 30.654) [ug/kg]										
184	5	0.13*	0.01	7.69	-9.32	-4.66	-3.11	9.32	4.66	3.11
152	5.3	97	10	10.31	-3	-1.5	-1	2.51	1.43	0.98
178	5.1	112	25.8	23.04	-2.02	-1.01	-0.67	1.03	0.77	0.59
203	5.3	122	8	6.56	-1.37	-0.69	-0.46	1.21	0.66	0.45
193	5	127	0.003	0	-1.04	-0.52	-0.35	1.04	0.52	0.35
186	5.1	130	30	23.08	-0.85	-0.42	-0.28	0.39	0.3	0.24
171	5.1	130	10	7.69	-0.85	-0.42	-0.28	0.71	0.4	0.28
40	5.1	130	10	7.69	-0.85	-0.42	-0.28	0.71	0.4	0.28
167	5	137.175	3.578	2.61	-0.38	-0.19	-0.13	0.37	0.19	0.13
199	5.1	144.569	49.833	34.47	0.1	0.05	0.03	0.03	0.03	0.02
170	5	149	13	8.72	0.39	0.2	0.13	0.3	0.18	0.13
61	5	149	30	20.13	0.39	0.2	0.13	0.18	0.14	0.11
176	5	153	3	1.96	0.65	0.33	0.22	0.64	0.32	0.22
172	5.1	156	8	5.13	0.85	0.42	0.28	0.75	0.41	0.28
169	5.1	156	6	3.85	0.85	0.42	0.28	0.79	0.42	0.28
175	5.3	160	20	12.5	1.11	0.55	0.37	0.67	0.46	0.34
53	1.3	257*	53	20.62	7.44	3.72	2.48	2.07	1.86	1.62
139	5	268*	25	9.33	8.16	4.08	2.72	4.26	3.16	2.39
Cd (260 ± 50.939) [ug/kg]										
68	1.22	14.88*	3.62	24.33	-9.62	-4.81	-3.21	9.53	4.8	3.2
207	7.1	15*	0.2	1.33	-9.62	-4.81	-3.21	9.62	4.81	3.21
149	6	251.5	23.54	9.36	-0.33	-0.17	-0.11	0.25	0.15	0.11
172	5.1	364	101	27.75	4.08	2.04	1.36	1	0.92	0.82
199	5.1	370	30	8.11	4.32	2.16	1.44	2.8	1.86	1.34
85	1.23	1210*	340	28.1	37.3	18.65	12.43	2.79	2.76	2.73
Co (81.4 ± 17.908) [ug/kg]										
149	5	9.812*	0.863	8.8	-8	-4	-2.67	7.96	3.99	2.66
196	5	57	7	12.28	-2.73	-1.36	-0.91	2.15	1.27	0.88
152	5.3	66	7	10.61	-1.72	-0.86	-0.57	1.35	0.8	0.55
40	5.1	70	4	5.71	-1.27	-0.64	-0.42	1.16	0.62	0.42
193	5	71	0.001	0	-1.16	-0.58	-0.39	1.16	0.58	0.39
199	5.1	79.3	6.75	8.51	-0.23	-0.12	-0.08	0.19	0.11	0.08
170	5	79.8	9.9	12.41	-0.18	-0.09	-0.06	0.12	0.08	0.06
171	5.1	79.9	3.6	4.51	-0.17	-0.08	-0.06	0.16	0.08	0.06
183	5	80	2	2.5	-0.16	-0.08	-0.05	0.15	0.08	0.05
176	5	80.1	2.5	3.12	-0.15	-0.07	-0.05	0.14	0.07	0.05
61	5	85	11	12.94	0.4	0.2	0.13	0.25	0.17	0.12
169	5.1	93.78	4.33	4.62	1.38	0.69	0.46	1.24	0.67	0.46
203	5.3	98	5	5.1	1.85	0.93	0.62	1.62	0.89	0.61
195	5	99.2	11	11.09	1.99	0.99	0.66	1.25	0.85	0.61
202	5.1	110	10	9.09	3.19	1.6	1.06	2.13	1.39	1
172	5.1	116	26	22.41	3.86	1.93	1.29	1.26	1.1	0.93
204	1.21	240*	30	12.5	17.71	8.86	5.9	5.07	4.54	3.94
5	1.22	580*	180	31.03	55.68	27.84	18.56	2.77	2.76	2.74
178	5.1	1150*	58.4	5.08	119.34	59.67	39.78	18.09	17.49	16.62

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
Cr (454 ± 81.790) [ug/kg]										
105	1.32	1.1*	0.27	24.55	-11.07	-5.54	-3.69	11.07	5.54	3.69
207	7.1	9*	0.032	0.36	-10.88	-5.44	-3.63	10.88	5.44	3.63
193	5	380	0.001	0	-1.81	-0.9	-0.6	1.81	0.9	0.6
149	5	414.8	21.3	5.14	-0.96	-0.48	-0.32	0.85	0.46	0.31
152	5.3	420	42	10	-0.83	-0.42	-0.28	0.58	0.37	0.26
183	5	500	10	2	1.12	0.56	0.37	1.09	0.56	0.37
175	5.3	550	50	9.09	2.35	1.17	0.78	1.49	1	0.72
170	5	591	97	16.41	3.35	1.68	1.12	1.3	1.08	0.88
176	5	610	30	4.92	3.81	1.91	1.27	3.08	1.79	1.24
199	5.1	628.845	85.02	13.52	4.28	2.14	1.43	1.85	1.48	1.17
202	5.1	740	110	14.86	6.99	3.5	2.33	2.44	2.09	1.74
169	5.1	1649*	102	6.19	29.22	14.61	9.74	10.87	9.14	7.49
204	1.21	3200*	230	7.19	67.15	33.57	22.38	11.75	11.25	10.53
172	5.1	3309*	821	24.81	69.81	34.91	23.27	3.47	3.46	3.44
5	1.22	6900*	2400	34.78	157.62	78.81	52.54	2.69	2.68	2.68
Hg (5.4 ± 1.188) [ug/kg]										
126	1.23	1.3	0.7	53.85	-6.9	-3.45	-2.3	4.47	2.97	2.14
85	1.23	21	6	28.57	26.26	13.13	8.75	2.59	2.55	2.49
193	5	38	0.001	0	54.88	27.44	18.29	54.88	27.44	18.29
172	5.1	66.7	27.9	41.83	103.2	51.6	34.4	2.2	2.2	2.19
Mo (170 ± 35.506) [ug/kg]										
68	1.22	0.011	0.001	9.09	-9.58	-4.79	-3.19	9.58	4.79	3.19
172	5.1	170	74	43.53	0	0	0	0	0	0
199	5.1	197.8	47	23.76	1.57	0.78	0.52	0.55	0.47	0.39
204	1.21	1500*	200	13.33	74.92	37.46	24.97	6.62	6.55	6.43
206	2	2000*	0.009	0	103.08	51.54	34.36	103.08	51.54	34.36
Ni (522 ± 92.085) [ug/kg]										
105	1.32	2*	0.81	40.5	-11.29	-5.65	-3.76	11.29	5.65	3.76
126	1.23	3.4*	0.17	5	-11.26	-5.63	-3.75	11.26	5.63	3.75
53	1.3	366	83	22.68	-3.39	-1.69	-1.13	1.64	1.26	0.97
108	1.3	510	240	47.06	-0.26	-0.13	-0.09	0.05	0.05	0.04
78	1.3	530	60	11.32	0.17	0.09	0.06	0.11	0.07	0.05
203	5.3	624	72	11.54	2.22	1.11	0.74	1.19	0.87	0.65
5	1.22	2800*	330	11.79	49.48	24.74	16.49	6.84	6.65	6.37
209	1.4	4100*	1200	29.27	77.71	38.86	25.9	2.98	2.97	2.96
204	1.21	11700*	400	3.42	242.77	121.39	80.92	27.76	27.23	26.41
206	2	15600*	0.001	0	327.48	163.74	109.16	327.48	163.74	109.16
96	1.13	16000*	1000	6.25	336.17	168.08	112.06	15.46	15.41	15.33
69	1.1	48600*	5000	10.29	1044.2	522.1	348.07	9.62	9.61	9.61
Pb (921 ± 149.166) [ug/kg]										
79	1.13	0.919	0.187	20.35	-12.34	-6.17	-4.11	12.34	6.17	4.11
105	1.32	0.96	0.28	29.17	-12.34	-6.17	-4.11	12.34	6.17	4.11
138	1.23	1.85	0.48	25.95	-12.32	-6.16	-4.11	12.32	6.16	4.11
126	1.23	2.4	0.5	20.83	-12.32	-6.16	-4.11	12.32	6.16	4.11

TABLE 3 (cont.). SUMMARY OF THE REPORTED RESULTS AND THE CALCULATED *z*- AND *u*-SCORES

Laboratory code	Technique code	Analyte concentration	Standard dev.	Relative std. dev., [%]	*z*-scores			*u*-scores		
					$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$
207	7.1	14.3	0.147	1.03	-12.16	-6.08	-4.05	12.16	6.08	4.05
149	6	557.2	59.11	10.61	-4.88	-2.44	-1.63	3.82	2.27	1.57
53	1.3	628	104	16.56	-3.93	-1.96	-1.31	2.29	1.61	1.19
209	1.4	800	200	25	-1.62	-0.81	-0.54	0.57	0.48	0.4
108	1.3	930	180	19.35	0.12	0.06	0.04	0.05	0.04	0.03
5	1.22	1350	620	45.93	5.75	2.88	1.92	0.69	0.67	0.65
85	1.23	1547	158	10.21	8.39	4.2	2.8	3.58	2.88	2.29
96	1.13	1800	100	5.56	11.79	5.89	3.93	7.05	4.89	3.59
78	1.3	2160	220	10.19	16.61	8.31	5.54	5.33	4.66	3.95
69	1.1	2430	349	14.36	20.23	10.12	6.74	4.23	3.98	3.64
204	1.21	2500	210	8.4	21.17	10.59	7.06	7.09	6.13	5.15
125	2	3700	100	2.7	37.26	18.63	12.42	22.28	15.47	11.34
				Sb (34.867 ± 7.671) [ug/kg]						
40	5.1	30	1	3.33	-1.27	-0.63	-0.42	1.23	0.63	0.42
183	5	30	1	3.33	-1.27	-0.63	-0.42	1.23	0.63	0.42
139	5	32.9	3.5	10.64	-0.51	-0.26	-0.17	0.38	0.23	0.16
203	5.3	34	3	8.82	-0.23	-0.11	-0.08	0.18	0.11	0.07
61	5	34.3	3.1	9.04	-0.15	-0.07	-0.05	0.11	0.07	0.05
193	5	35	0.002	0.01	0.03	0.02	0.01	0.03	0.02	0.01
171	5.1	35.3	2.7	7.65	0.11	0.06	0.04	0.09	0.05	0.04
152	5.3	37	2	5.41	0.56	0.28	0.19	0.49	0.27	0.18
199	5.1	38.12	7.76	20.36	0.85	0.42	0.28	0.38	0.3	0.23
172	5.1	38.2	2.2	5.76	0.87	0.43	0.29	0.75	0.42	0.28
176	5	41	4	9.76	1.6	0.8	0.53	1.11	0.71	0.5
196	5	51.1*	10	19.57	4.23	2.12	1.41	1.52	1.29	1.06
178	5.1	71.4*	6.55	9.17	9.53	4.76	3.18	4.81	3.62	2.76
				Se (24.1 ± 5.302) [ug/kg]*						
126	1.23	0.9	0.3	33.33	-8.75	-4.38	-2.92	8.7	4.37	2.92
207	7.1	5.4	0.185	3.43	-7.05	-3.53	-2.35	7.04	3.52	2.35
149	5	44.54	10.96	24.61	7.71	3.86	2.57	1.81	1.68	1.51
193	5	65	0.003	0	15.43	7.71	5.14	15.43	7.71	5.14
206	2	2000*	0.009	0	745.34	372.67	248.45	745.34	372.67	248.45
				V (402 ± 73.760) [ug/kg]						
105	1.32	1.1*	0.24	21.82	-10.87	-5.44	-3.62	10.87	5.44	3.62
191	5	340	30	8.82	-1.68	-0.84	-0.56	1.3	0.78	0.54
193	5	400	70	17.5	-0.05	-0.03	-0.02	0.03	0.02	0.02
172	5.1	403	94	23.33	0.03	0.01	0.01	0.01	0.01	0.01
176	5	430	30	6.98	0.76	0.38	0.25	0.59	0.35	0.24
199	5.1	433.16	40.133	9.27	0.84	0.42	0.28	0.57	0.37	0.26
152	5.3	516	52	10.08	3.09	1.55	1.03	1.79	1.26	0.93
178	5.1	567	54.1	9.54	4.47	2.24	1.49	2.52	1.8	1.34

TABLE 4. THE COMBINED *z*-SCORES FOR THE PARTICIPATING LABORATORIES

Lab Code	Number of analytes	Rescaled sum of scores (RSZ)			Sum of squared scores (SSZ)			Critical value
		$k = 0.5$	$k = 1.0$	$k = 1.5$	$k = 0.5$	$k = 1.0$	$k = 1.5$	χ^2
5	14	196	98.05	65.37	75679	18920	8409	26.12
39	5	-9.15	-4.57	-3.05	657	164	73.05	12.83
40	11	1.08	0.54	0.36	93.92	23.48	10.44	21.92
44	8	8.48	4.24	2.83	212	52.95	23.53	17.53
53	15	-0.67	-0.33	-0.22	311	77.87	34.61	27.49
54	5	-10.92	-5.46	-3.64	169	42.28	18.79	12.83
61	8	4.34	2.17	1.45	137	34.3	15.24	17.53
64	8	18.35	9.17	6.12	1649	412	183	17.53
68	13	99	49.58	33.05	47693	11923	5299	24.74
69	15	349	174	116	1163809	290952	129312	27.49
72	6	-70.1	-35.05	-23.37	5485	1371	609	14.45
73	6	-26.94	-13.47	-8.98	3358	840	373	14.45
74	7	5.15	2.57	1.72	36.71	9.18	4.08	16.01
78	14	23.02	11.51	7.67	931	233	103	26.12
79	9	-5.89	-2.94	-1.96	476	119	52.84	19.02
84	4	-30.03	-15.01	-10.01	906	227	101	11.14
85	13	25.73	12.86	8.58	3010	753	334	24.74
89	6	-11.98	-5.99	-3.99	480	120	53.31	14.45
95	8	14.88	7.44	4.96	678	170	75.37	17.53
96	10	137	68.64	45.76	118499	29625	13167	20.48
105	17	-9.04	-4.52	-3.01	8228	2057	914	30.19
108	8	-4.35	-2.18	-1.45	37.38	9.35	4.15	17.53
116	11	1.84	0.92	0.61	64.29	16.07	7.14	21.92
125	3	26.24	13.12	8.75	1427	357	159	9.35
126	15	499	249	166	2727560	681890	303062	27.49
127	6	-2.49	-1.25	-0.83	175	43.78	19.46	14.45
138	11	-2.63	-1.31	-0.88	704	176	78.26	21.92
139	9	6.89	3.44	2.3	311	77.72	34.54	19.02
149	12	-14.46	-7.23	-4.82	822	206	91.34	23.34
152	19	-5.59	-2.79	-1.86	265	66.17	29.41	32.85
156	3	376	188	125	426086	106521	47343	9.35
167	8	-4.45	-2.22	-1.48	349	87.31	38.8	17.53
169	12	17.8	8.9	5.93	1298	325	144	23.34
170	12	11.69	5.85	3.9	247	61.64	27.39	23.34
171	12	1.45	0.73	0.48	71.32	17.83	7.92	23.34
172	20	46.1	23.05	15.37	15817	3954	1757	34.17
175	12	11.26	5.63	3.75	515	129	57.21	23.34
176	19	10.27	5.13	3.42	278	69.4	30.84	32.85
178	16	54.43	27.21	18.14	15407	3852	1712	28.85
183	17	125	62.44	41.62	289156	72289	32128	30.19
184	8	-3.18	-1.59	-1.06	225	56.18	24.97	17.53
186	10	-7.84	-3.92	-2.61	789	197	87.63	20.48
191	7	-3.78	-1.89	-1.26	91.86	22.96	10.21	16.01
193	20	6.72	3.36	2.24	4155	1039	462	34.17
195	11	44.88	22.44	14.96	15291	3823	1699	21.92
196	5	0.08	0.04	0.03	59.05	14.76	6.56	12.83
199	22	5.45	2.73	1.82	233	58.27	25.9	36.78
202	11	27.43	13.72	9.14	1547	387	172	21.92
203	15	2.82	1.41	0.94	581	145	64.55	27.49
204	20	209	104	69.53	115075	28769	12786	34.17
206	17	196	98.11	65.41	148218	37055	16469	30.19
207	10	80.6	40.3	26.87	180915	45229	20102	20.48
209	10	157	78.49	52.33	38923	9731	4325	20.48

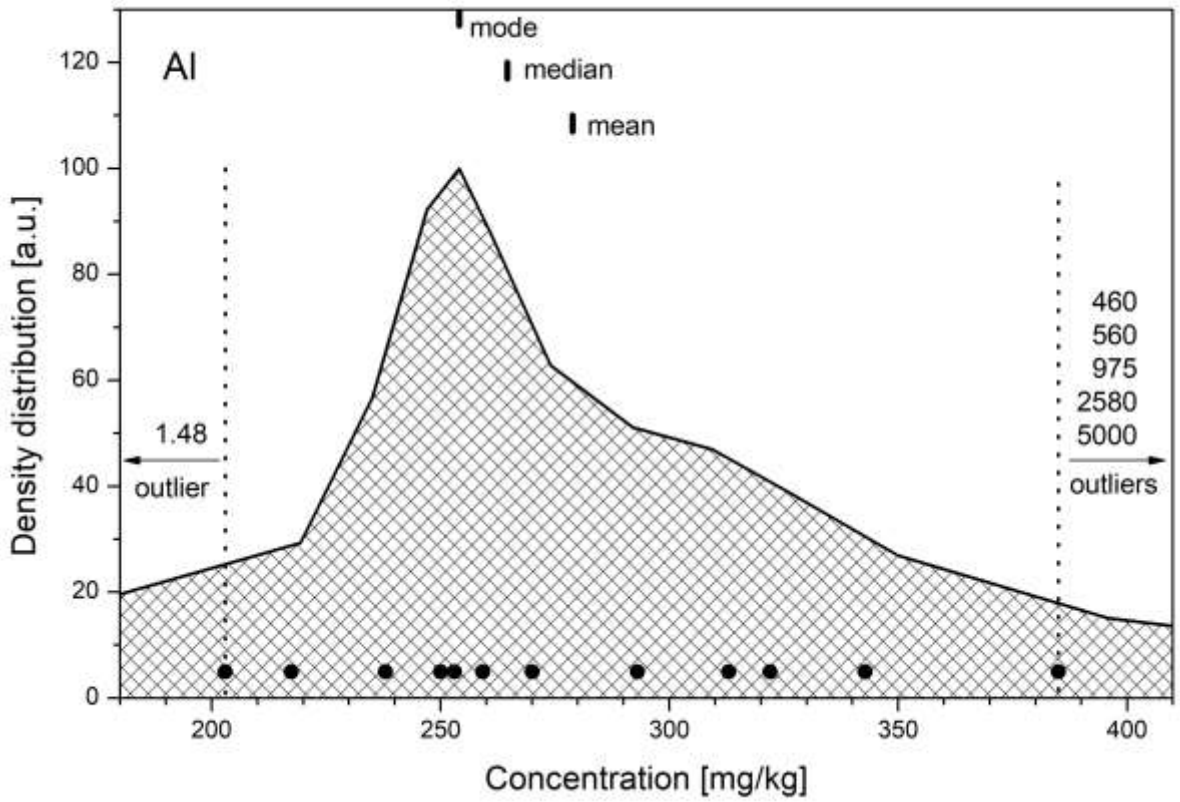

FIG. 3. The density distribution function for the analyte Al.

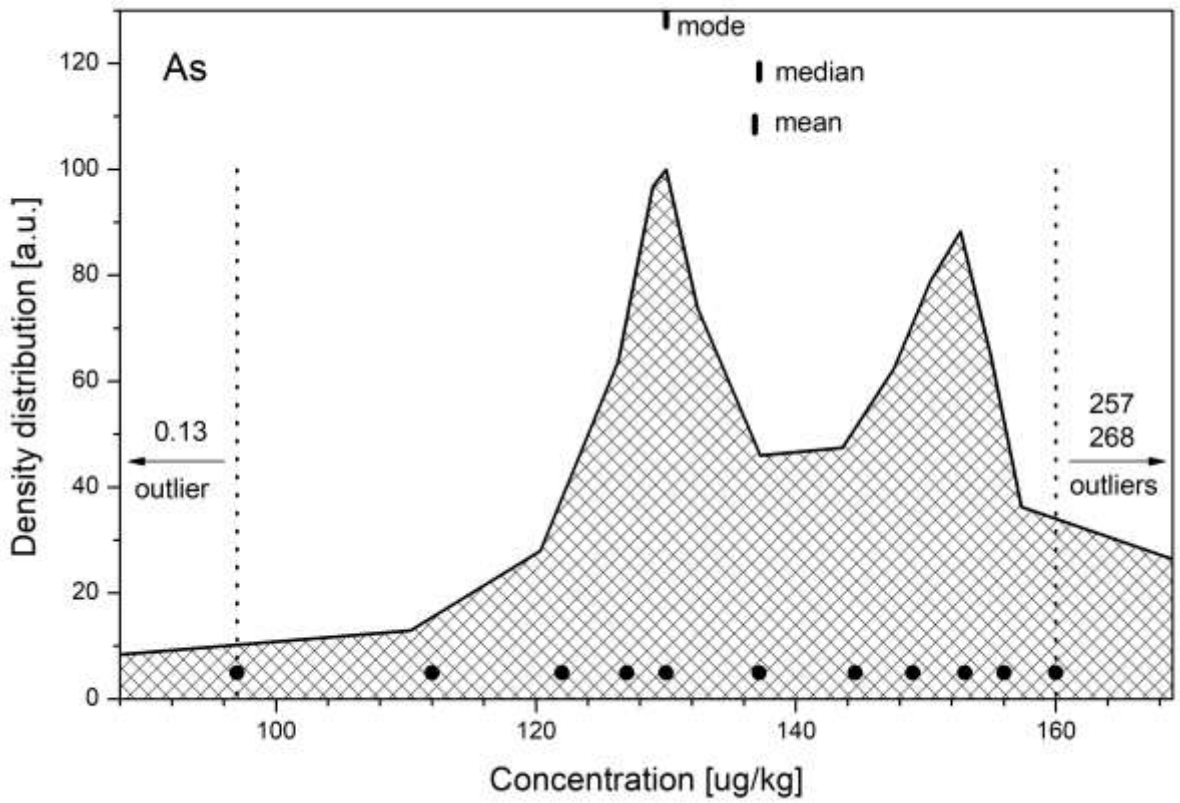

FIG. 4. The density distribution function for the analyte As.

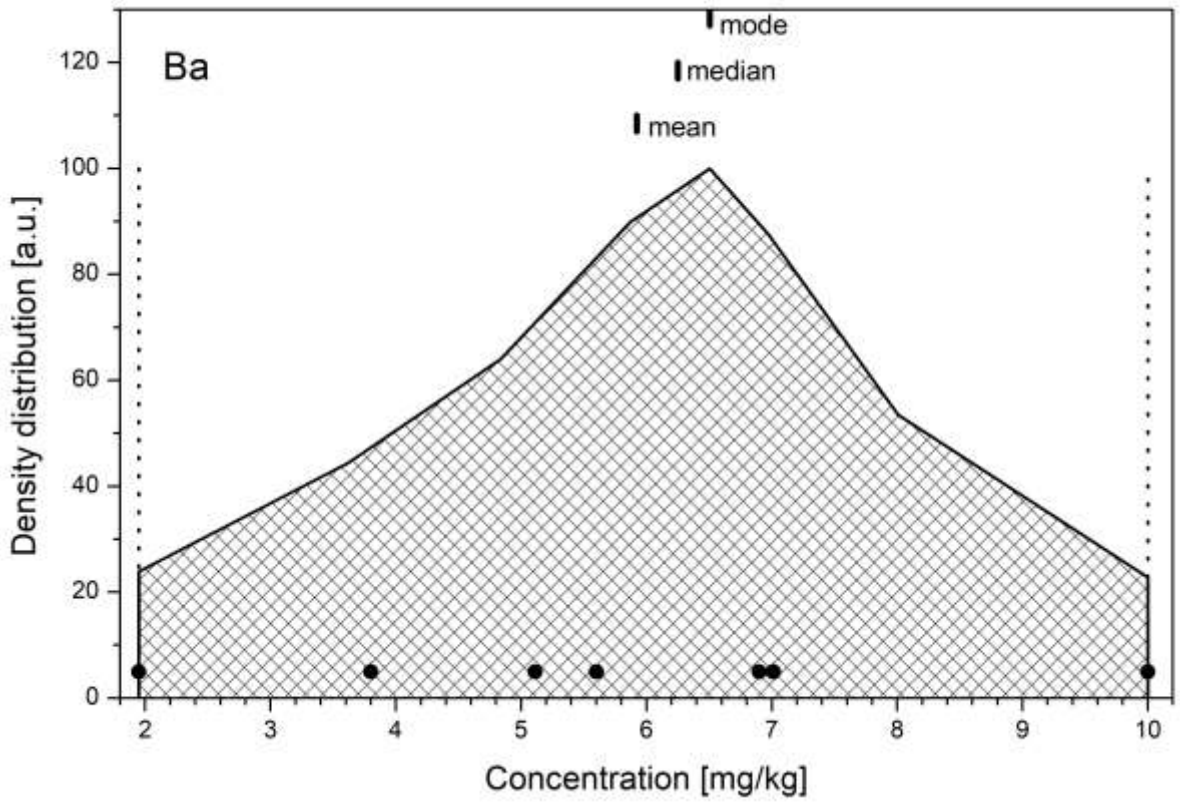

FIG. 5. The density distribution function for the analyte Ba.

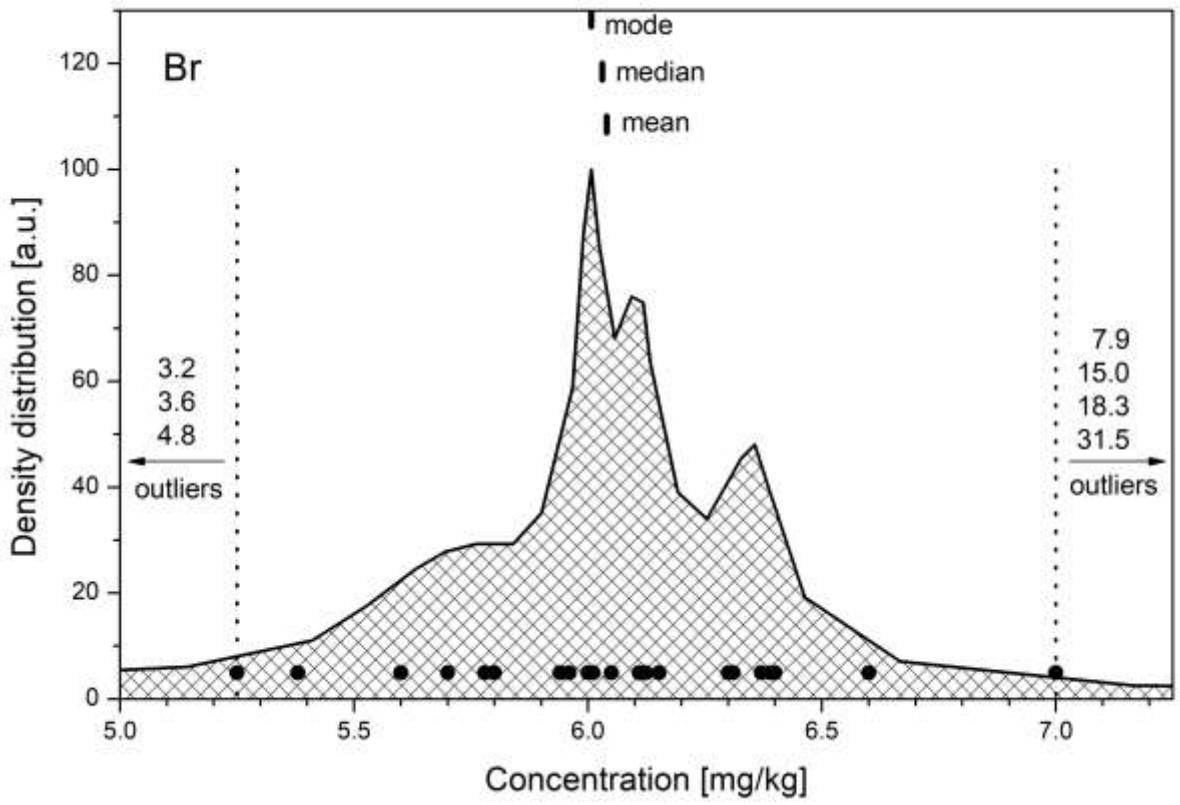

FIG. 6. The density distribution function for the analyte Br.

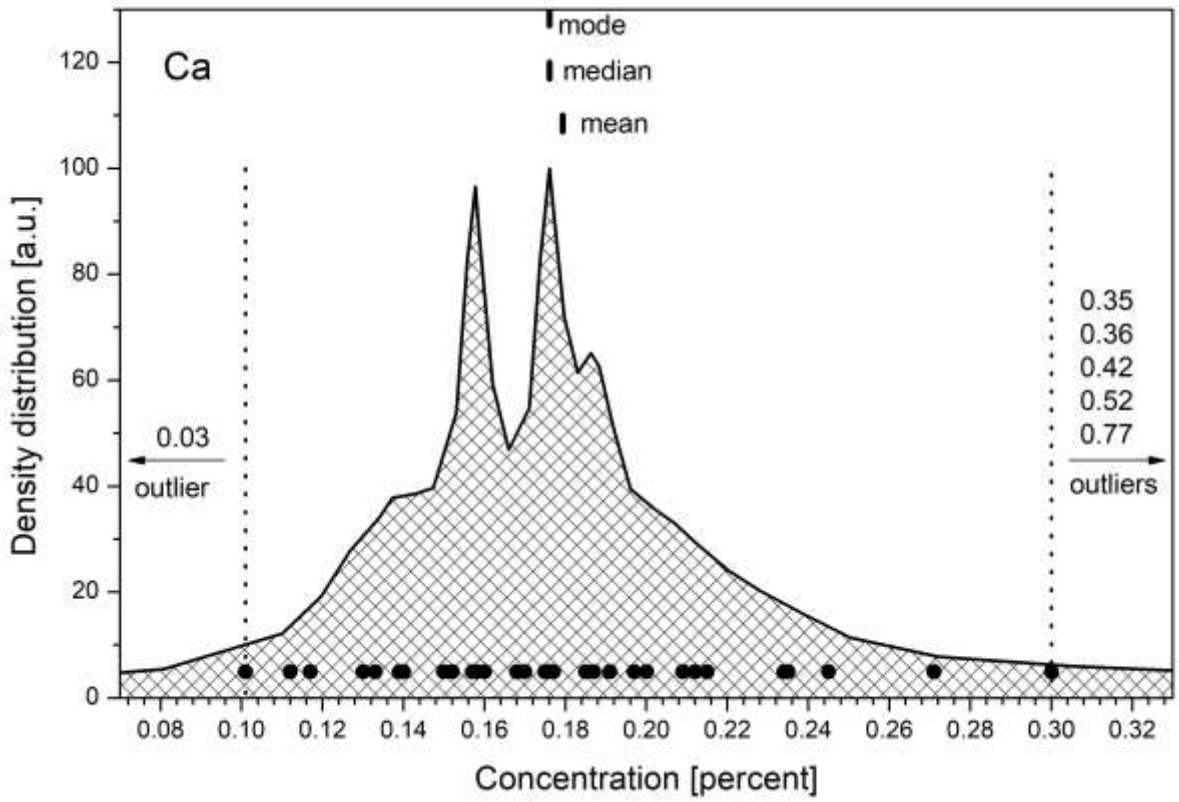

FIG. 7. The density distribution function for the analyte Ca.

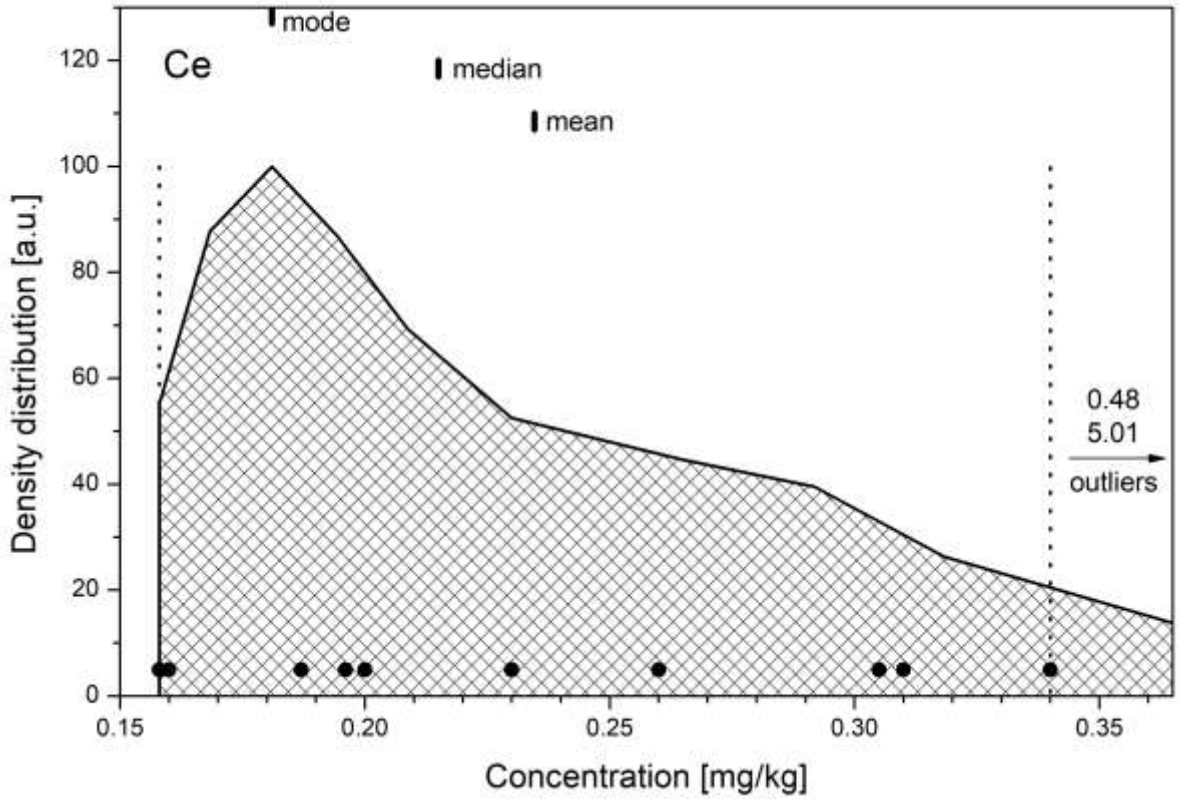

FIG. 8. The density distribution function for the analyte Ce.

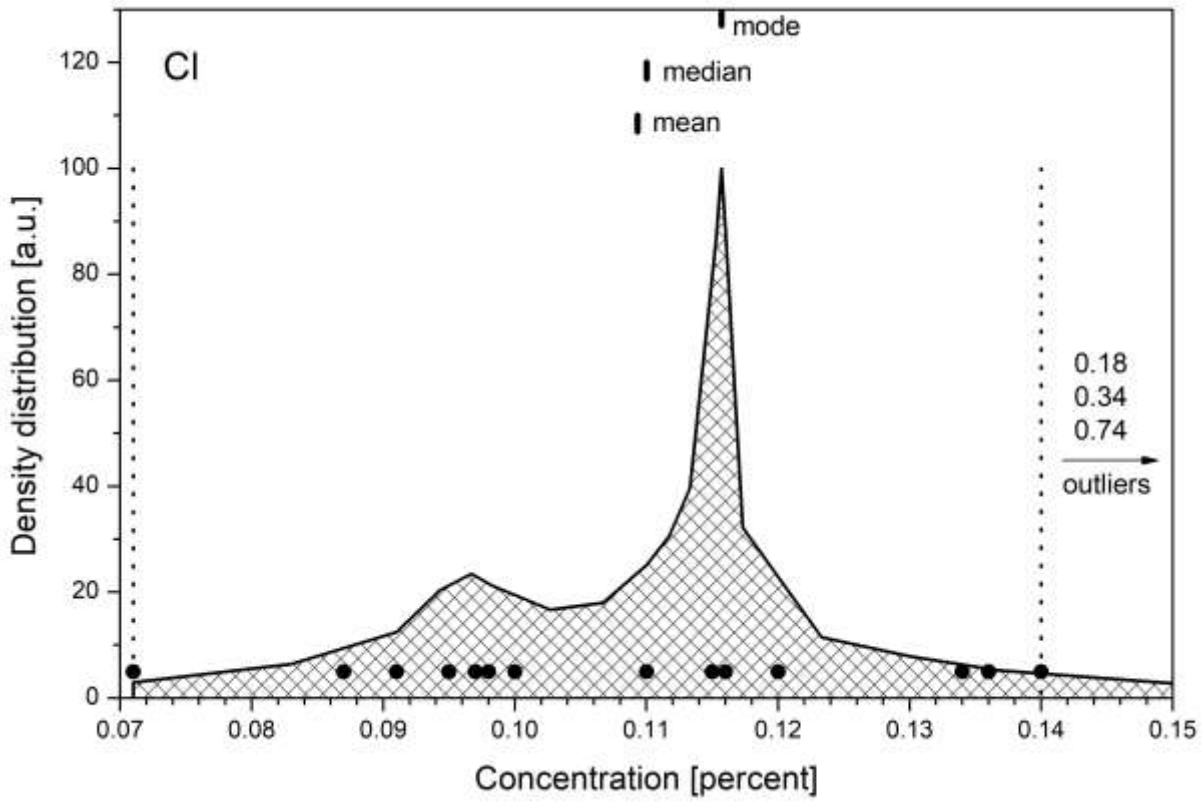

FIG. 9. The density distribution function for the analyte Cl.

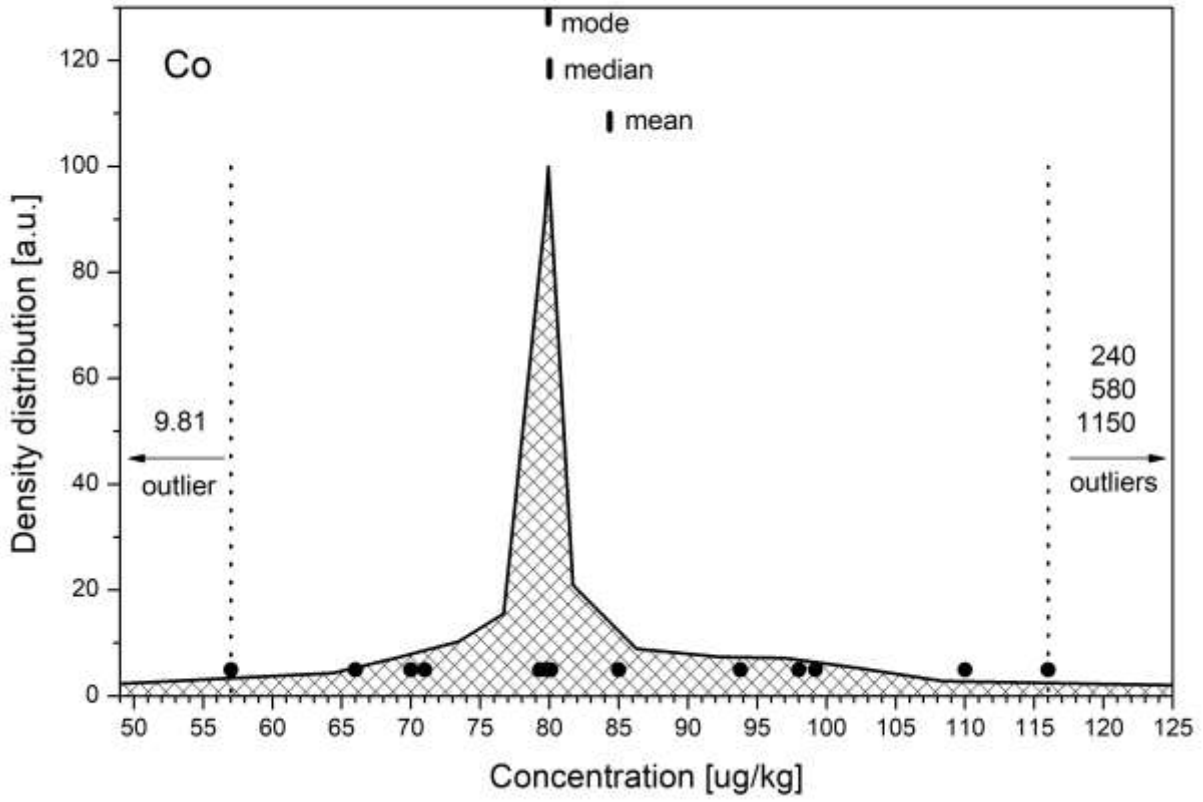

FIG. 10. The density distribution function for the analyte Co.

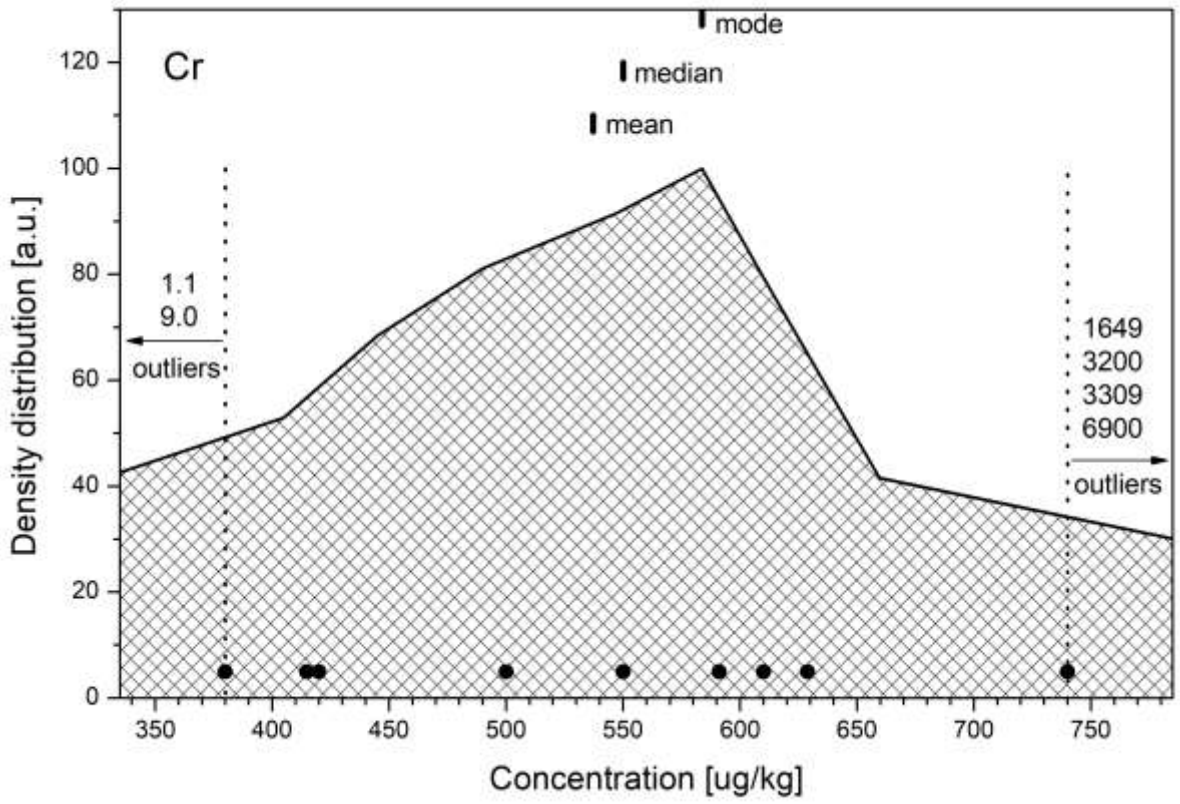

FIG. 11. The density distribution function for the analyte Cr.

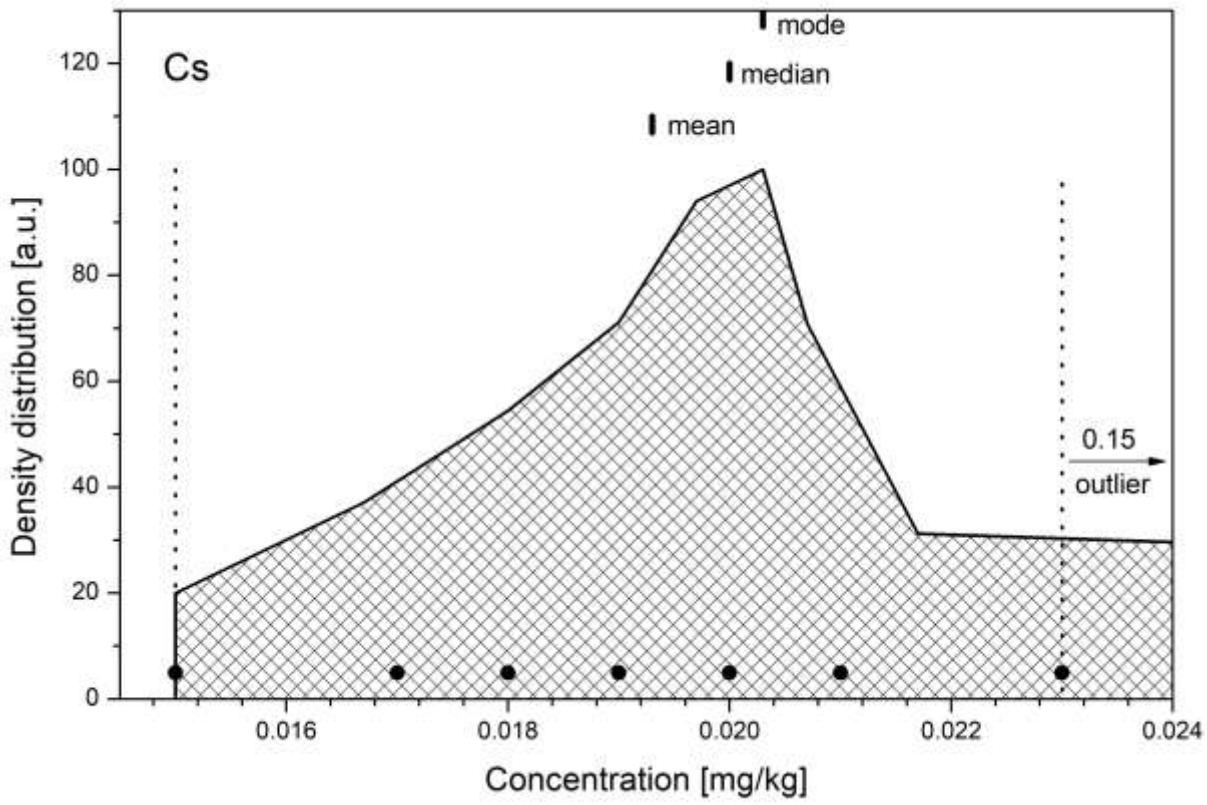

FIG. 12. The density distribution function for the analyte Cs.

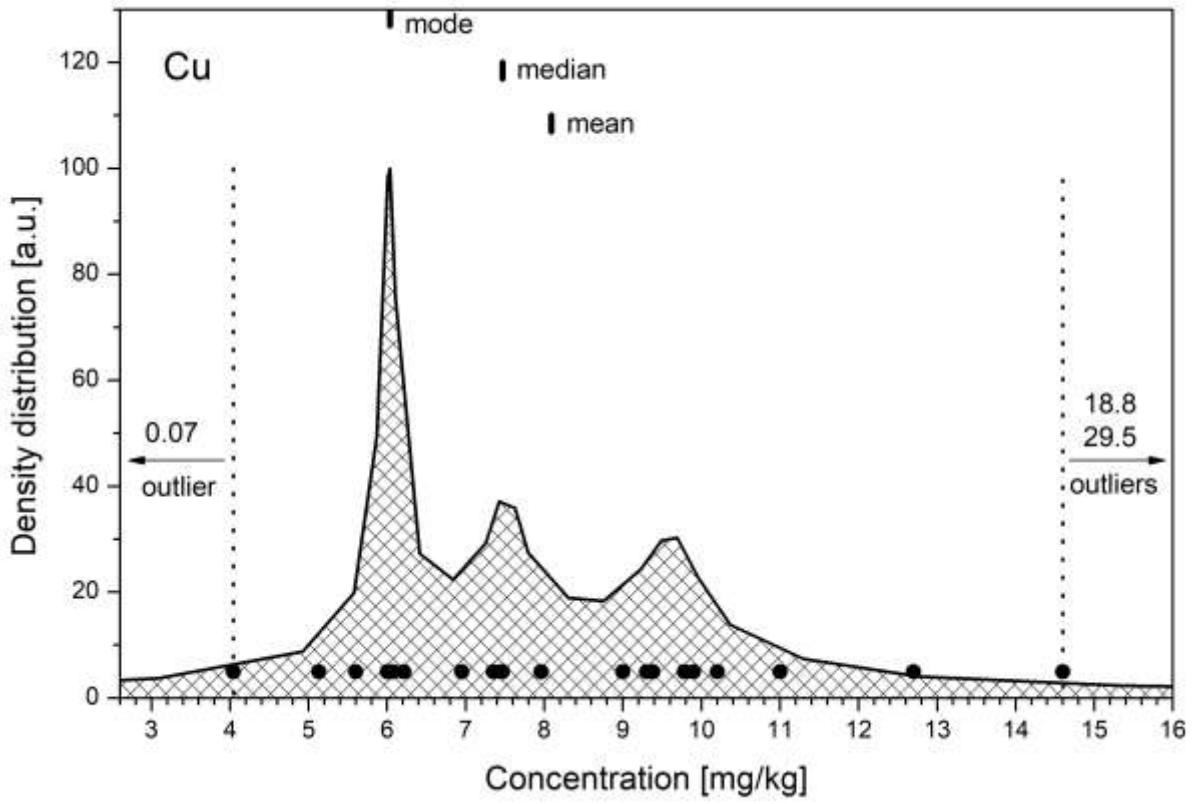

FIG. 13. The density distribution function for the analyte Cu.

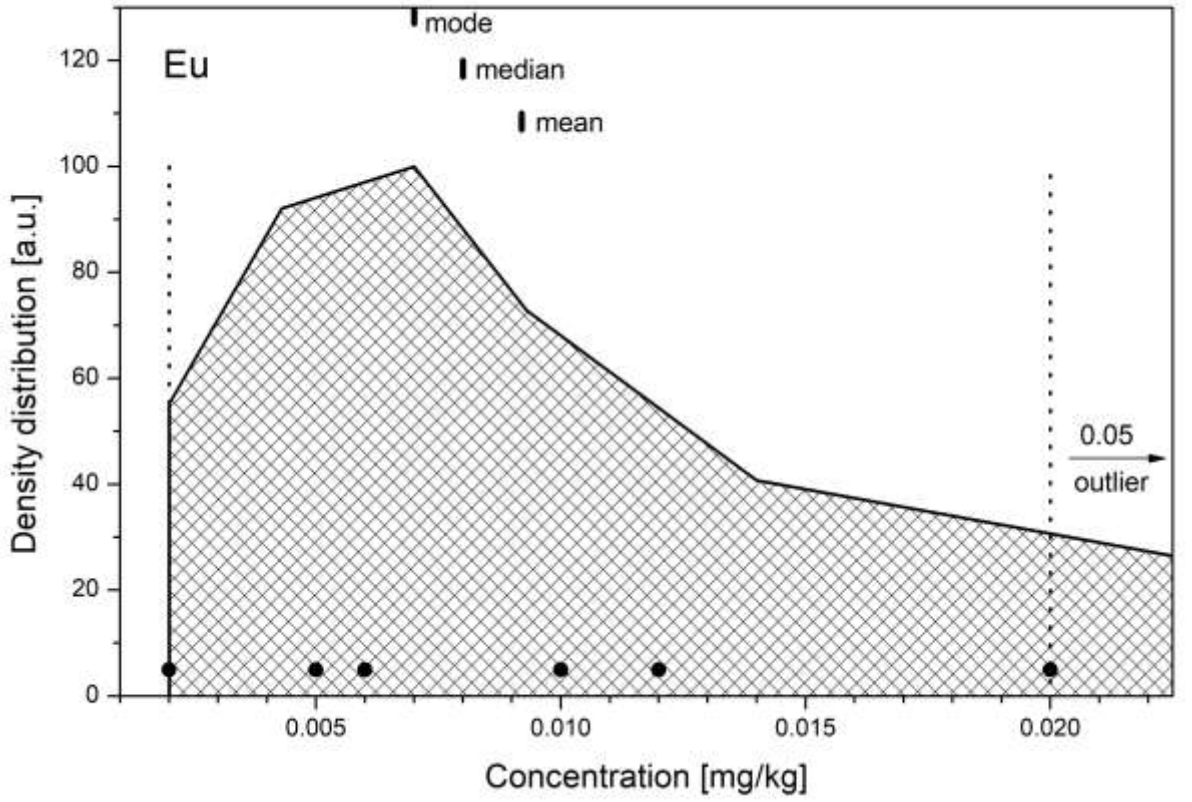

FIG. 14. The density distribution function for the analyte Eu.

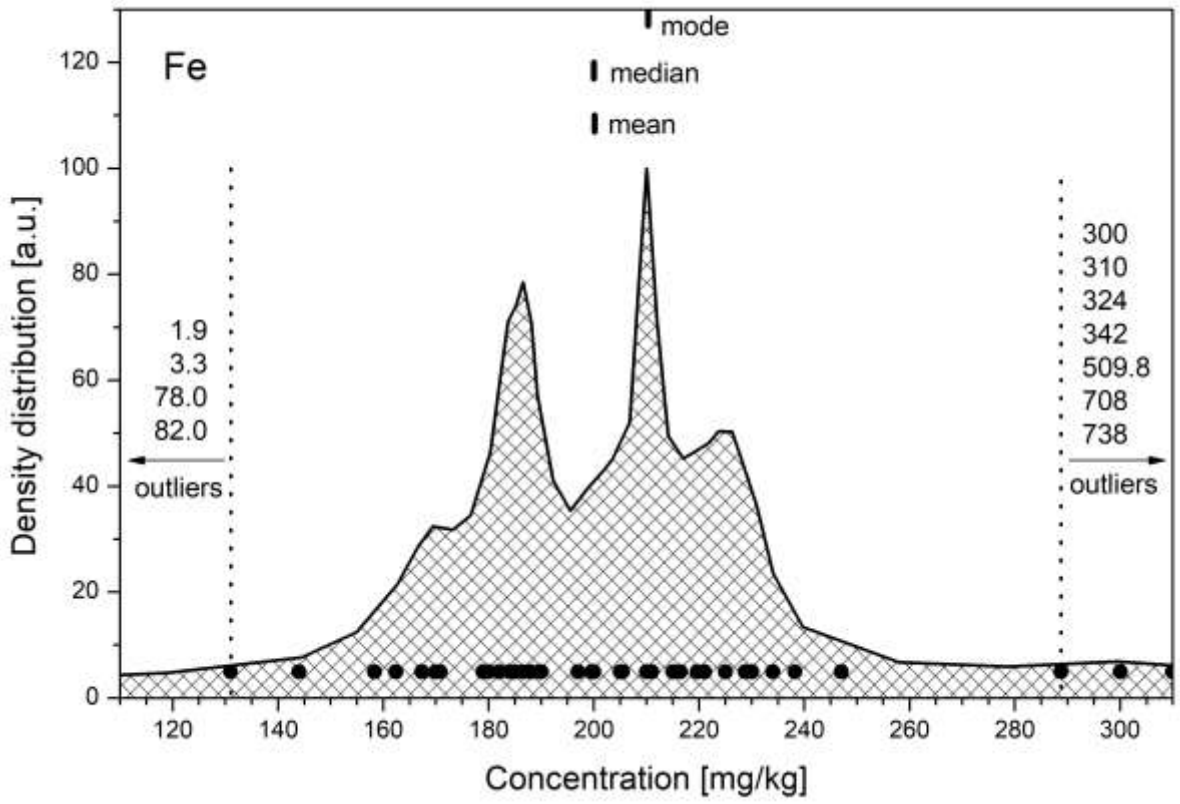

FIG. 15. The density distribution function for the analyte Fe.

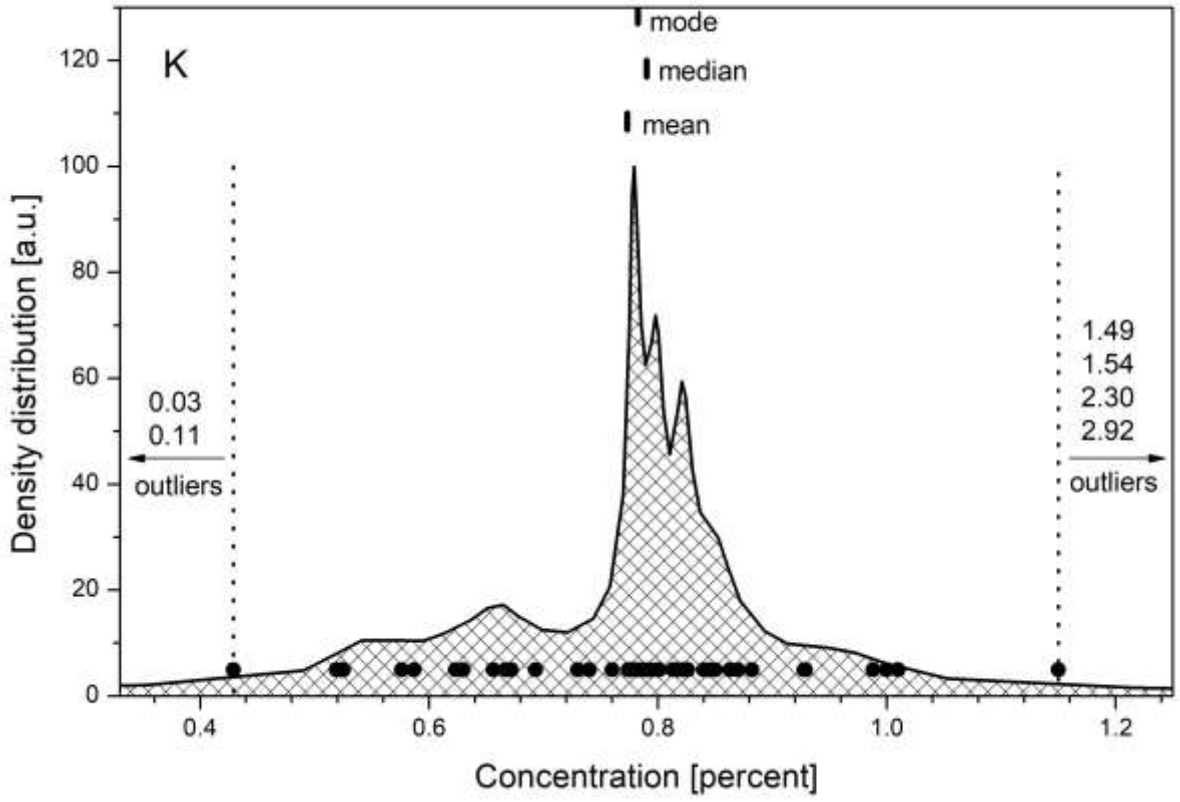

FIG. 16. The density distribution function for the analyte K.

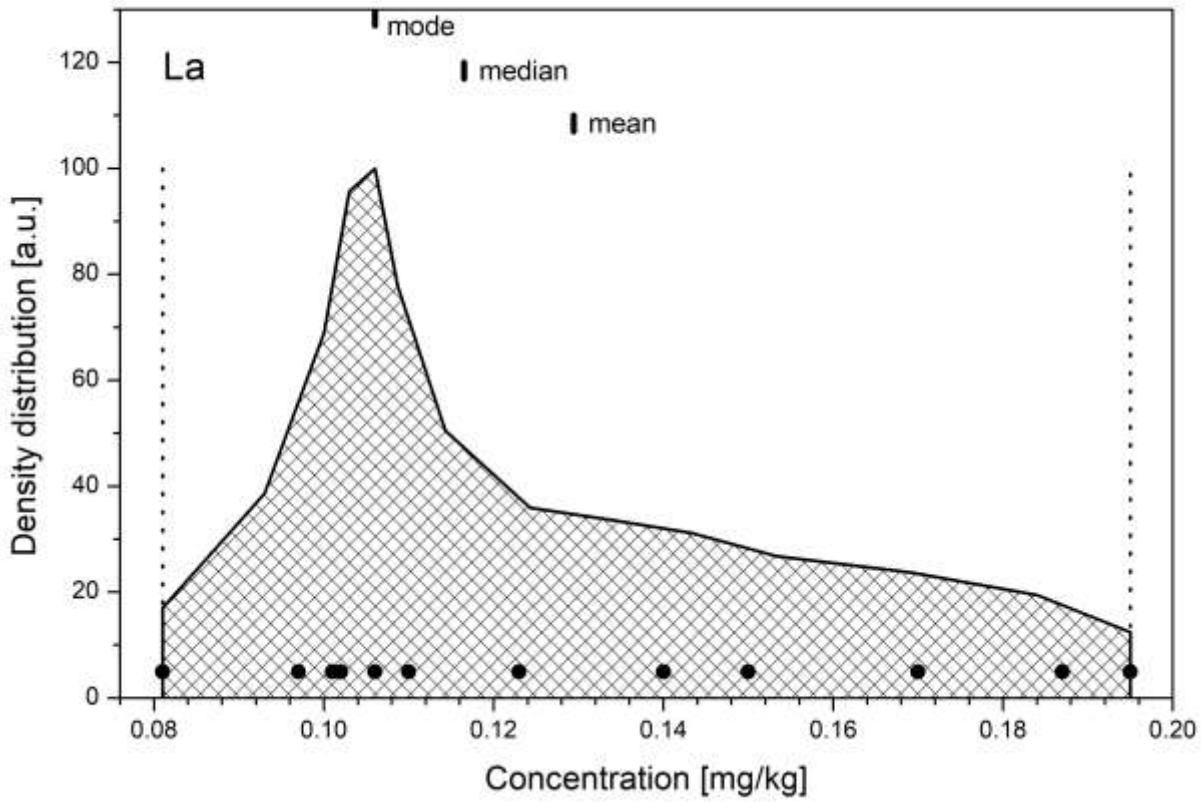

FIG. 17. The density distribution function for the analyte La.

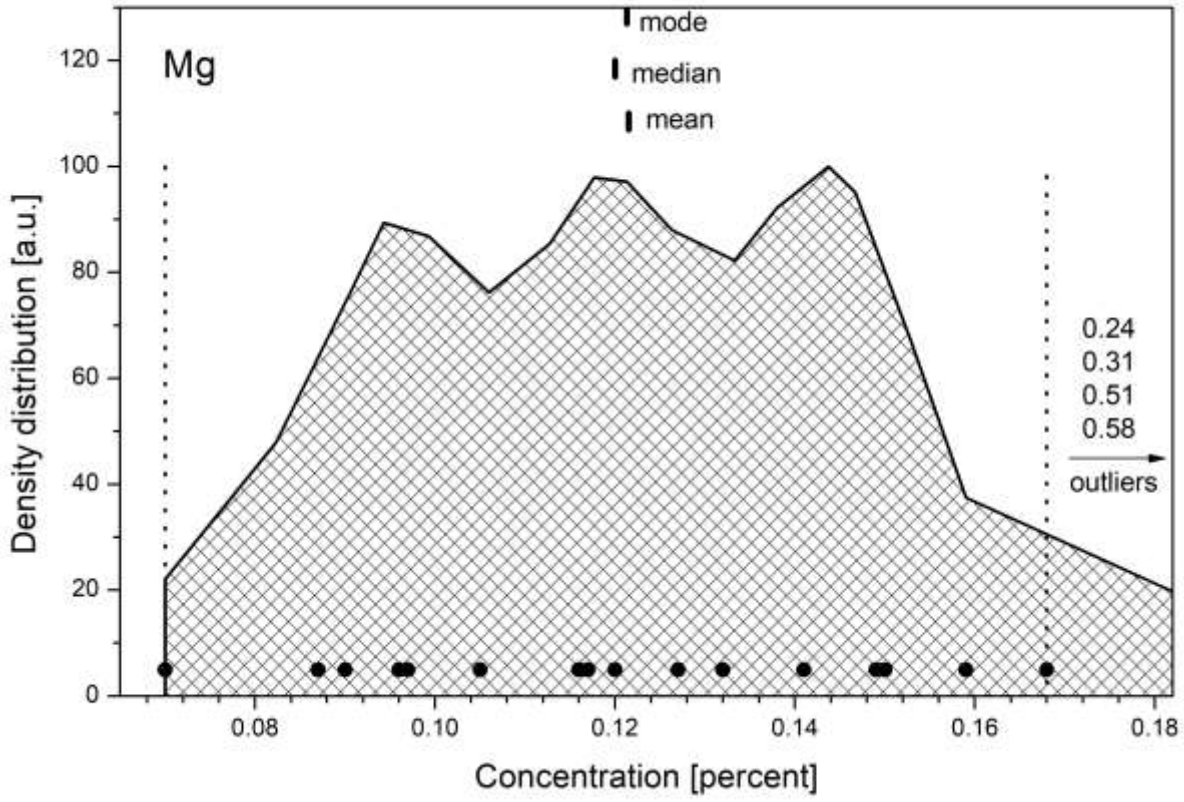

FIG. 18. The density distribution function for the analyte Mg.

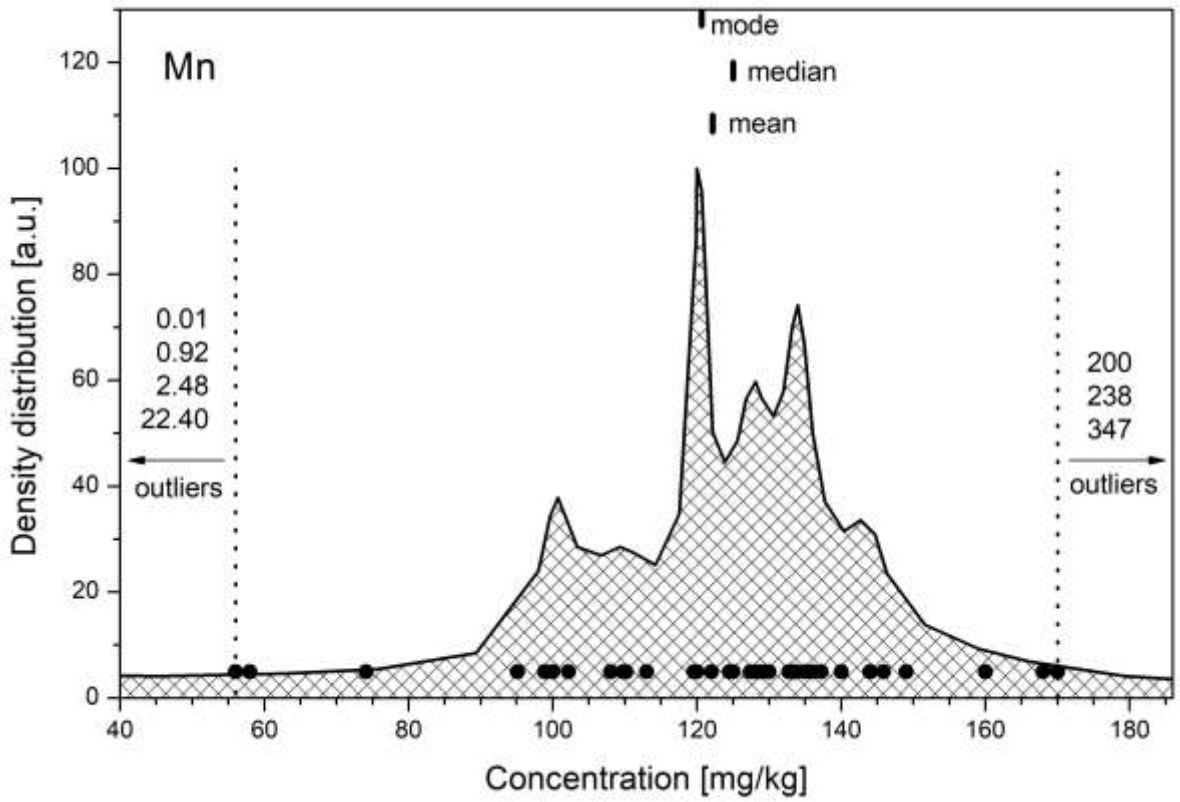

FIG. 19. The density distribution function for the analyte Mn.

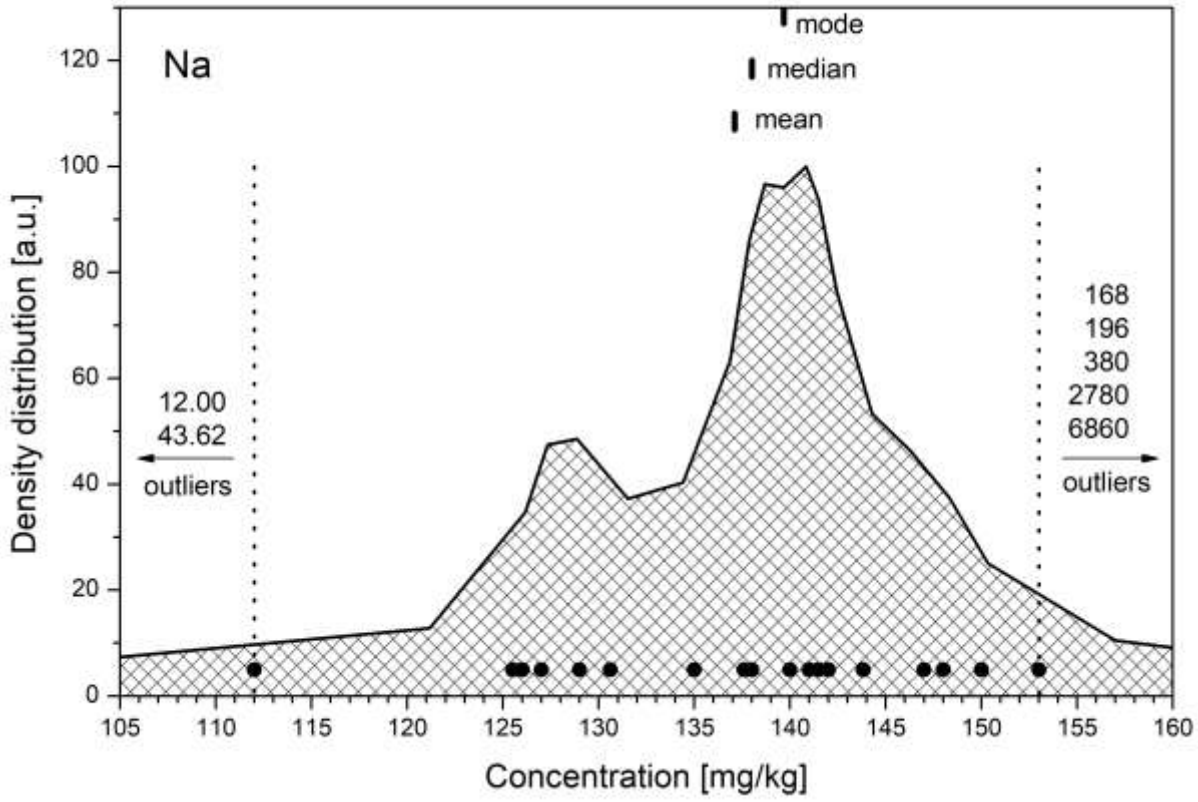

FIG. 20. The density distribution function for the analyte Na.

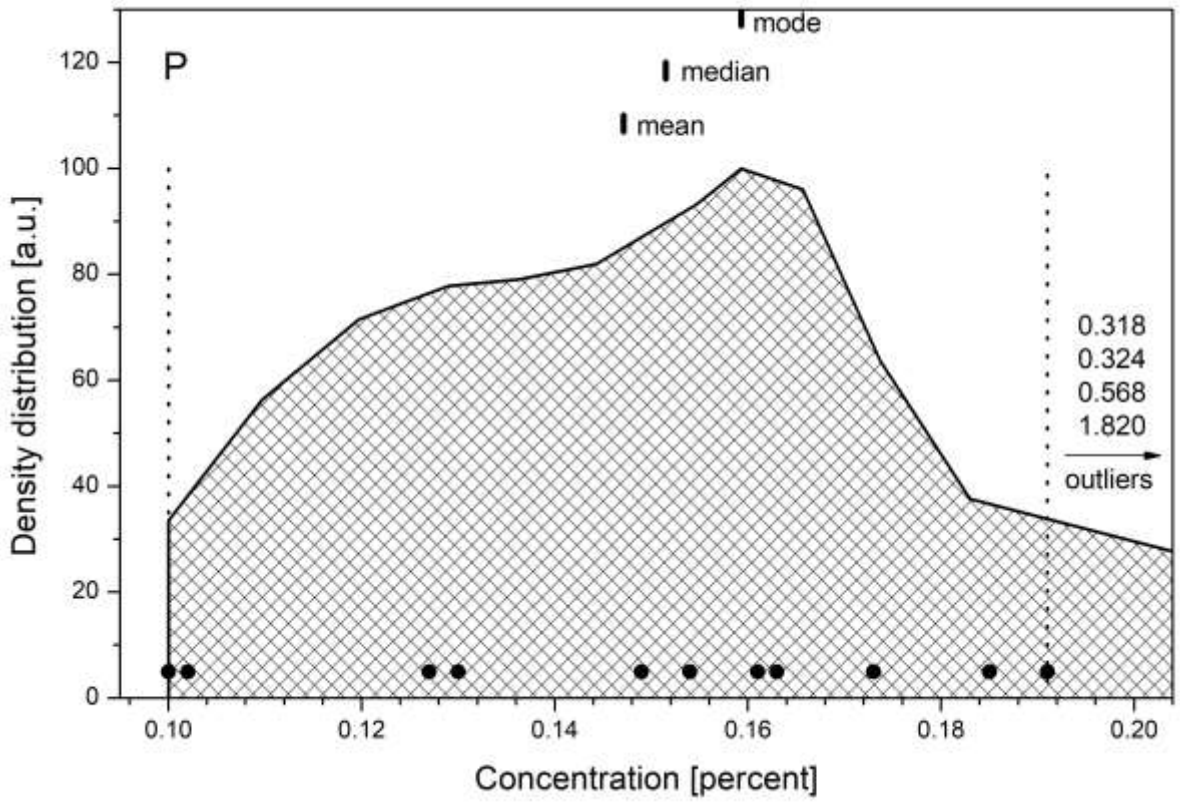

FIG. 21. The density distribution function for the analyte P.

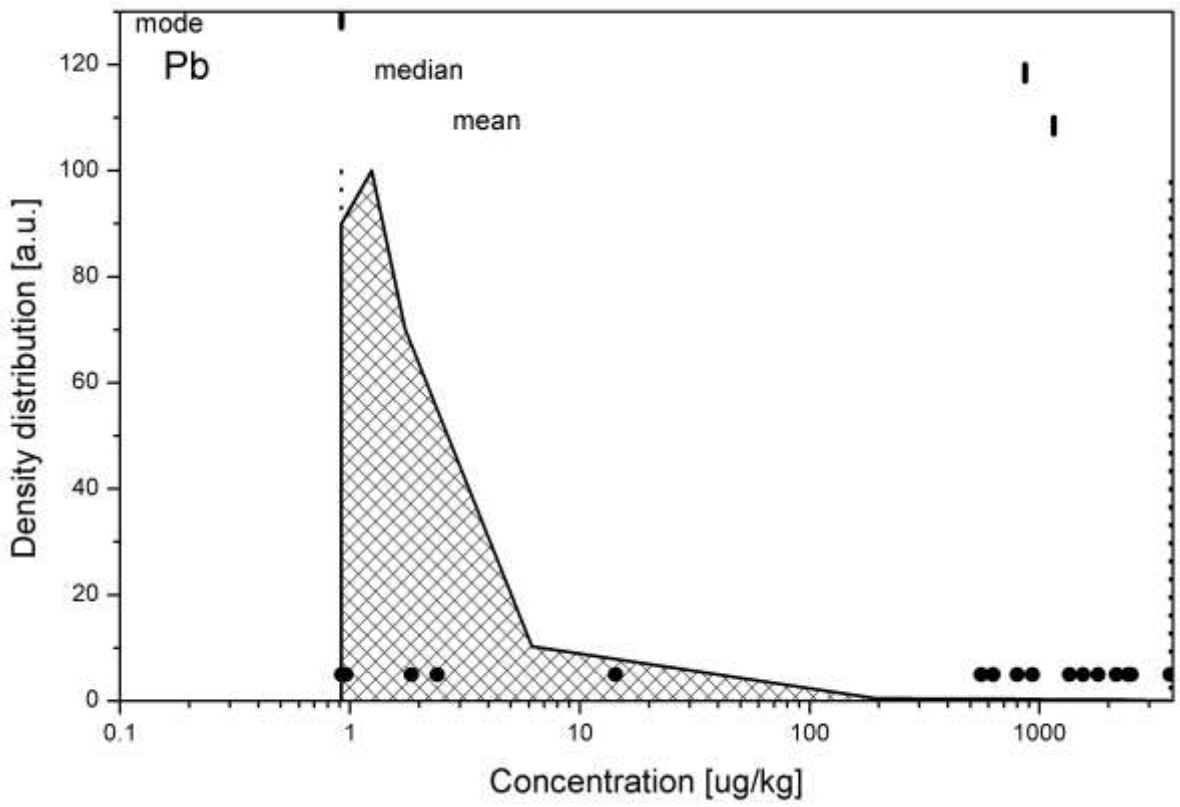

FIG. 22. The density distribution function for the analyte Pb. Please note the "Concentration" axis in logarithmic scale.

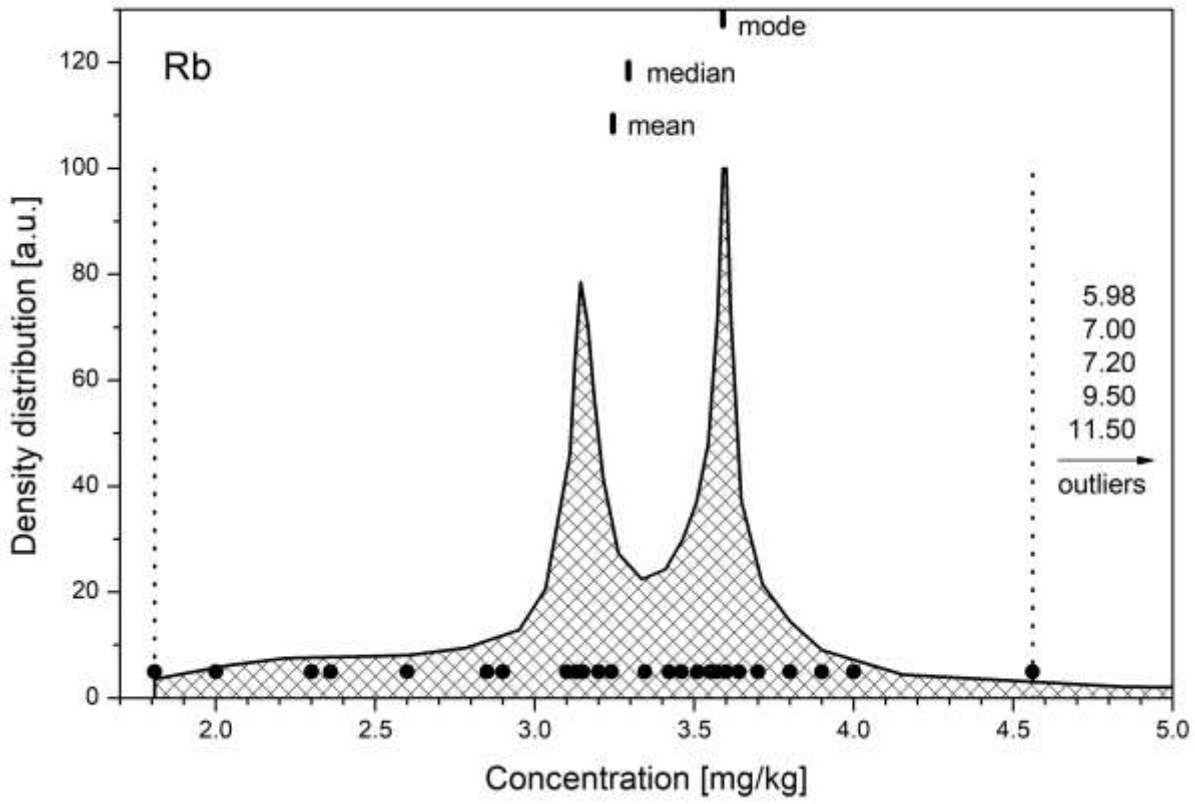

FIG. 23. The density distribution function for the analyte Rb.

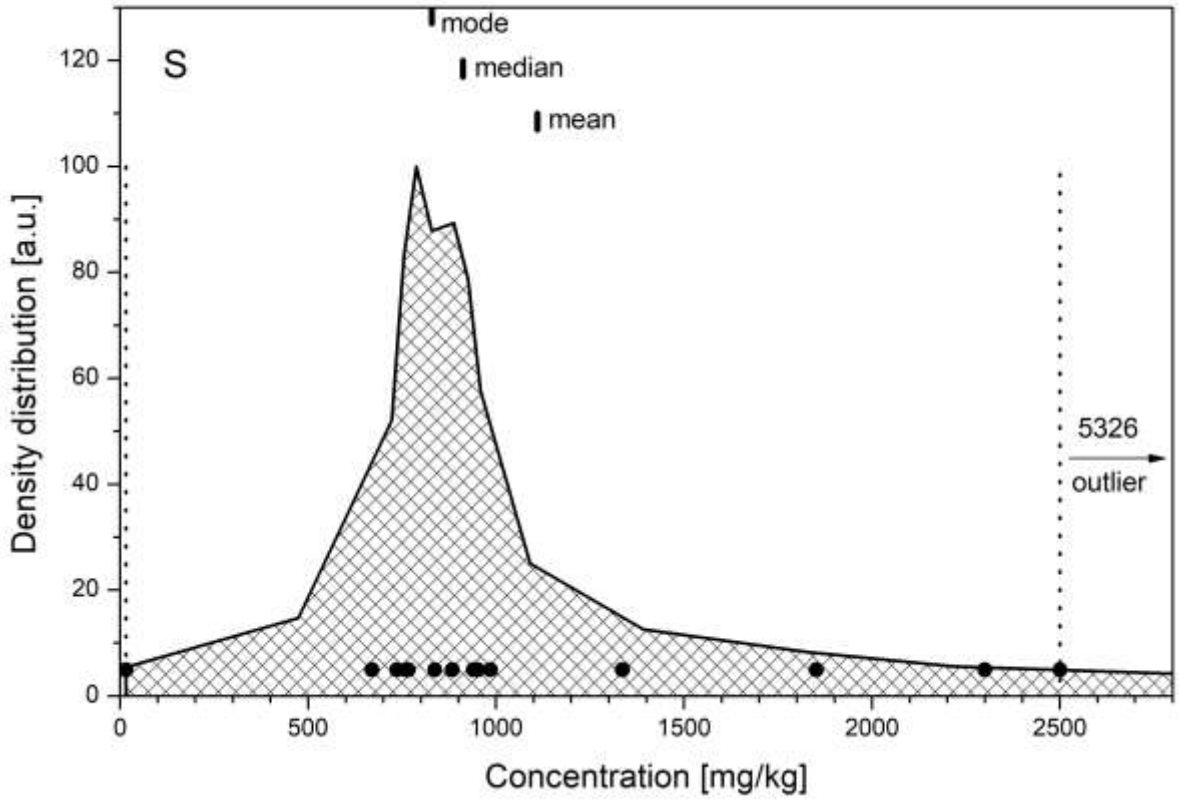

FIG. 24. The density distribution function for the analyte S.

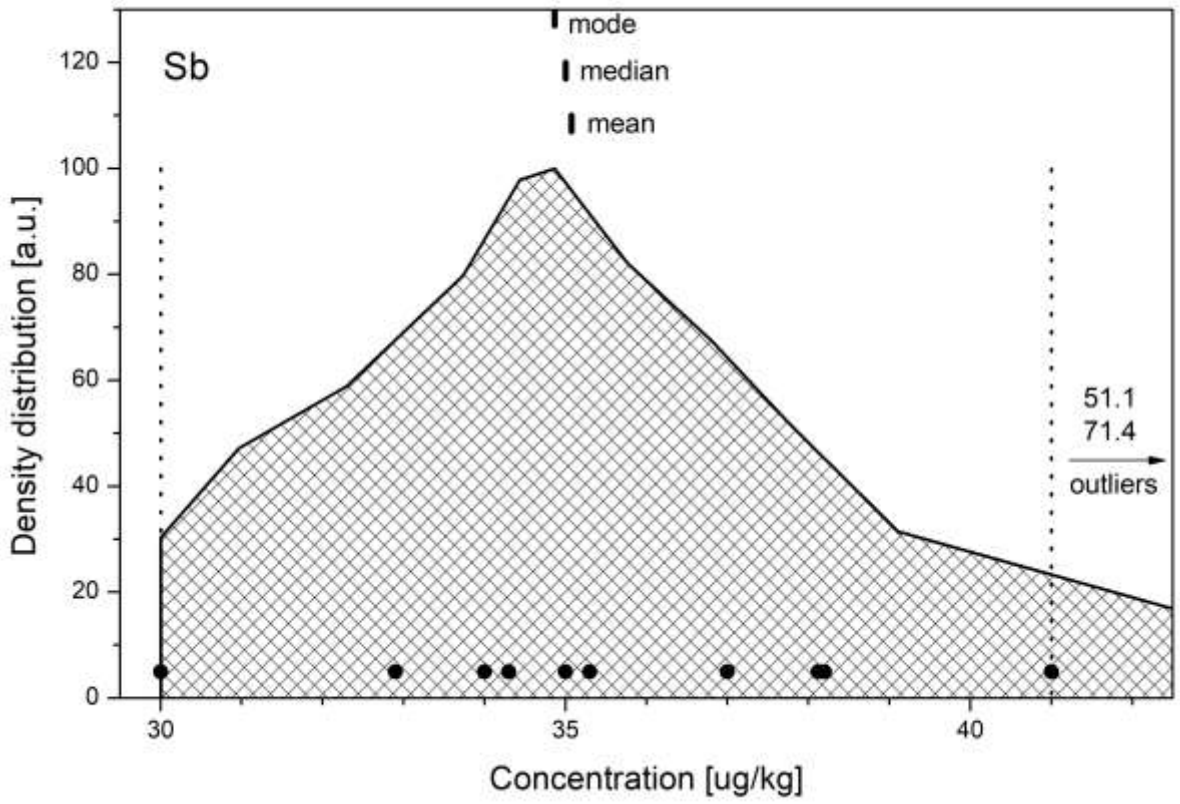

FIG. 25. The density distribution function for the analyte Sb.

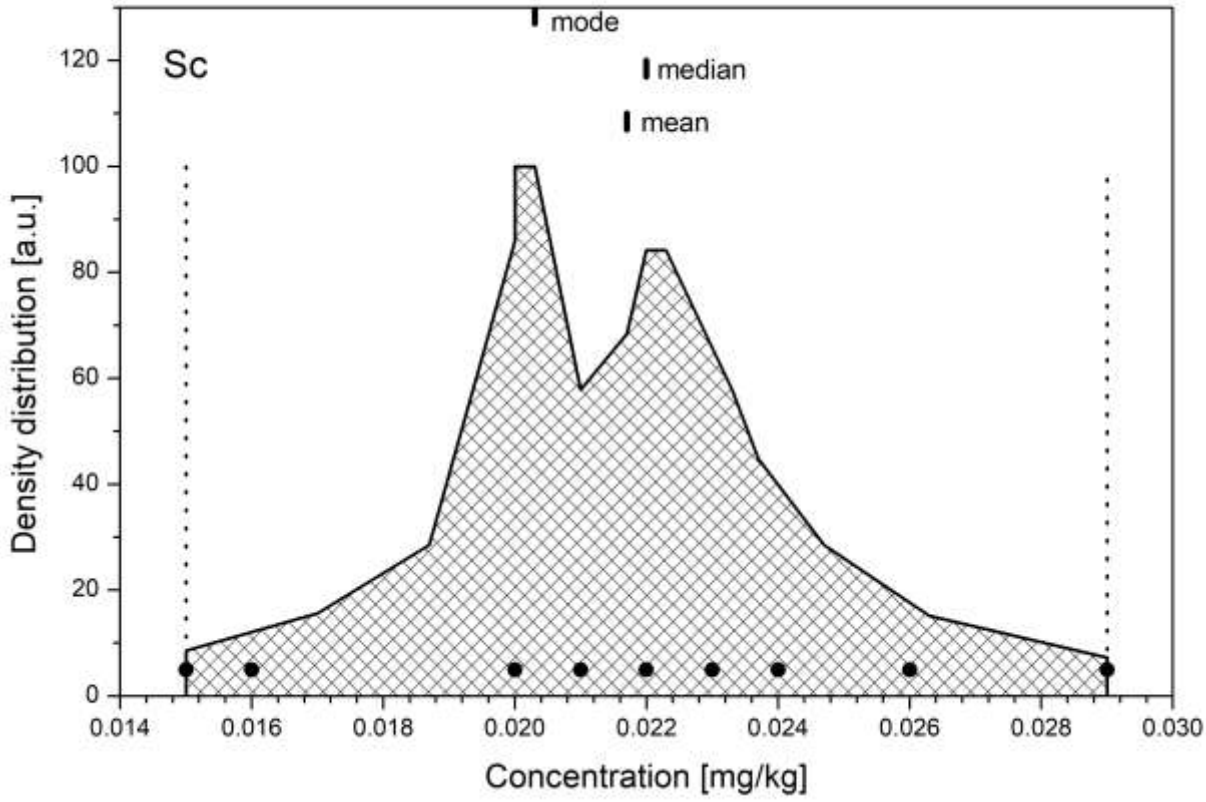

FIG. 26. The density distribution function for the analyte Sc.

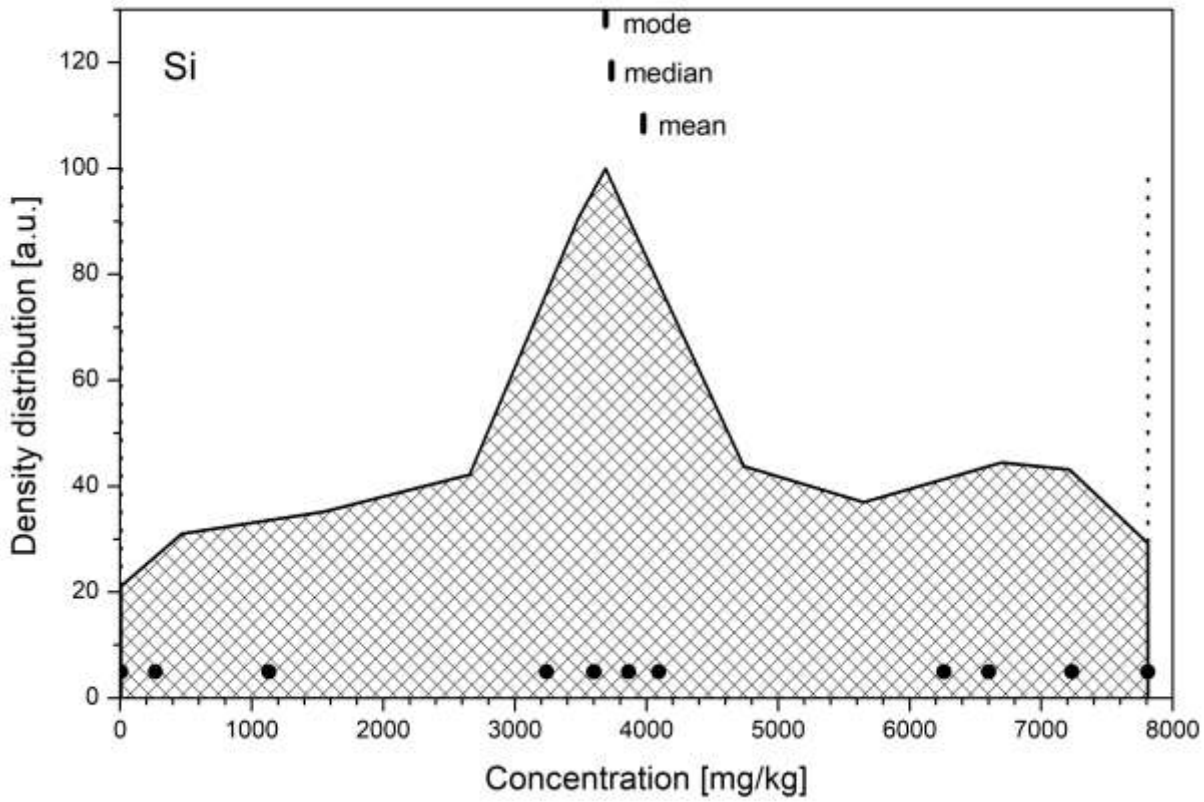

FIG. 27. The density distribution function for the analyte Si.

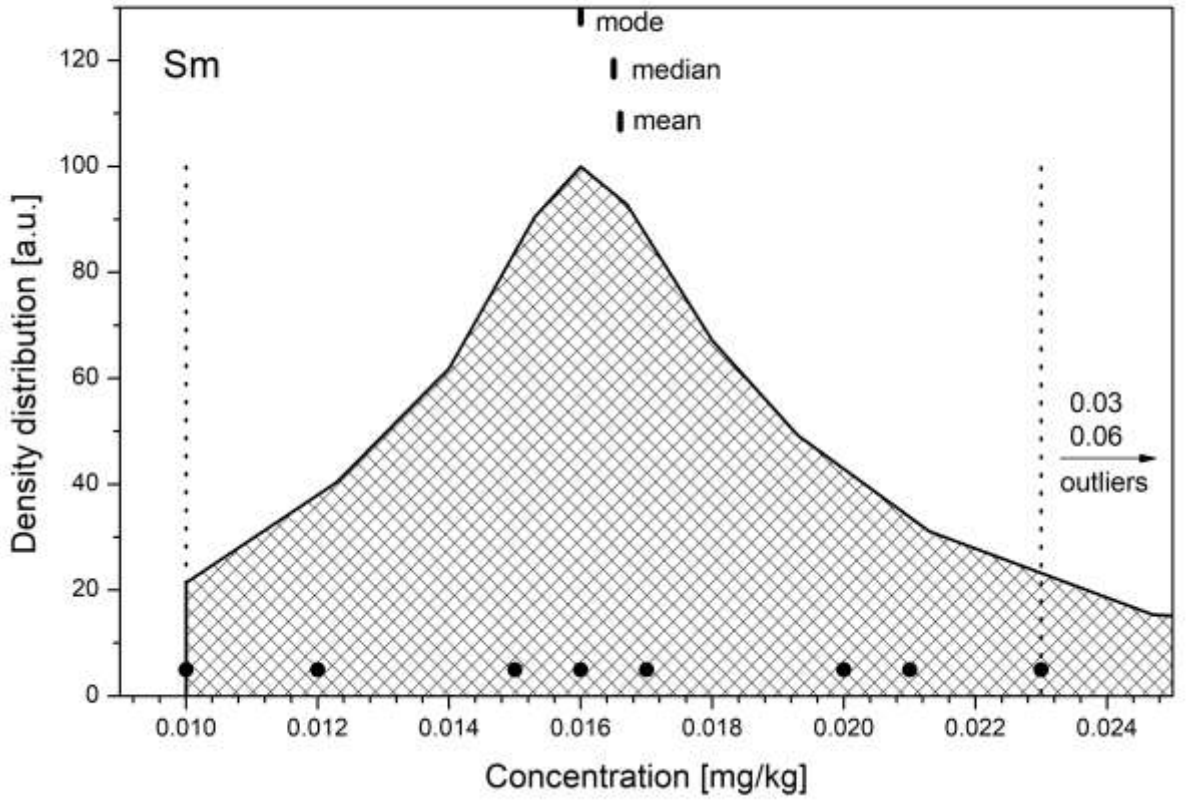

FIG. 28. The density distribution function for the analyte Sm.

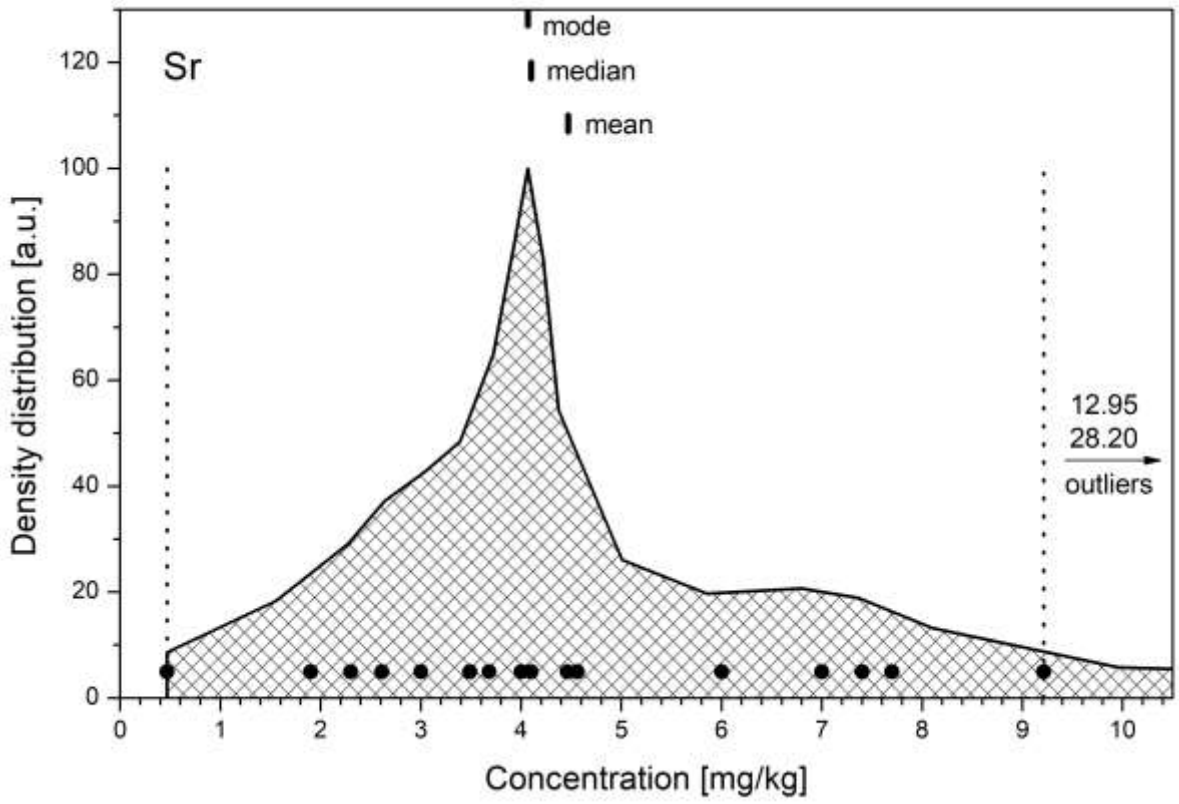

FIG. 29. The density distribution function for the analyte Sr.

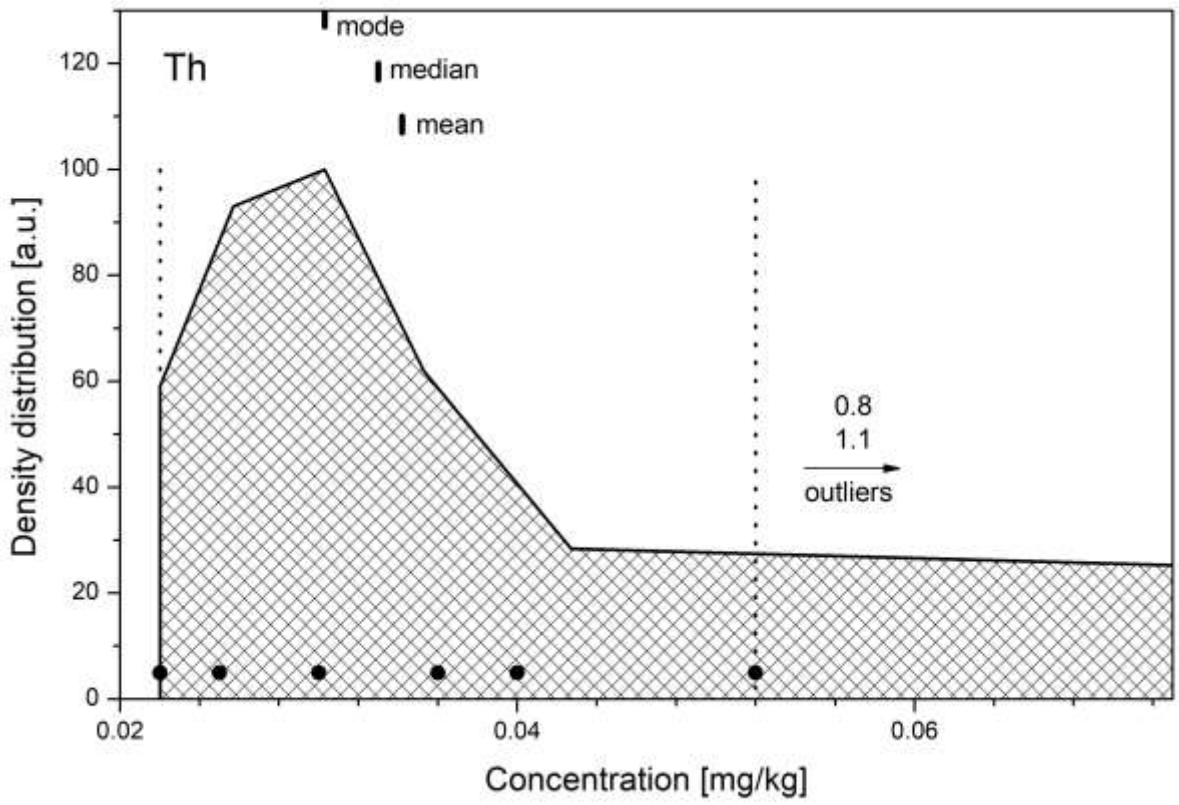

FIG. 30. The density distribution function for the analyte Th.

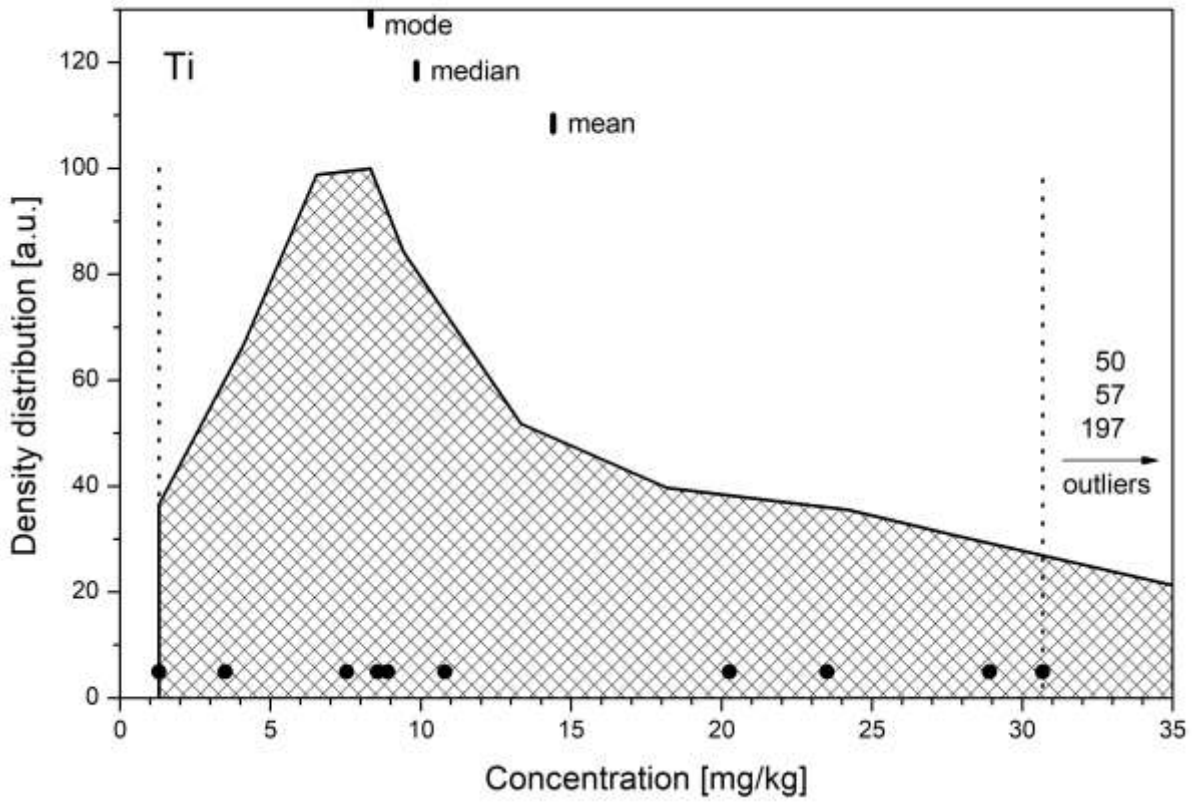

FIG. 31. The density distribution function for the analyte Ti.

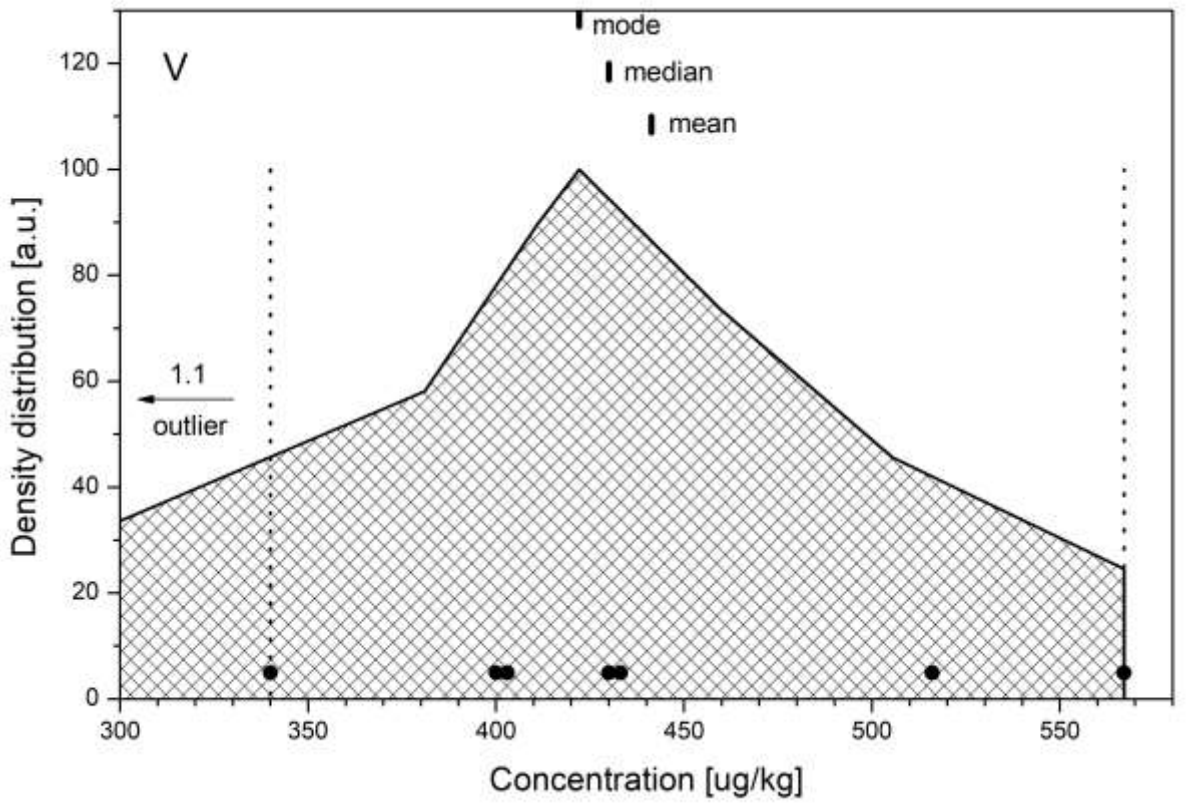

FIG. 32. The density distribution function for the analyte V.

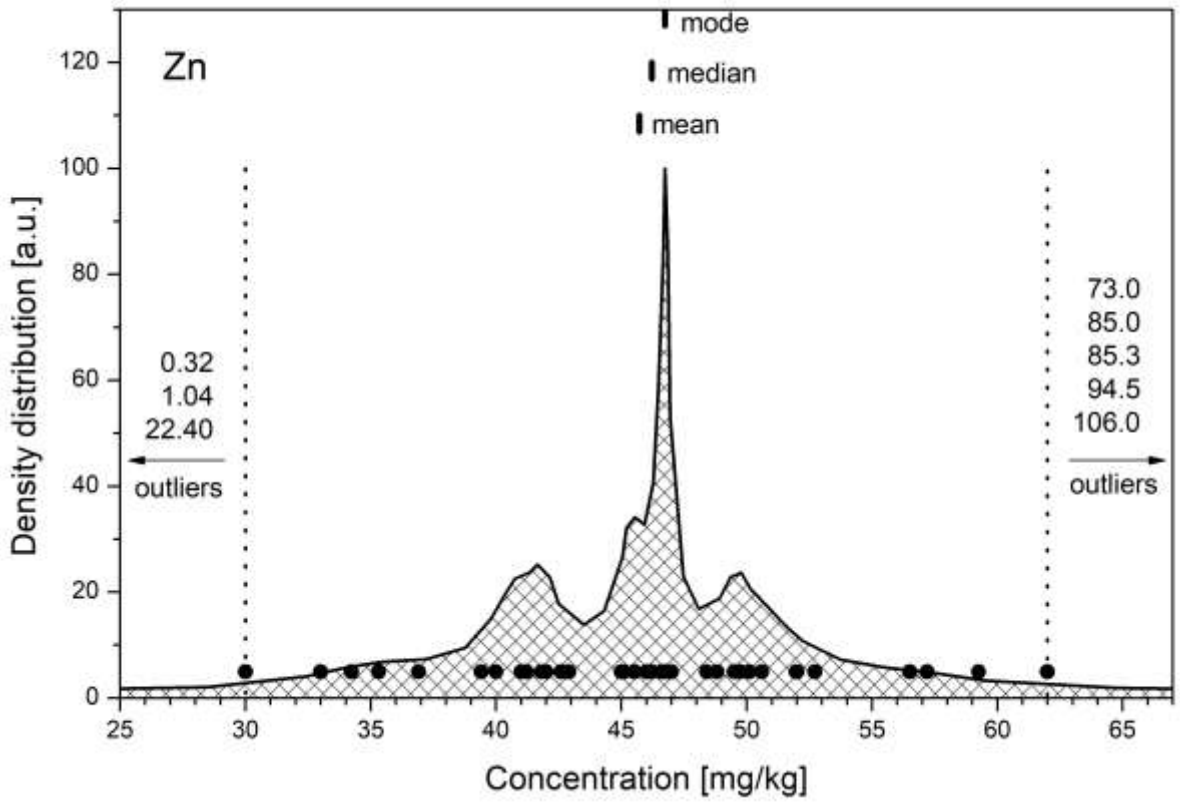

FIG. 33. The density distribution function for the analyte Zn.

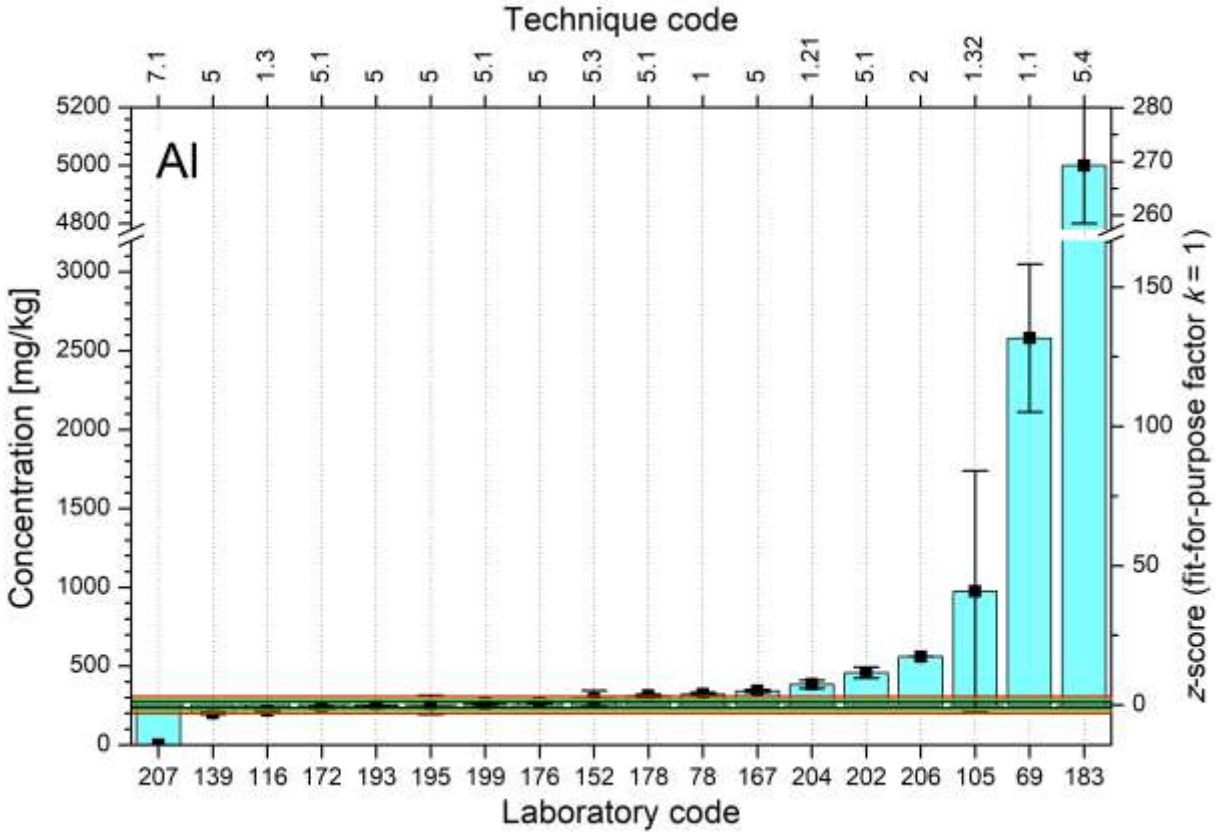

FIG. 34. Distributions of z-scores for analyte Al.

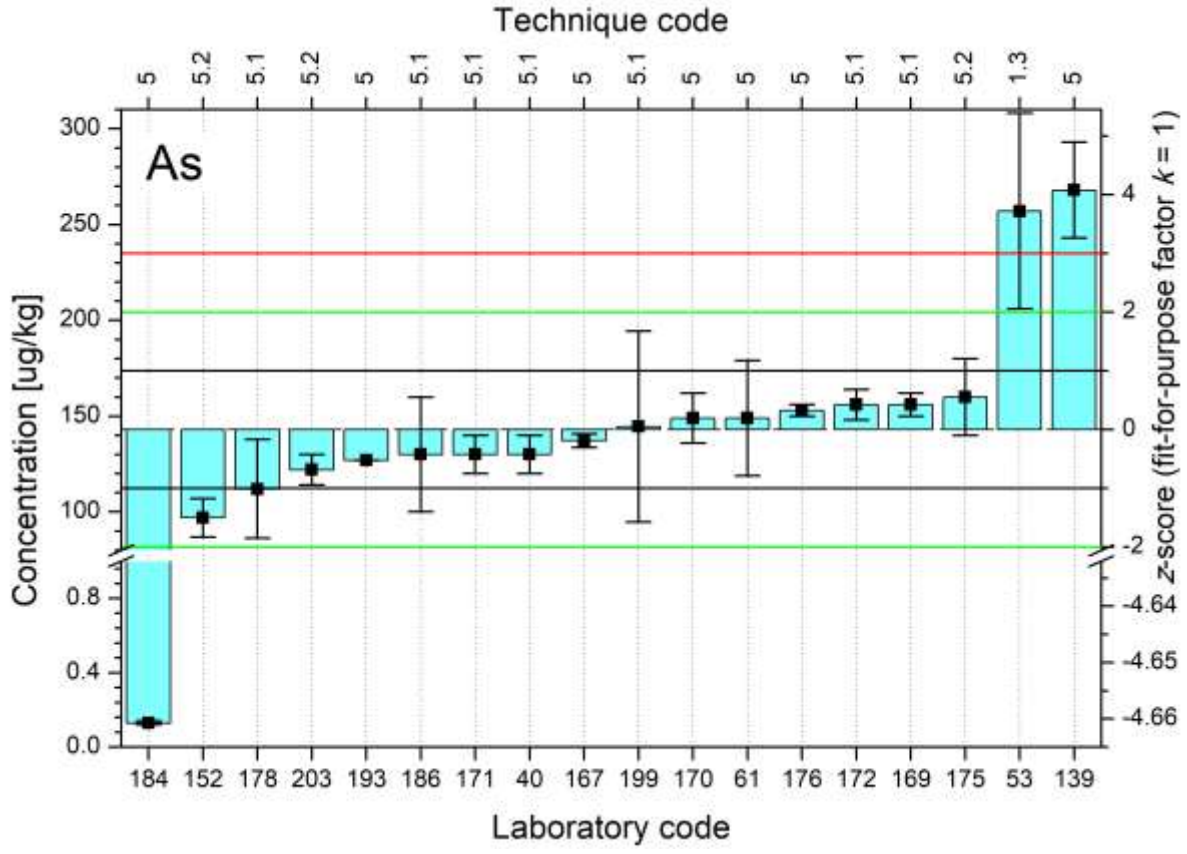

FIG. 35. Distributions of z-scores for analyte As.

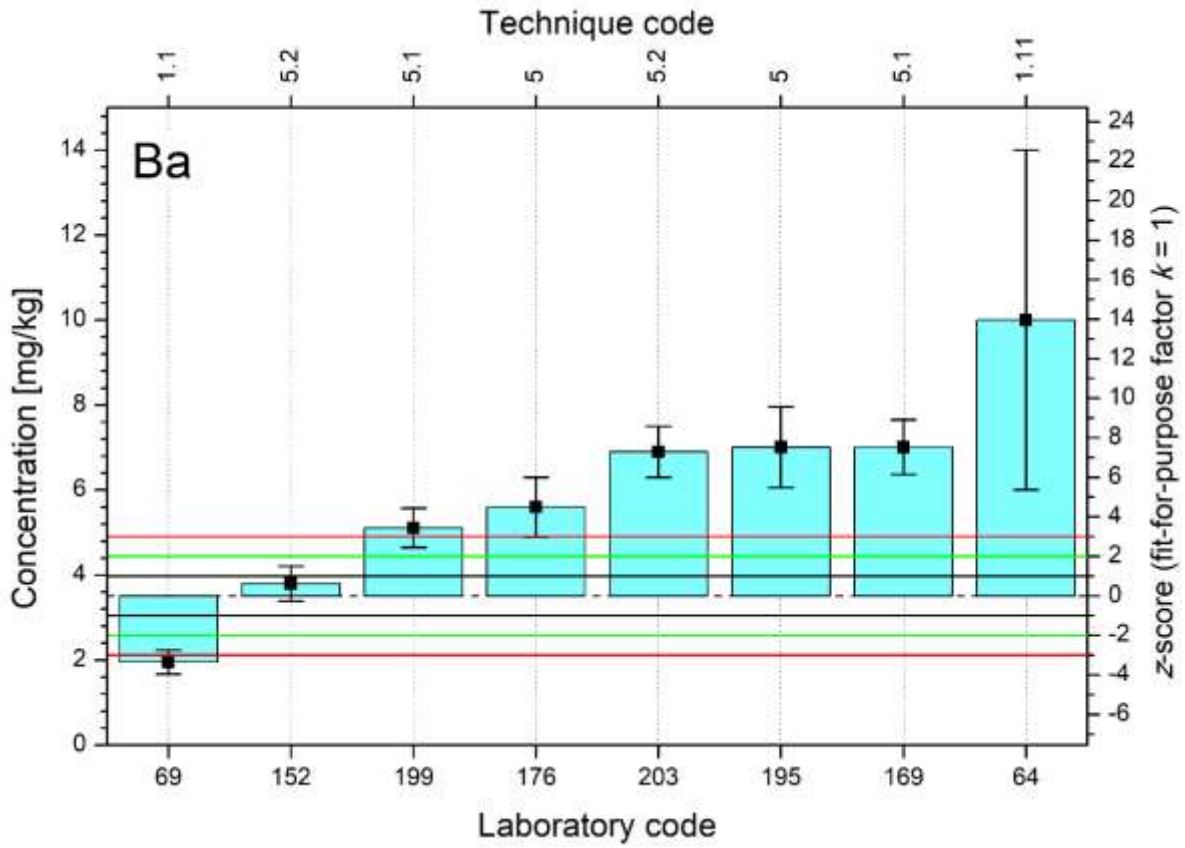

FIG. 36. Distributions of z-scores for analyte Ba.

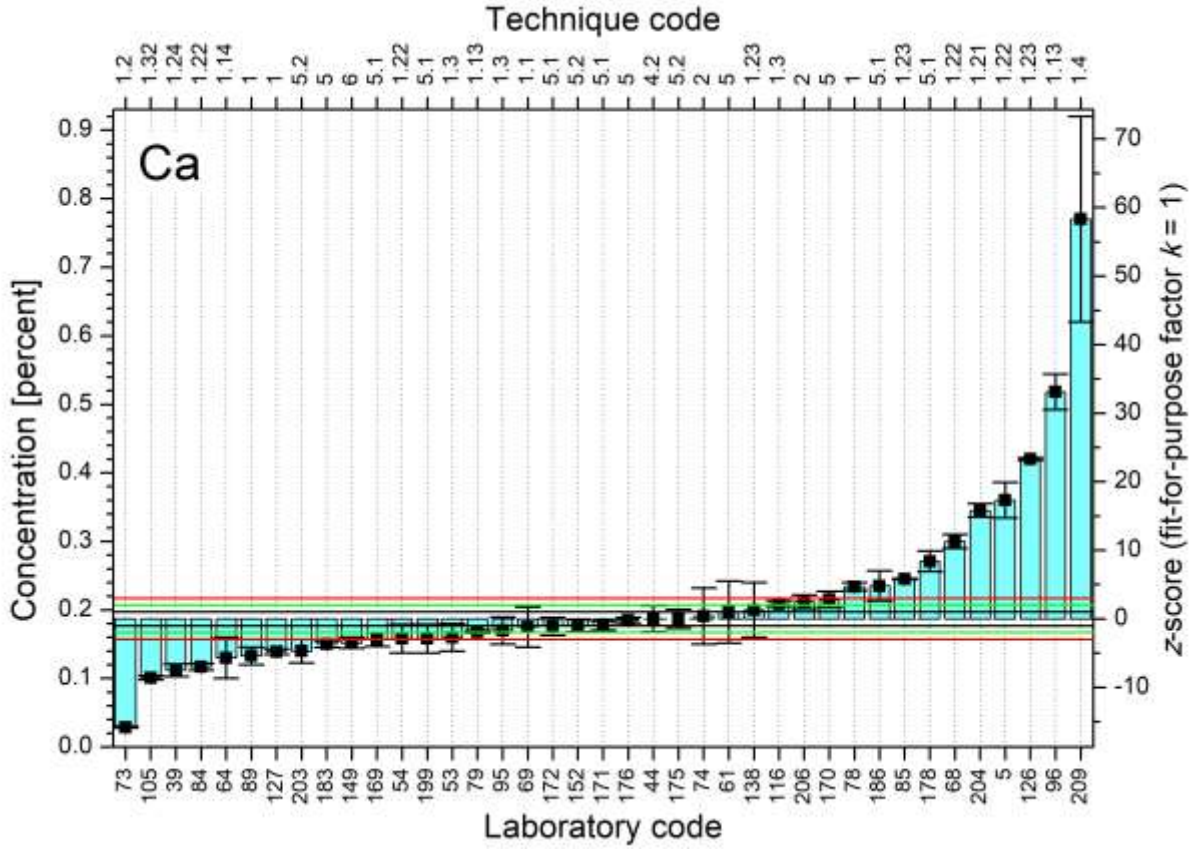

FIG. 37. Distributions of z-scores for analyte Ca.

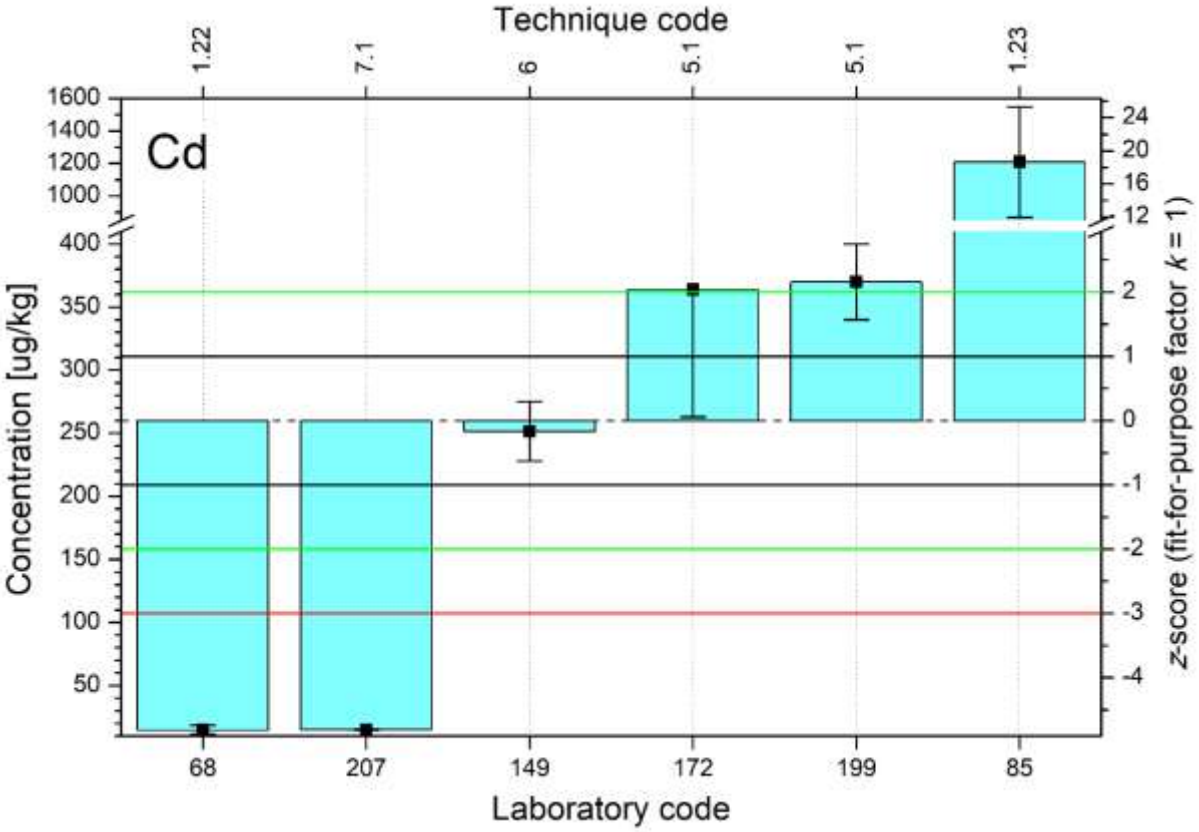

FIG. 38. Distributions of z-scores for analyte Cd.

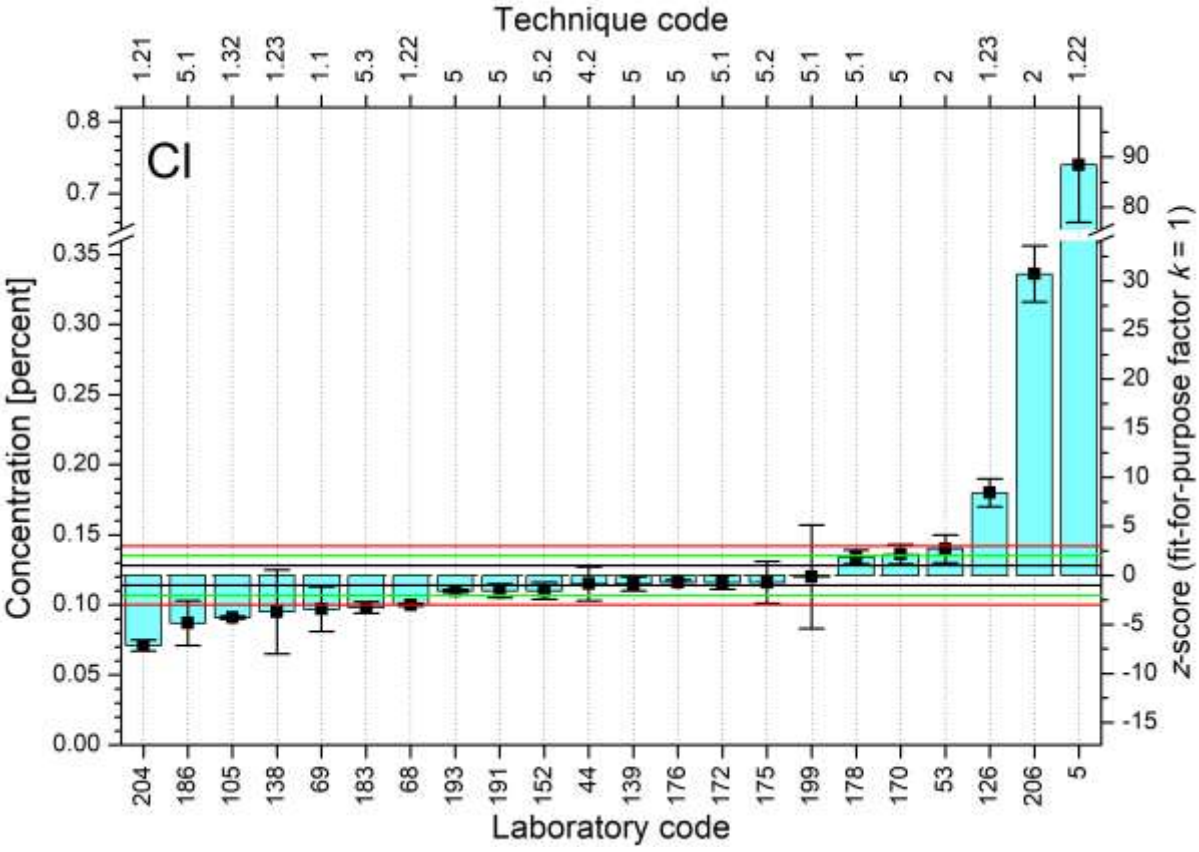

FIG. 39. Distributions of z-scores for analyte Cl.

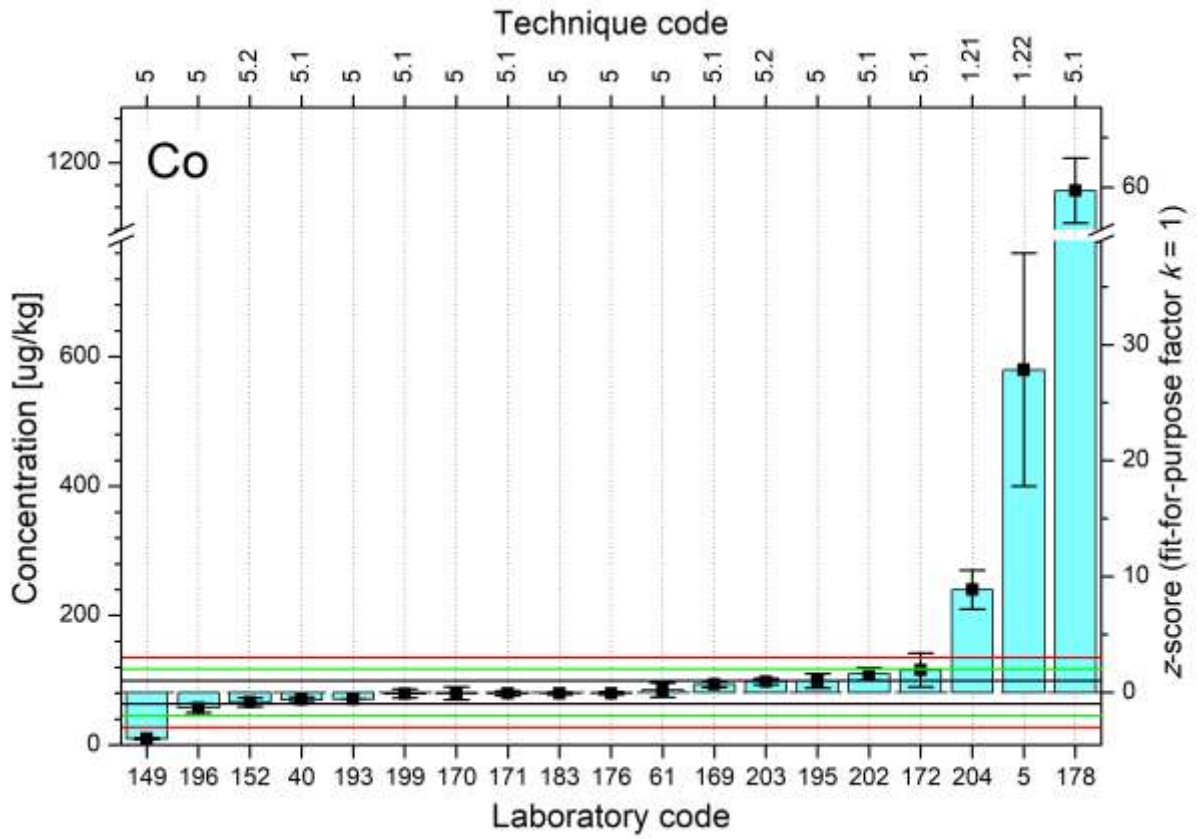

FIG. 40. Distributions of z-scores for analyte Co.

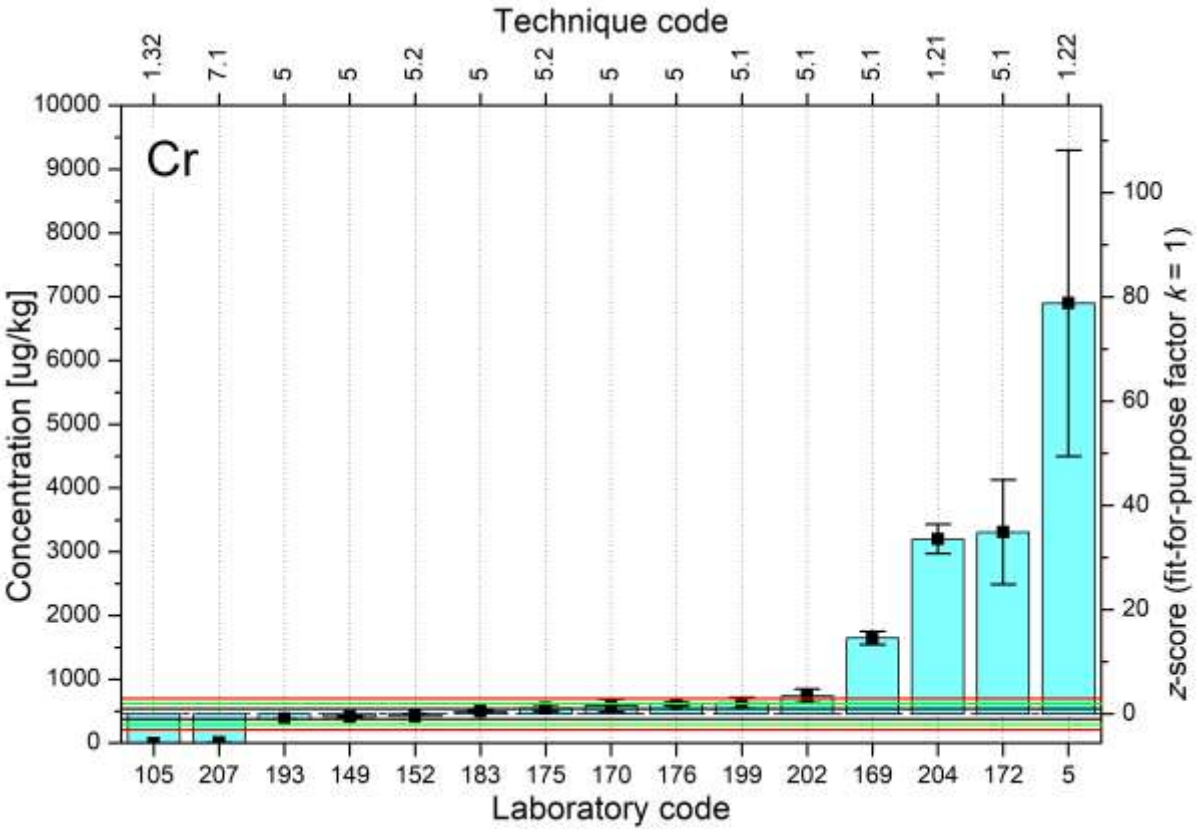

FIG. 41. Distributions of z-scores for analyte Cr.

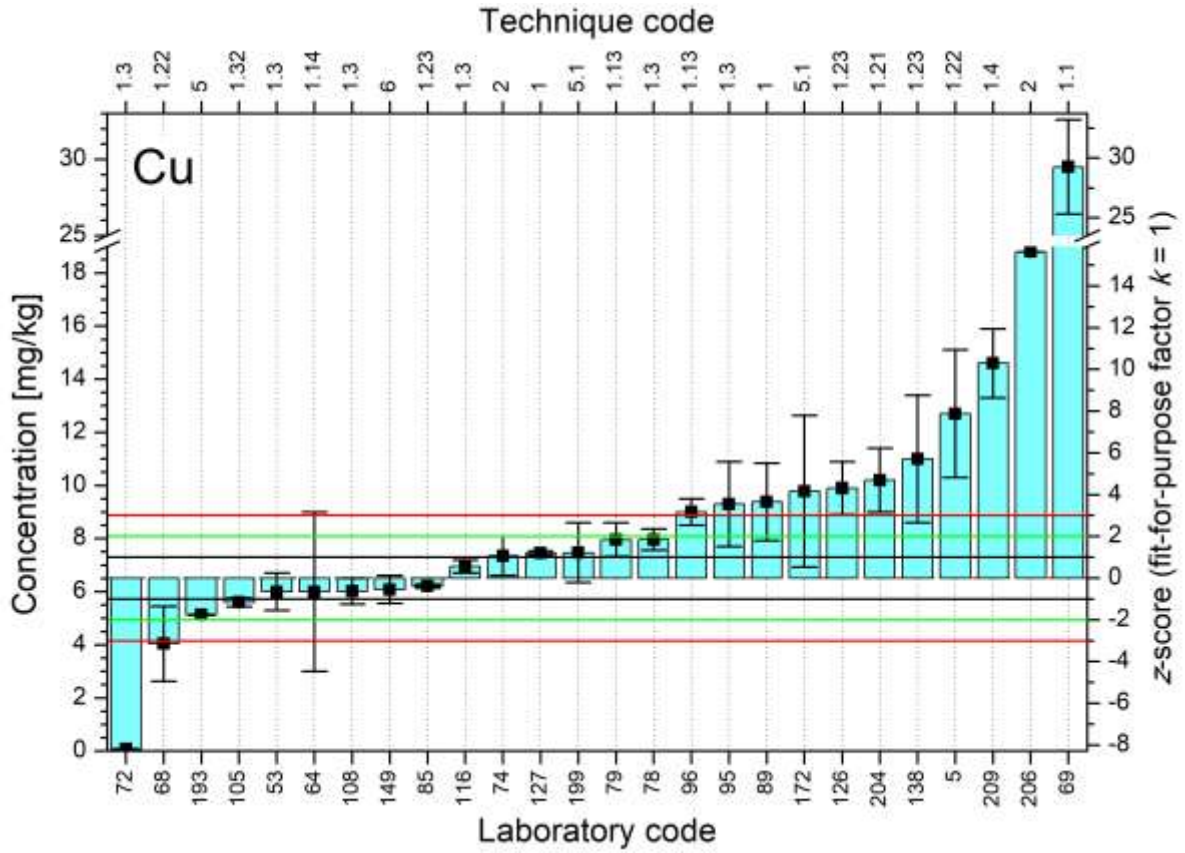

FIG. 42. Distributions of z-scores for analyte Cu.

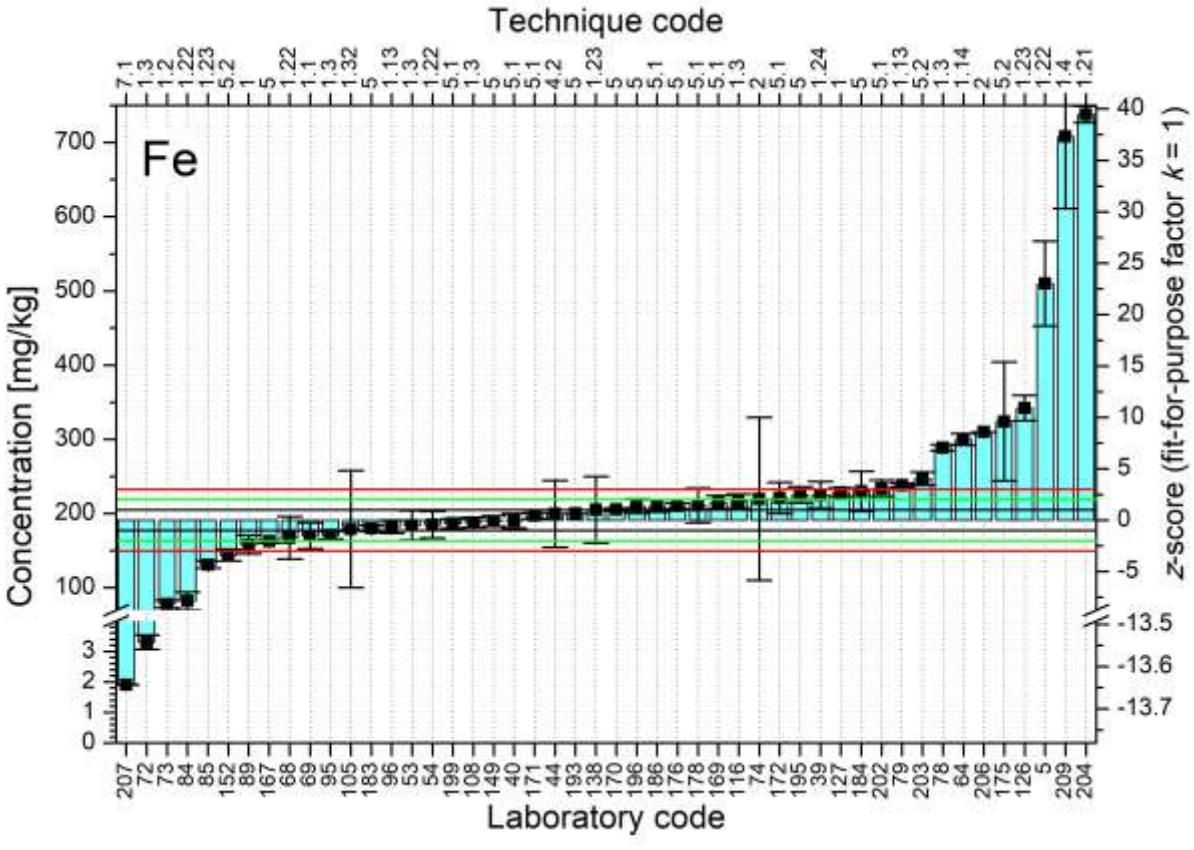

FIG. 43. Distributions of z-scores for analyte Fe.

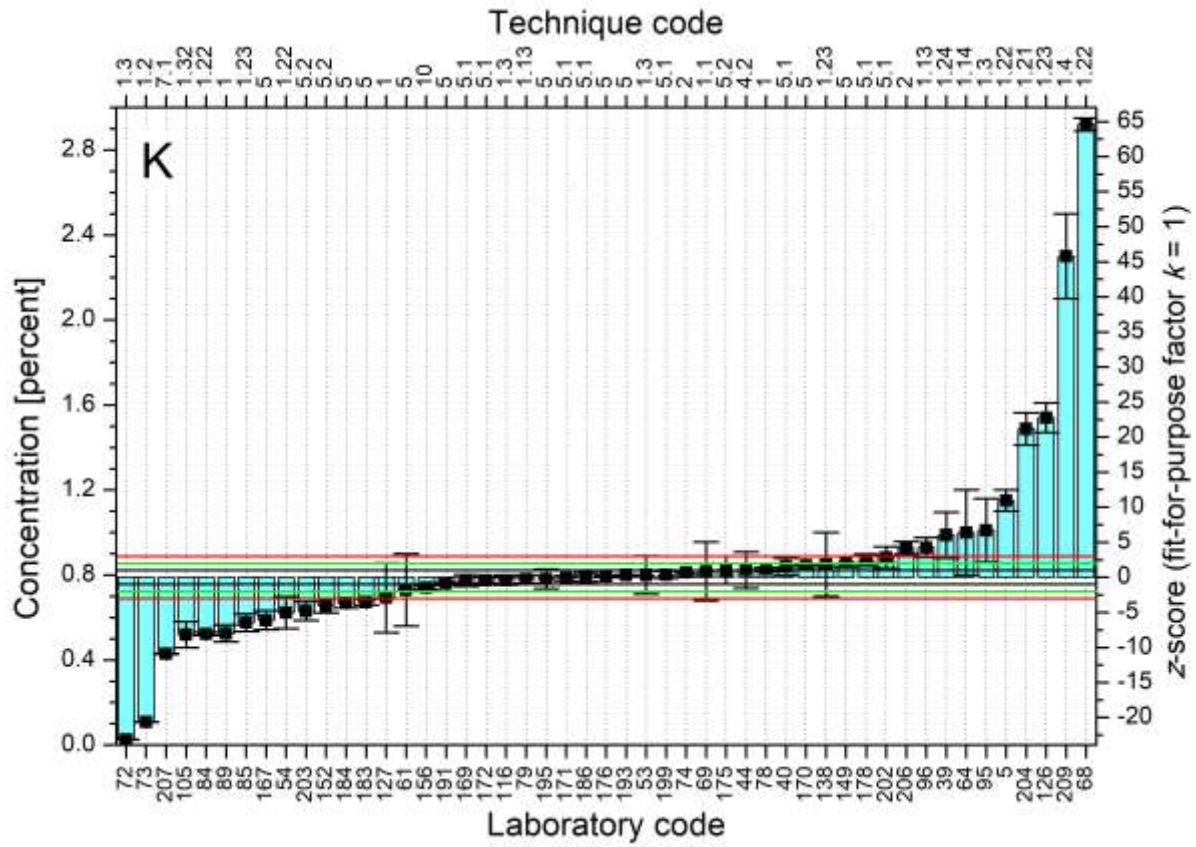

FIG. 44. Distributions of z-scores for analyte K.

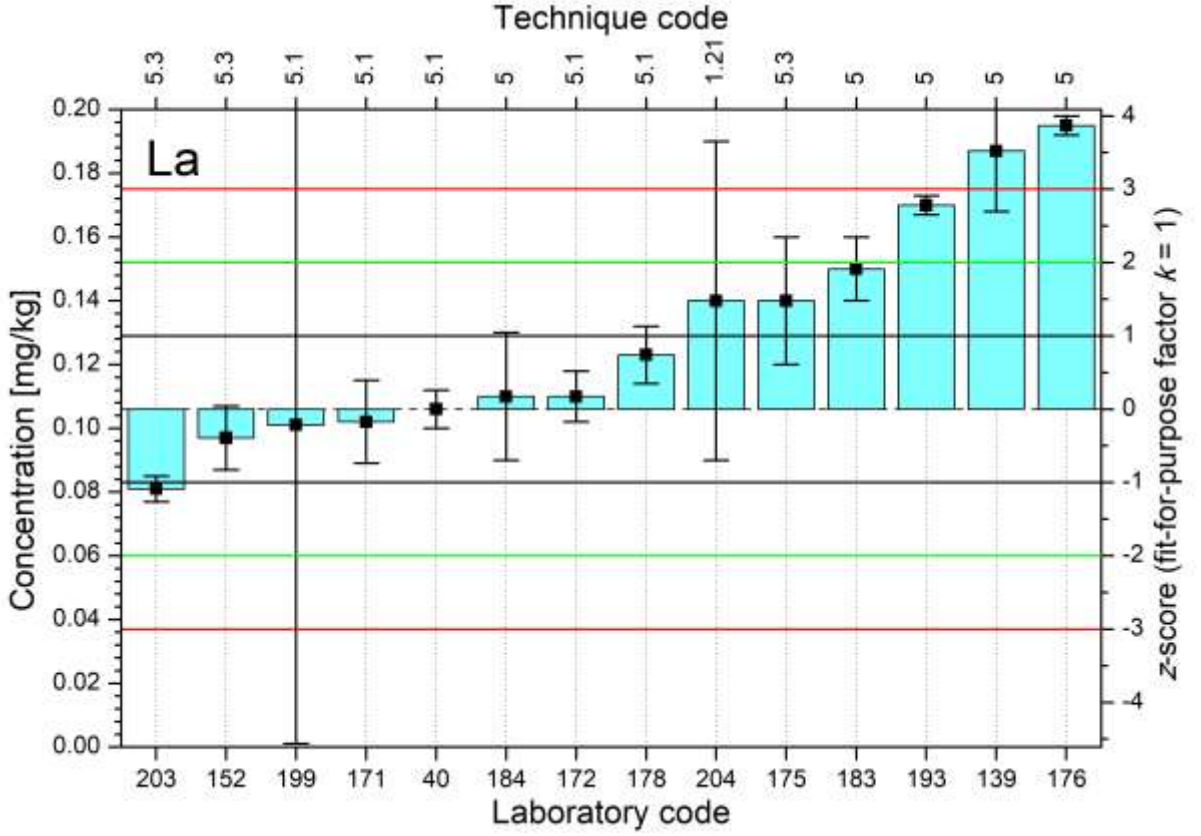

FIG. 45. Distributions of z-scores for analyte La.

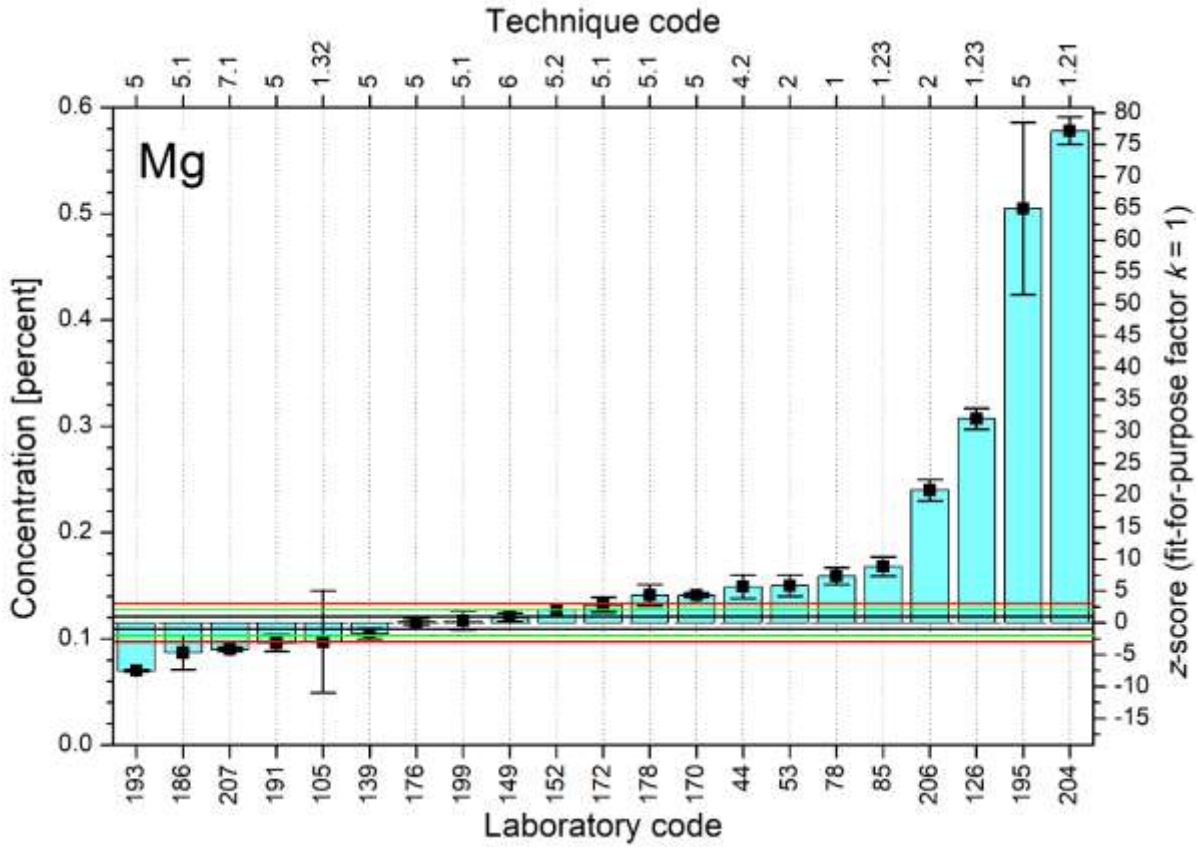

FIG. 46. Distributions of z-scores for analyte Mg.

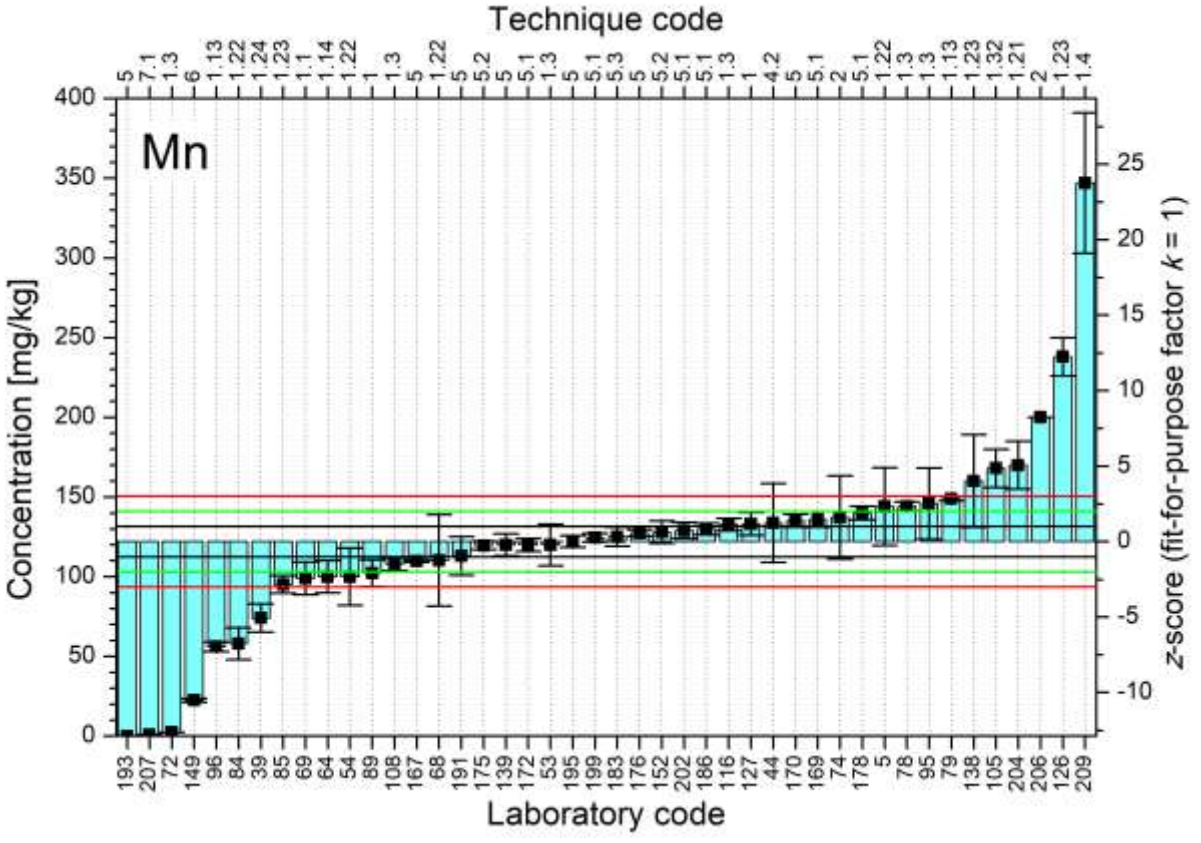

FIG. 47. Distributions of z-scores for analyte Mn.

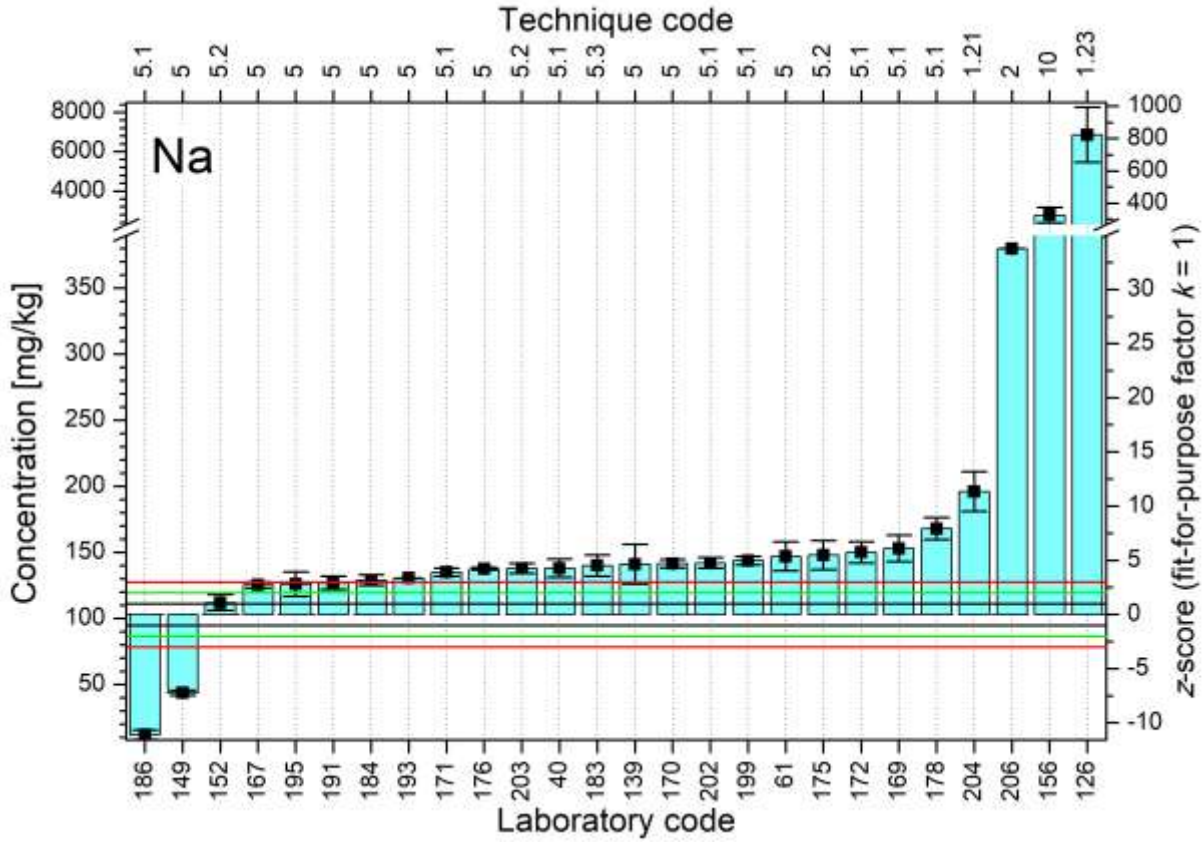

FIG. 48. Distributions of z-scores for analyte Na.

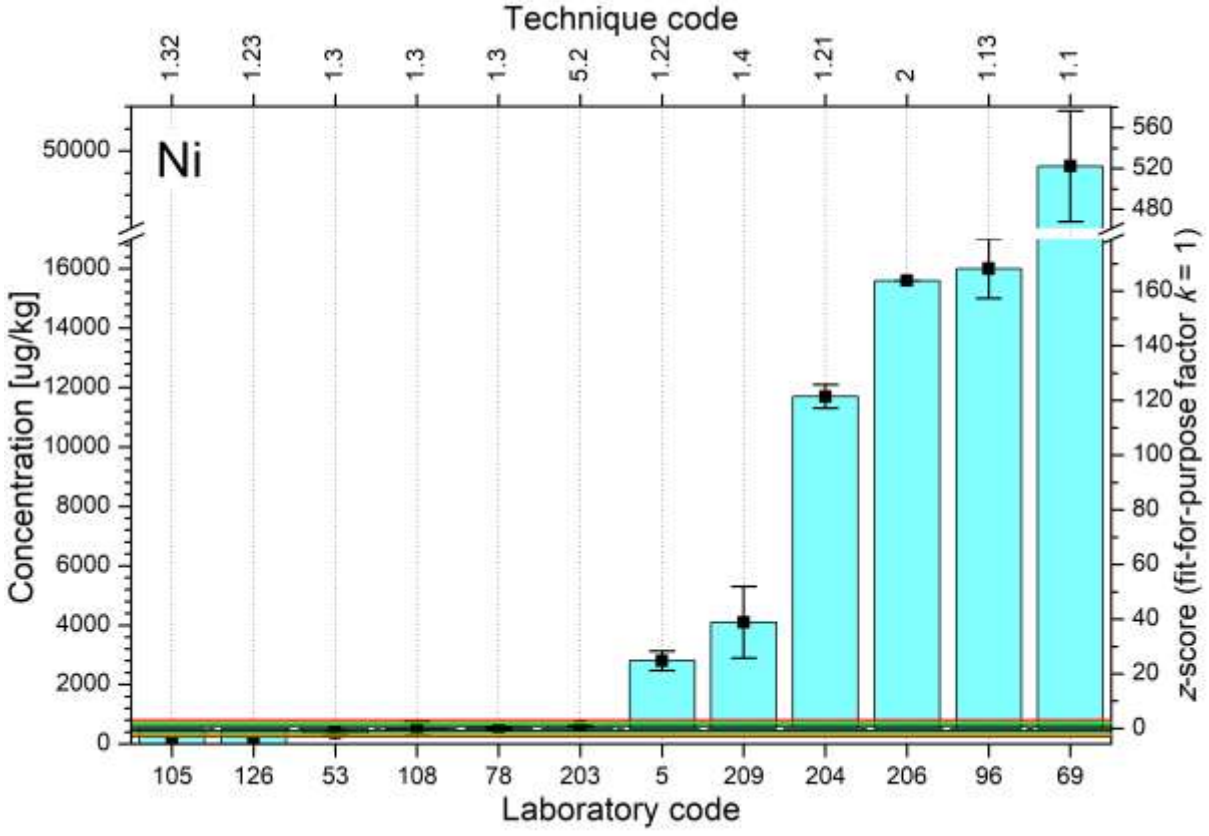

FIG. 49. Distributions of z-scores for analyte Ni.

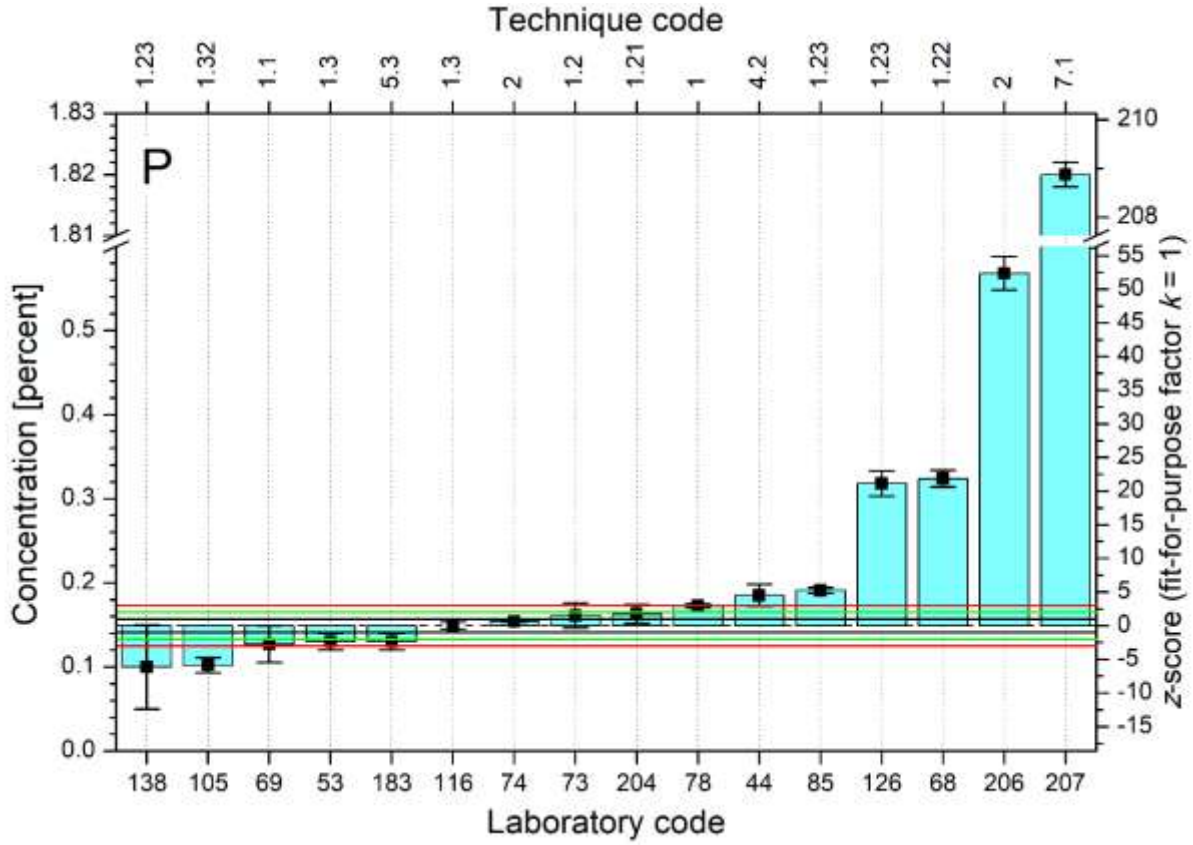

FIG. 50. Distributions of z-scores for analyte P.

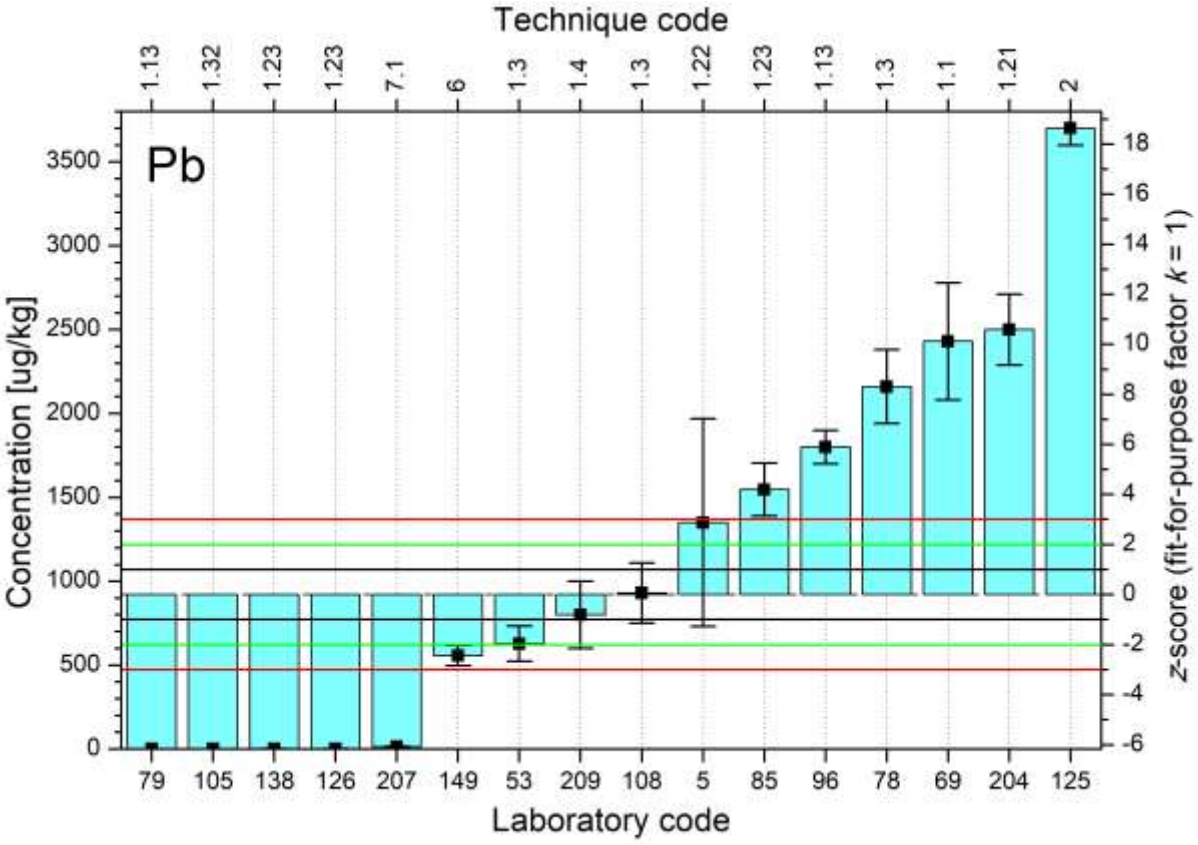

FIG. 51. Distributions of z-scores for analyte Pb.

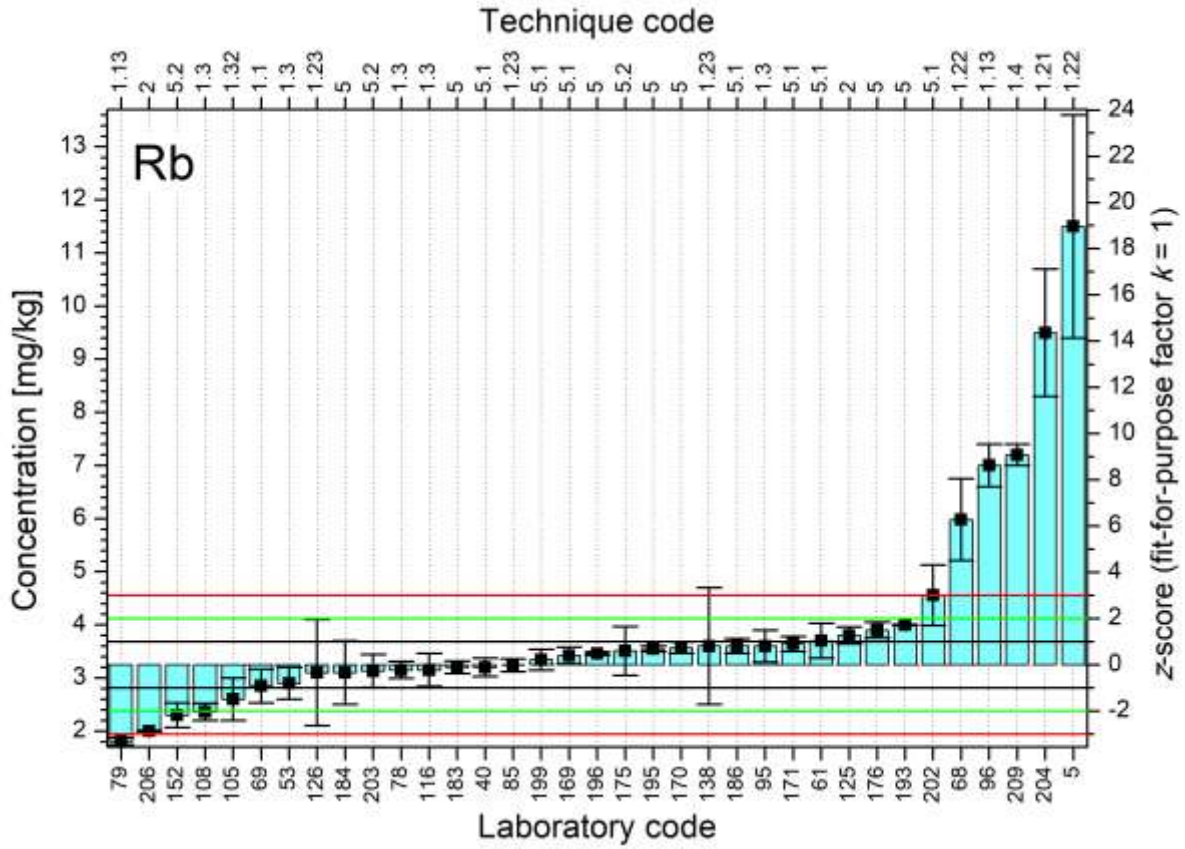

FIG. 52. Distributions of z-scores for analyte Rb.

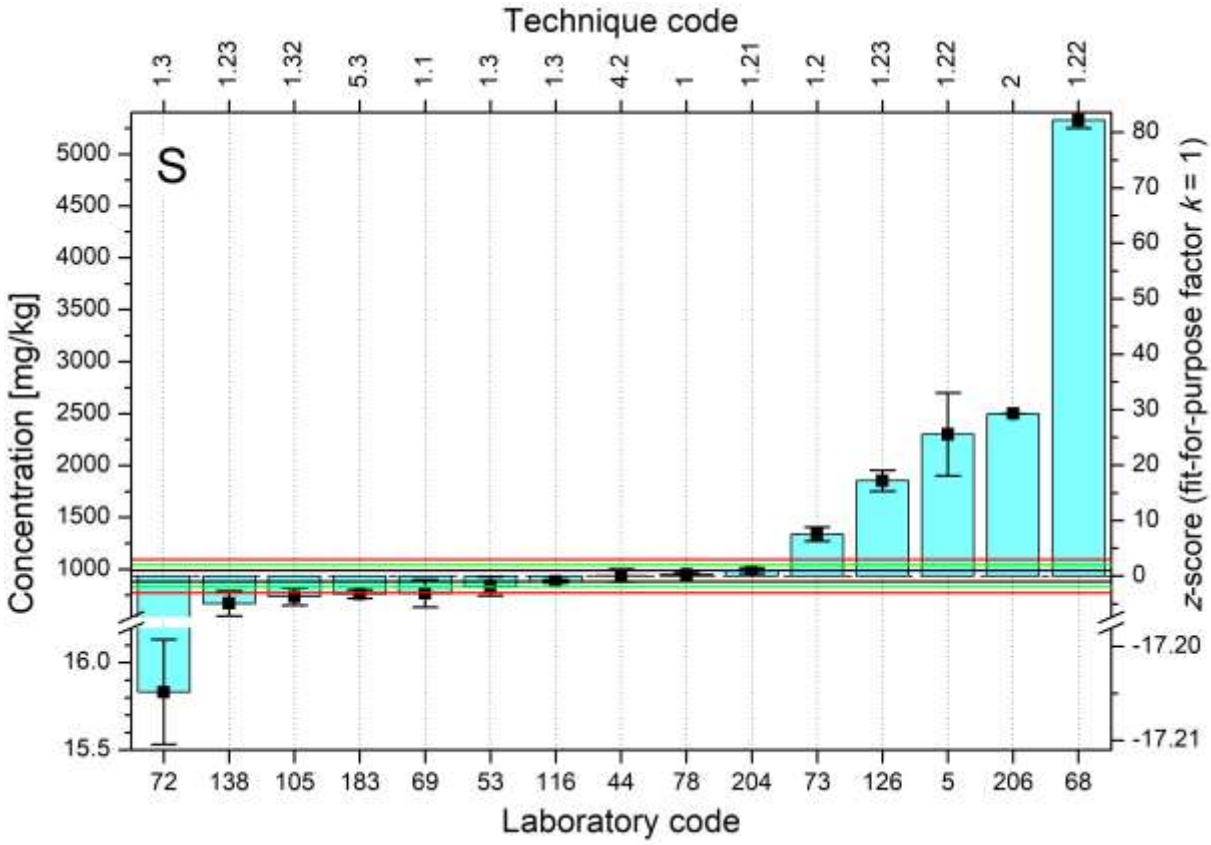

FIG. 53. Distributions of z-scores for analyte S.

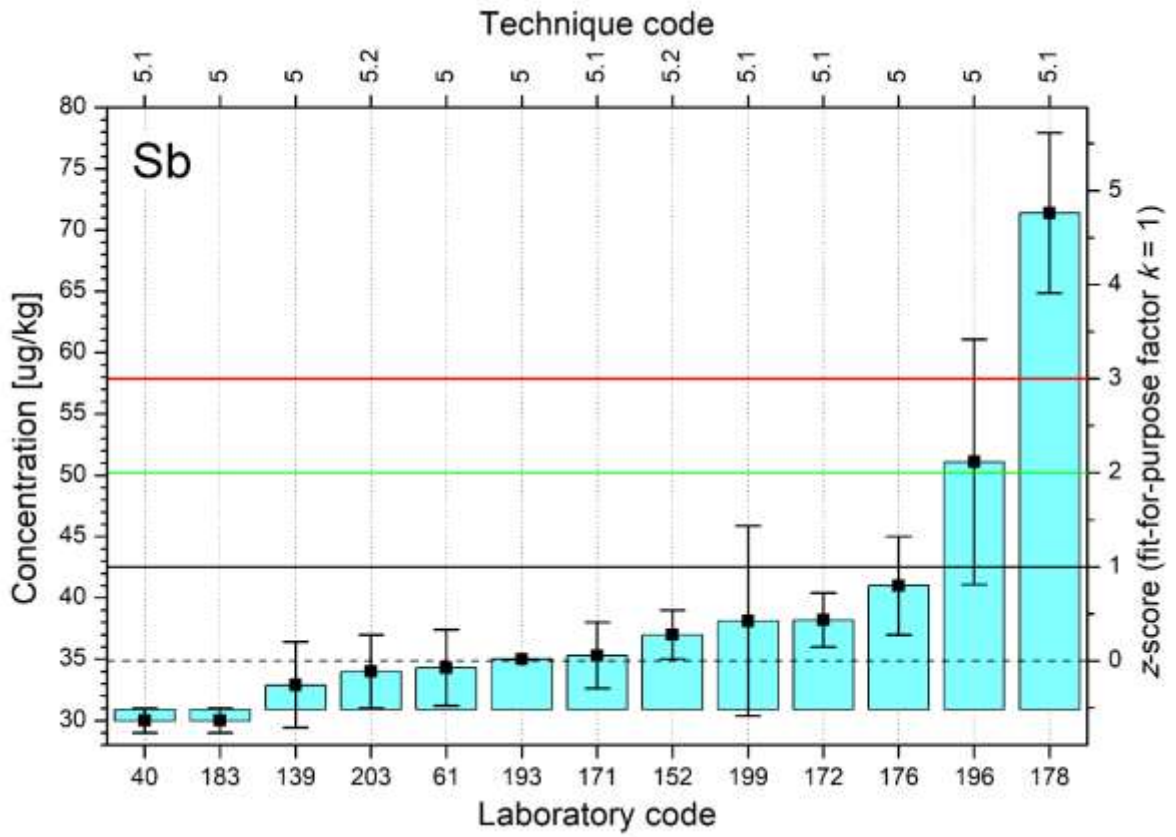

FIG. 54. Distributions of z-scores for analyte Sb.

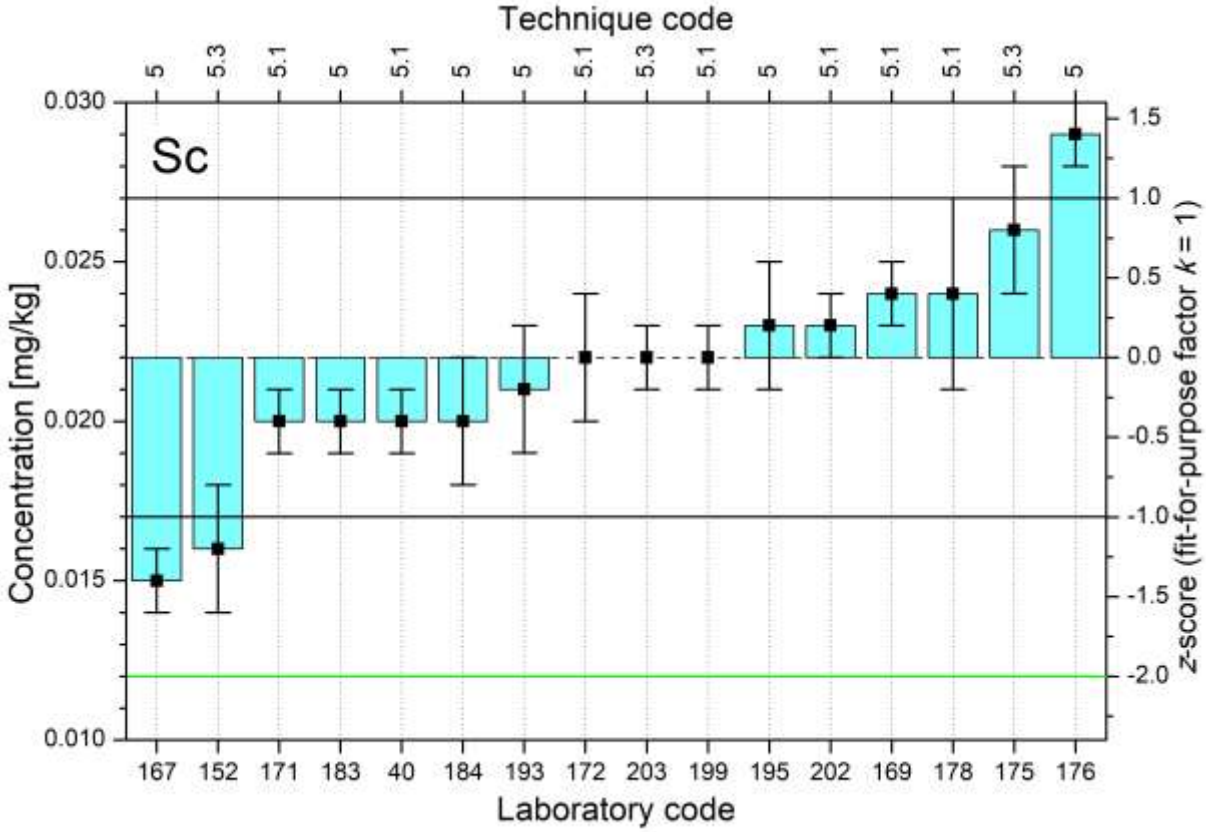

FIG. 55. Distributions of z-scores for analyte Sc.

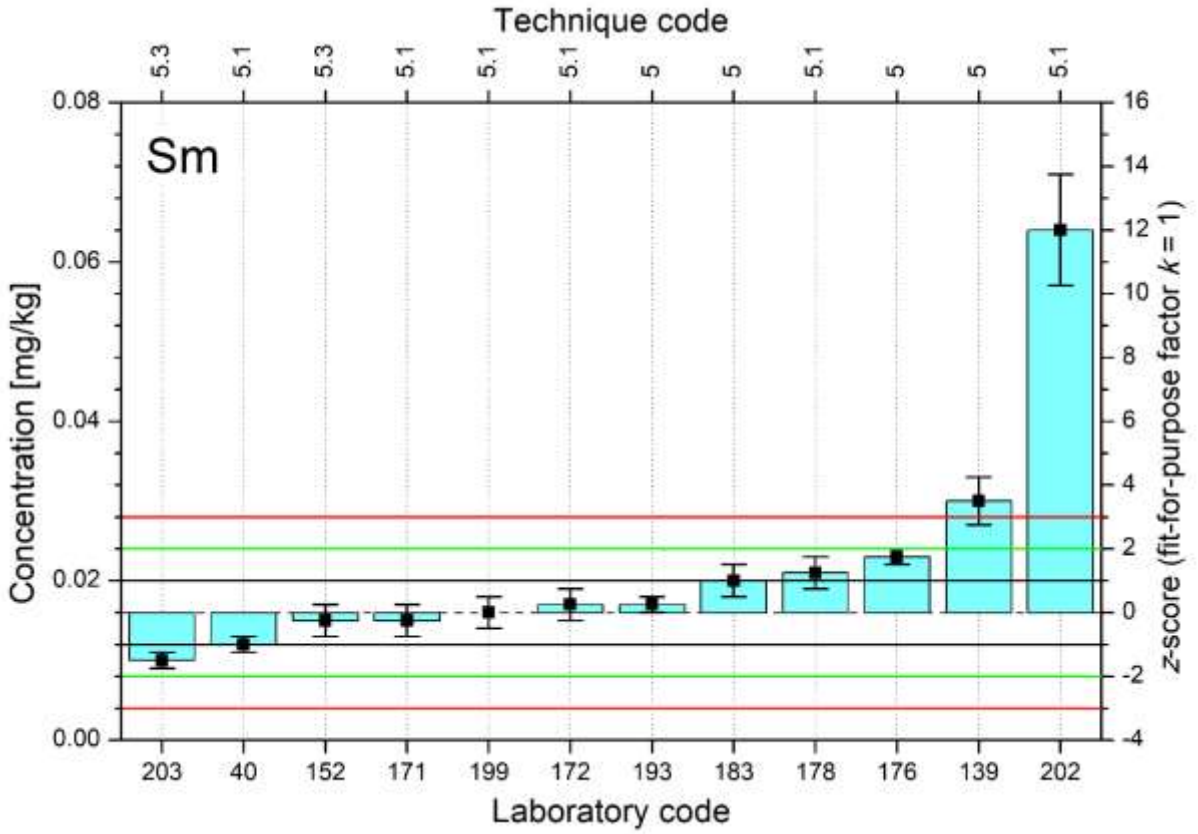

FIG. 56. Distributions of z-scores for analyte Sm.

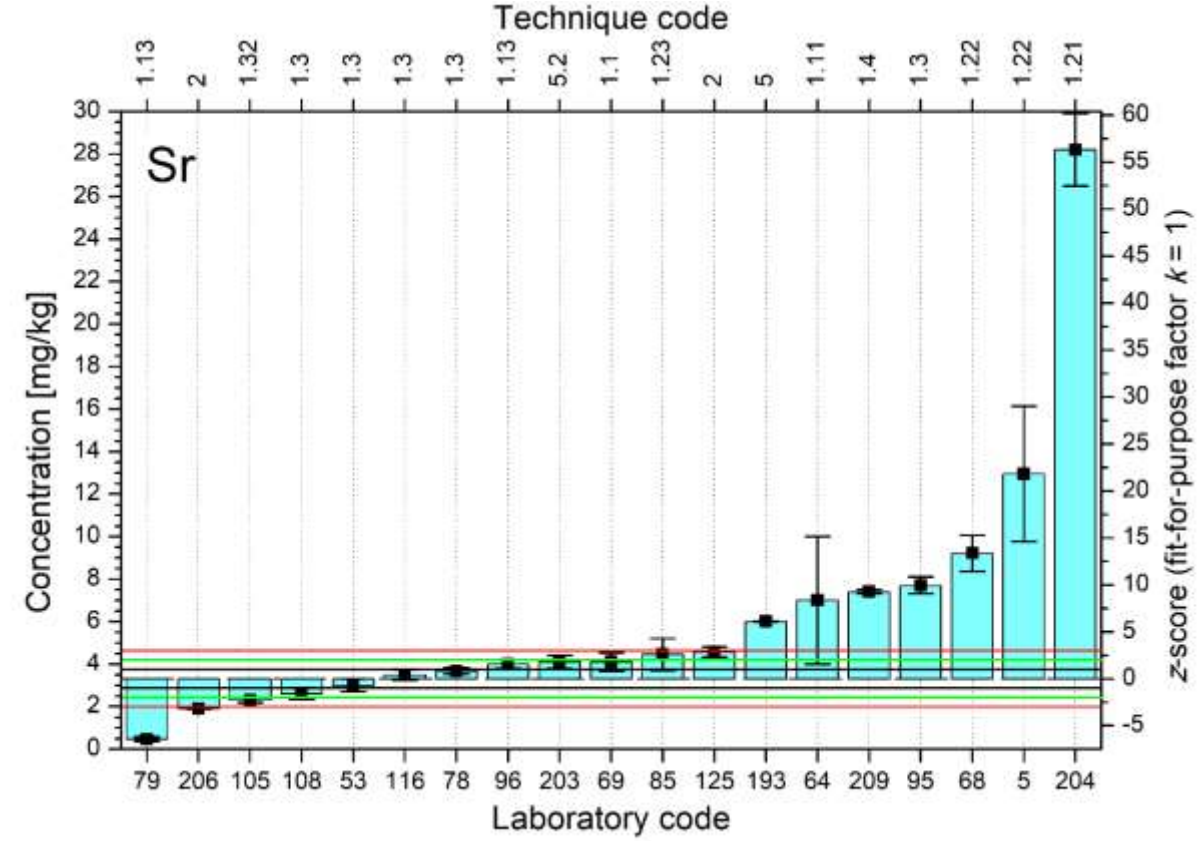

FIG. 57. Distributions of z-scores for analyte Sr.

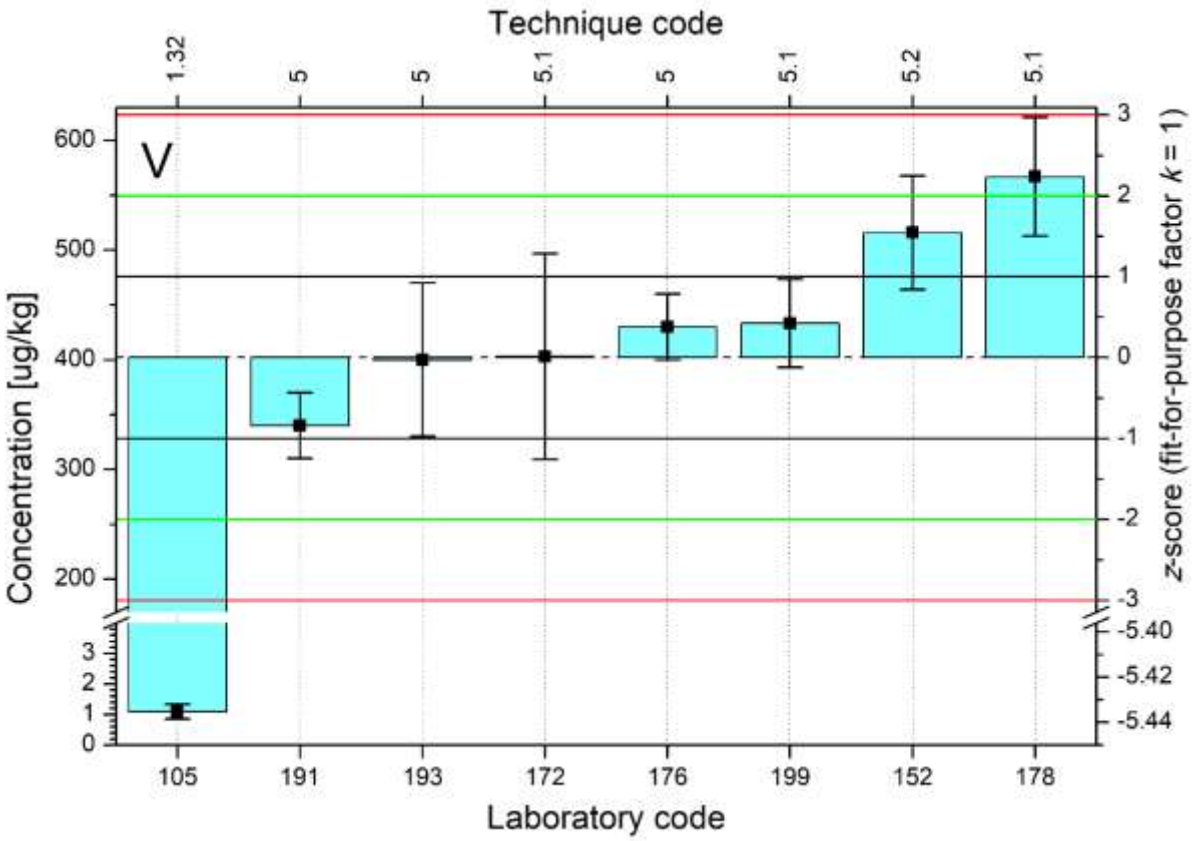

FIG. 58. Distributions of z-scores for analyte V.

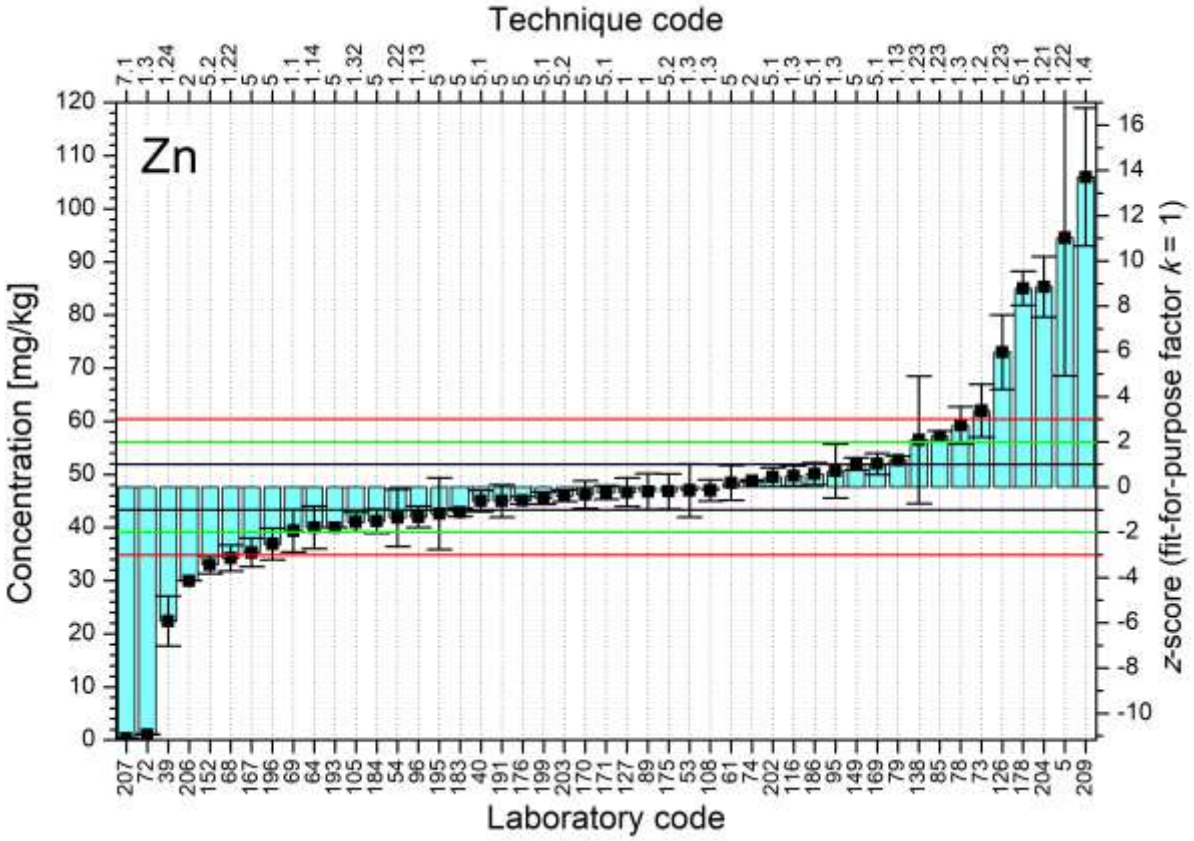

FIG. 59. Distributions of z-scores for analyte Zn.

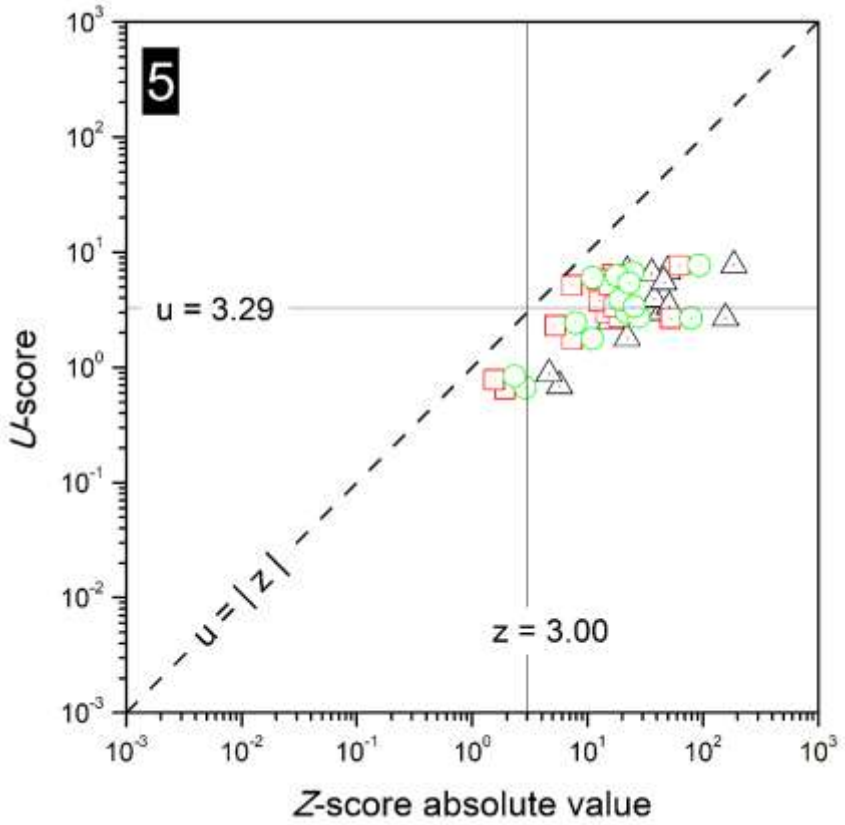

FIG. 60. Combined plots of z- and u-scores for the laboratory with code 5.

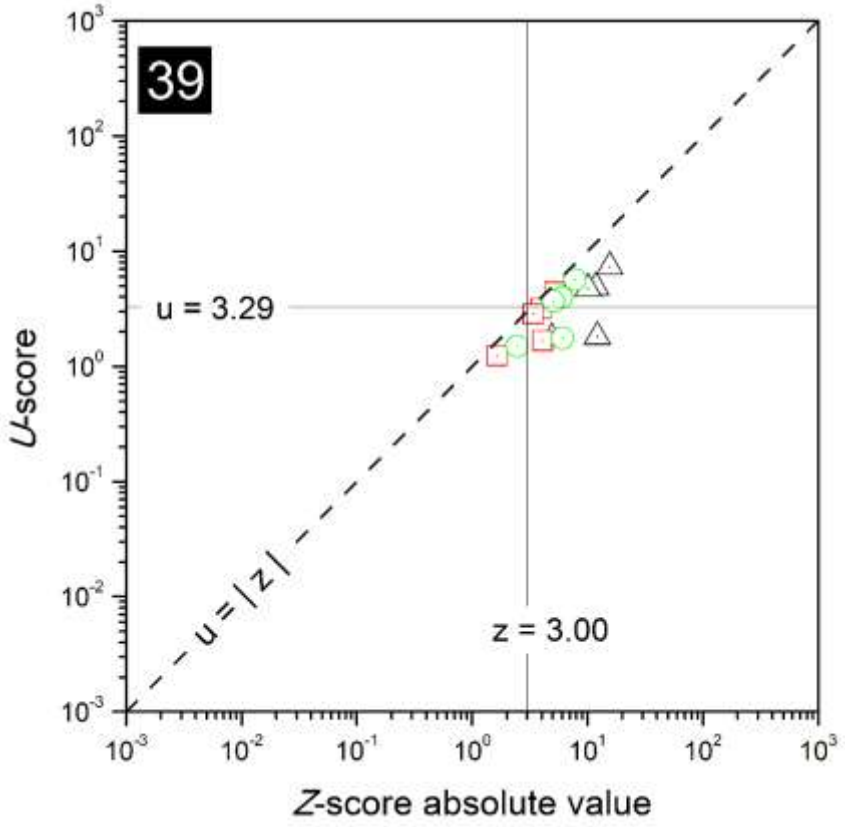

FIG. 61. Combined plots of z- and u-scores for the laboratory with code 39.

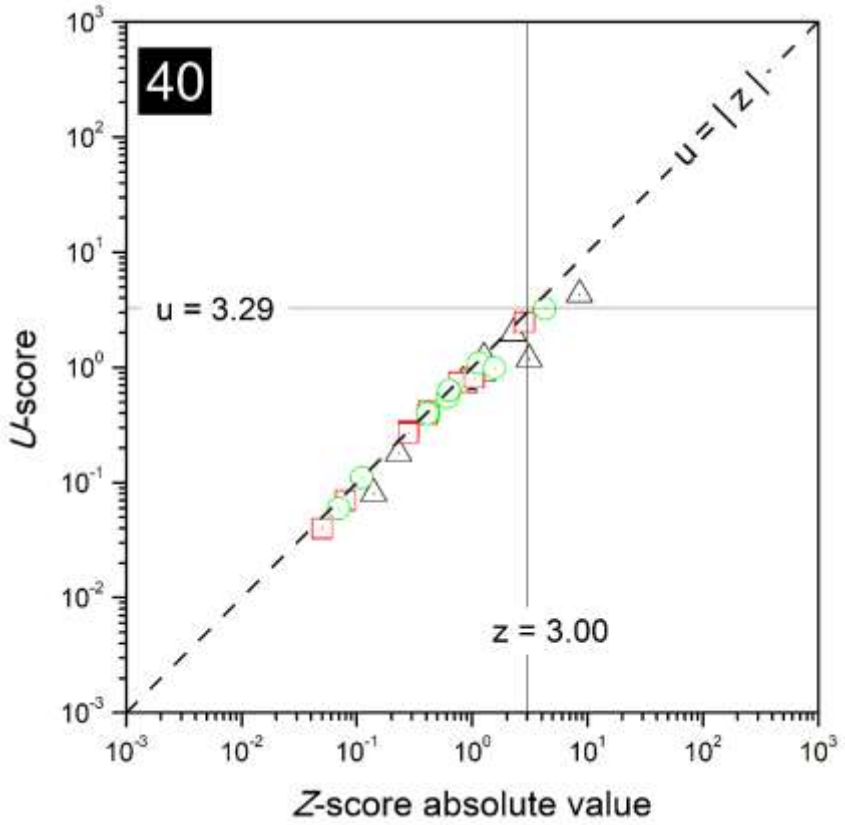

FIG. 62. Combined plots of z- and u-scores for the laboratory with code 40.

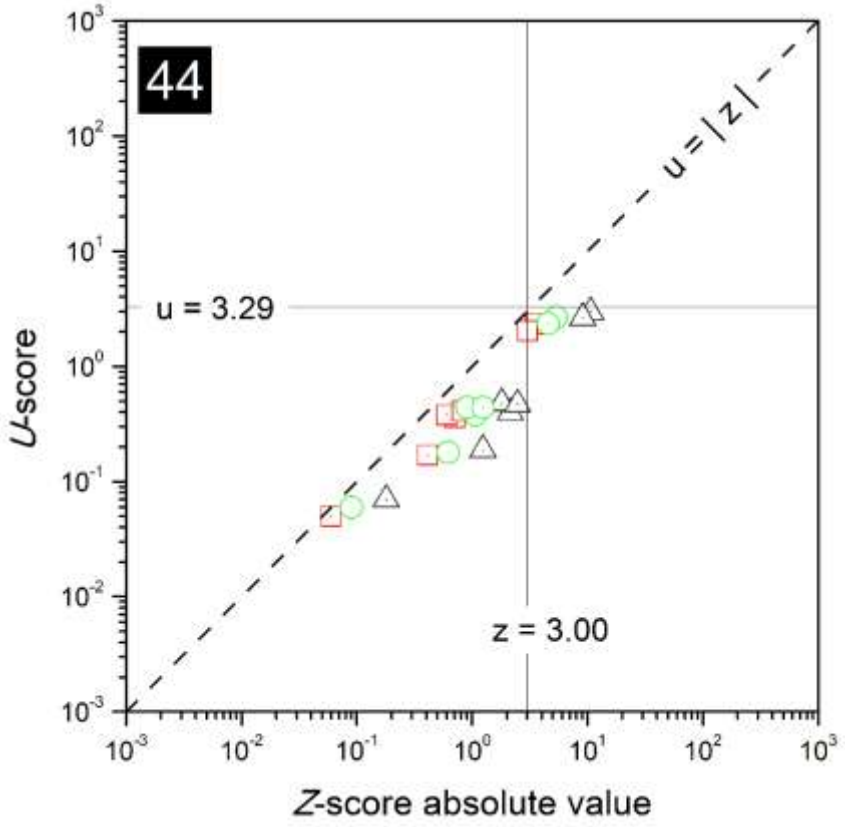

FIG. 63. Combined plots of z- and u-scores for the laboratory with code 44.

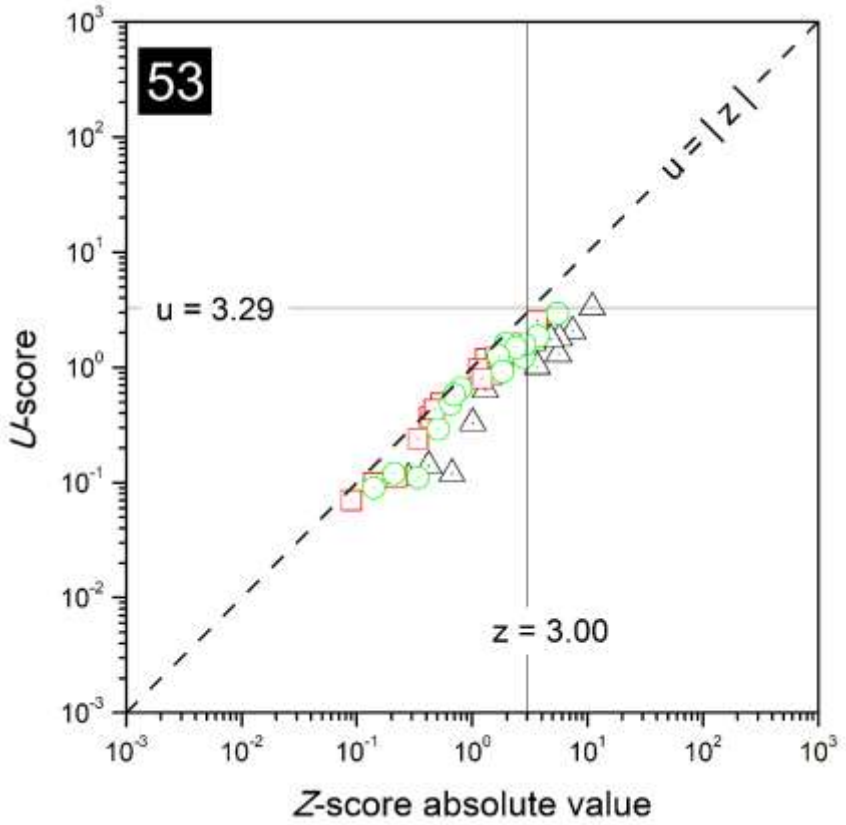

FIG. 64. Combined plots of z- and u-scores for the laboratory with code 53.

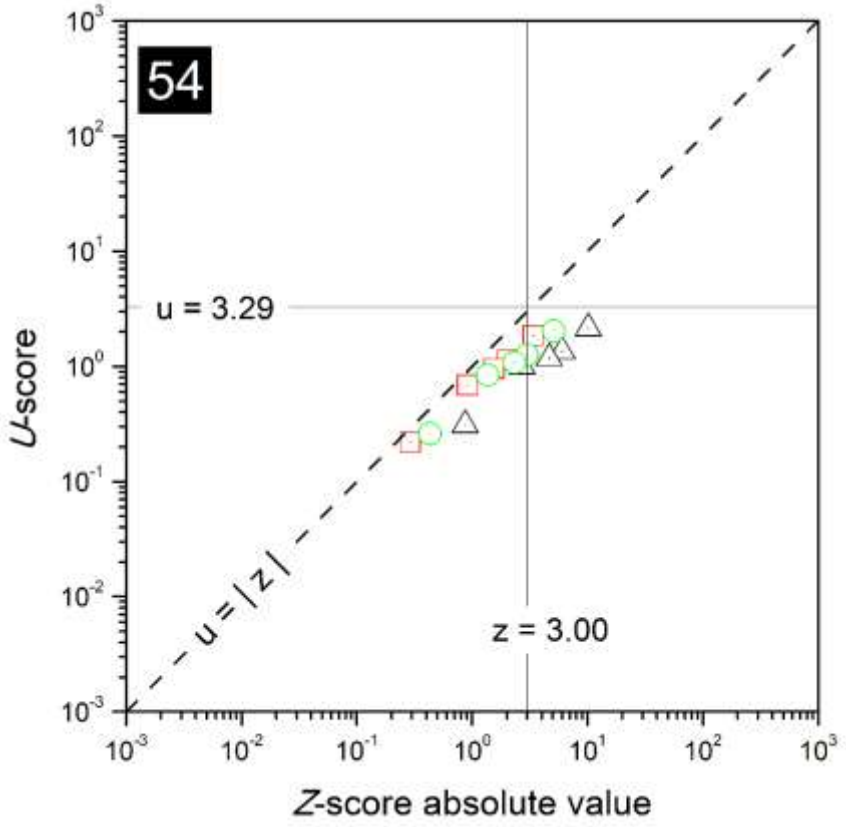

FIG. 65. Combined plots of z- and u-scores for the laboratory with code 54.

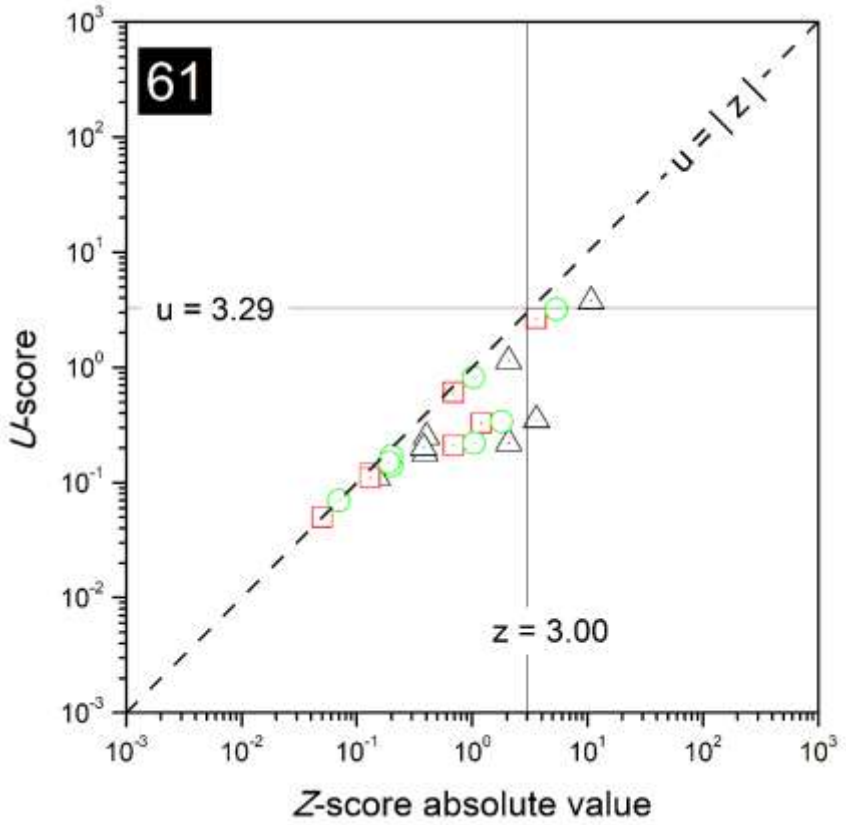

FIG. 66. Combined plots of z- and u-scores for the laboratory with code 61.

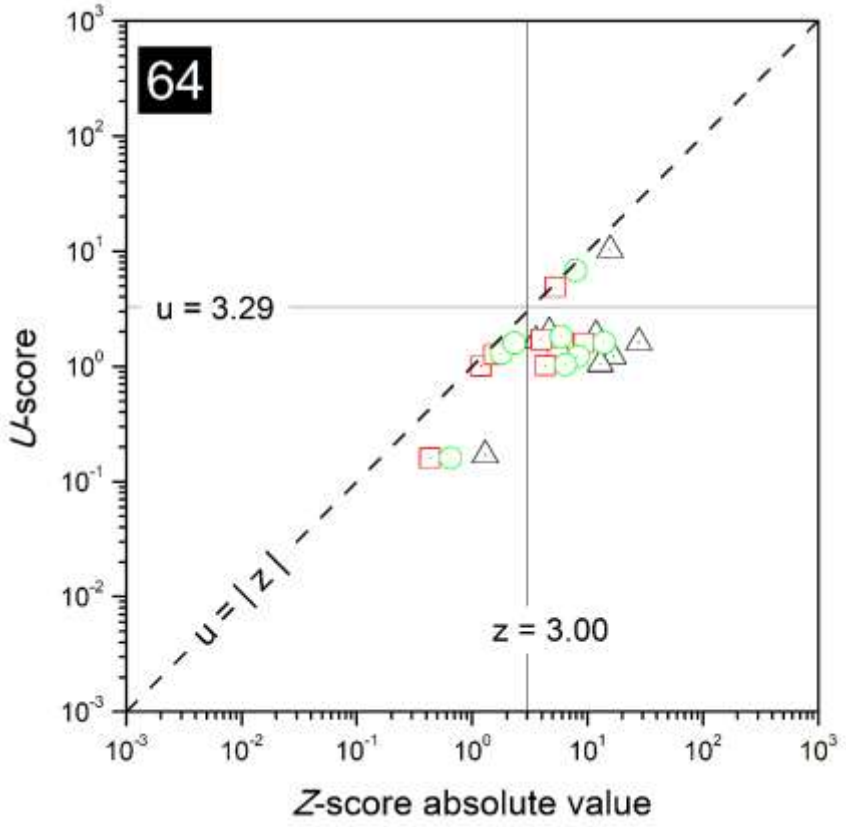

FIG. 67. Combined plots of z- and u-scores for the laboratory with code 64.

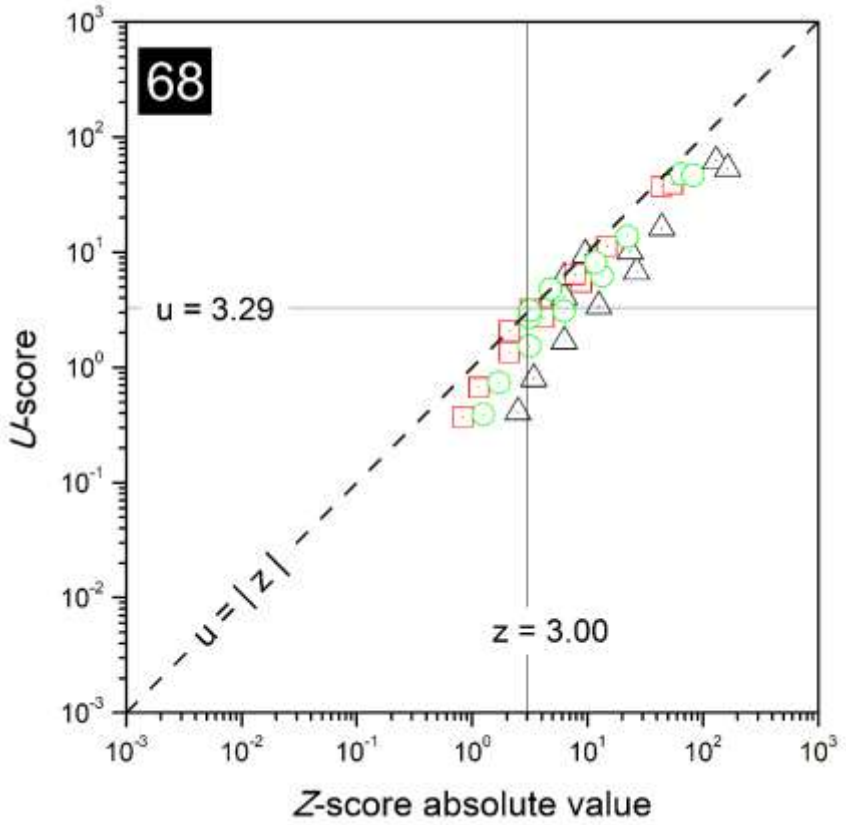

FIG. 68. Combined plots of z- and u-scores for the laboratory with code 68.

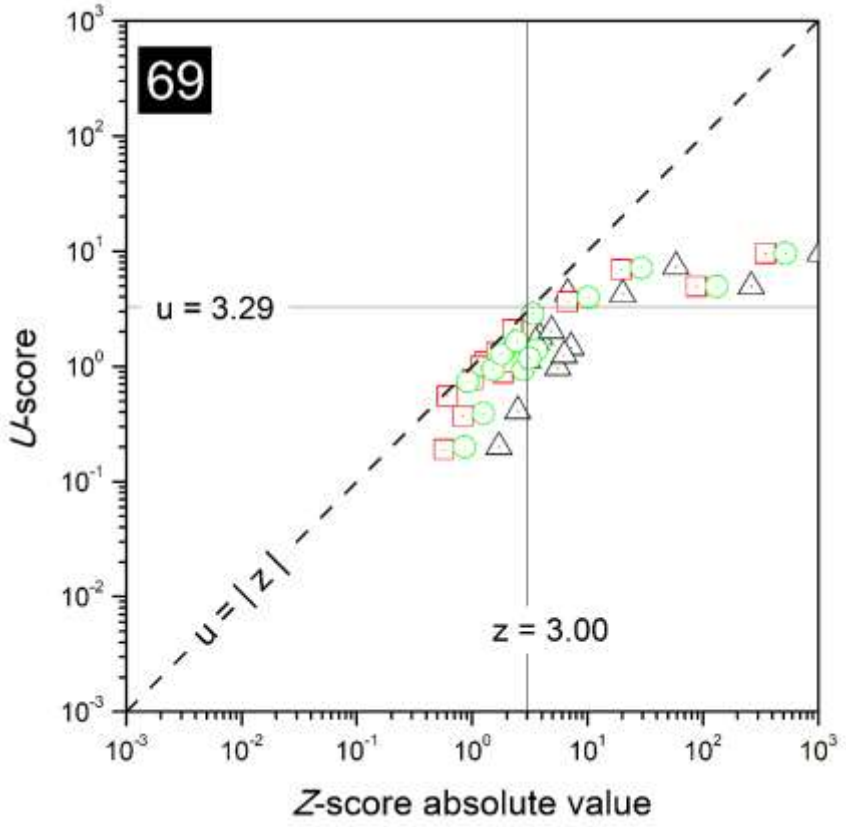

FIG. 69. Combined plots of z- and u-scores for the laboratory with code 69.

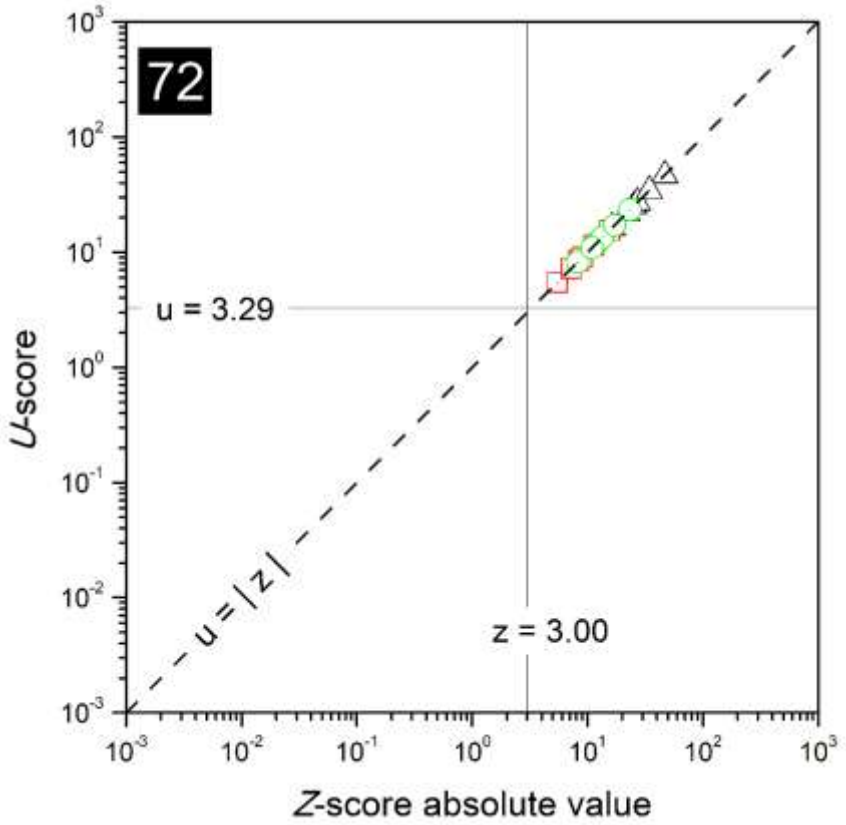

FIG. 70. Combined plots of z- and u-scores for the laboratory with code 72.

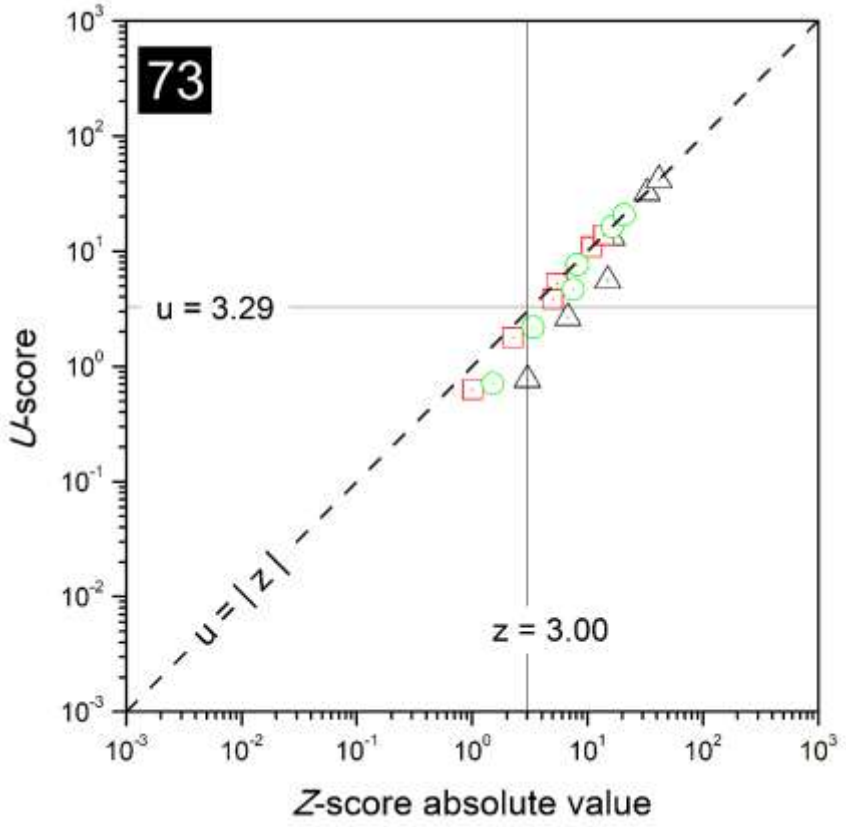

FIG. 71. Combined plots of z- and u-scores for the laboratory with code 73.

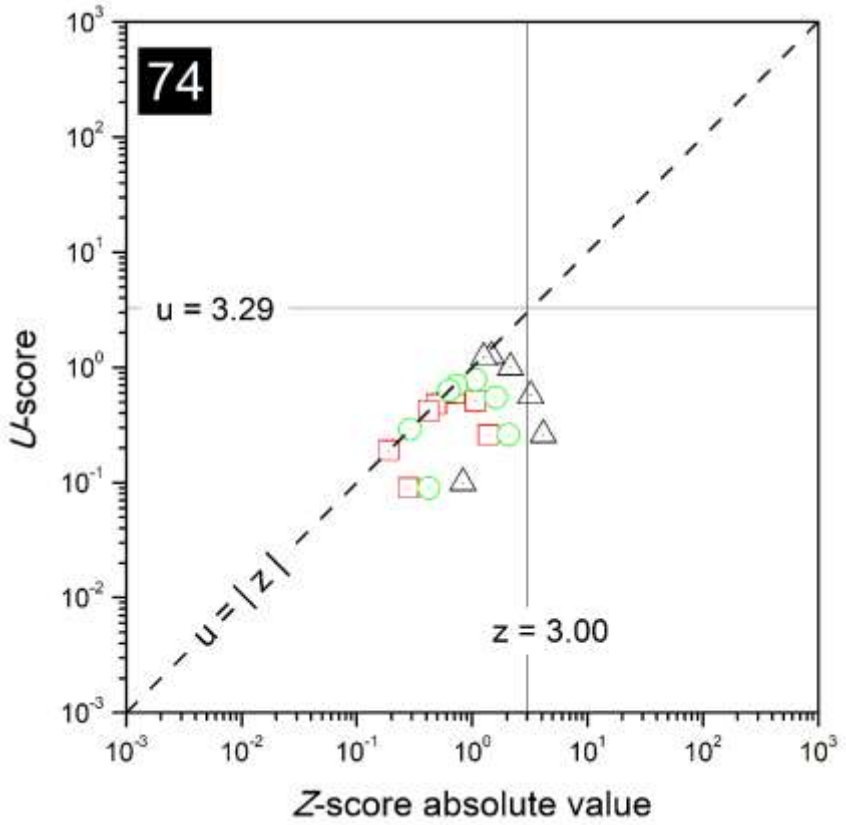

FIG. 72. Combined plots of z- and u-scores for the laboratory with code 74.

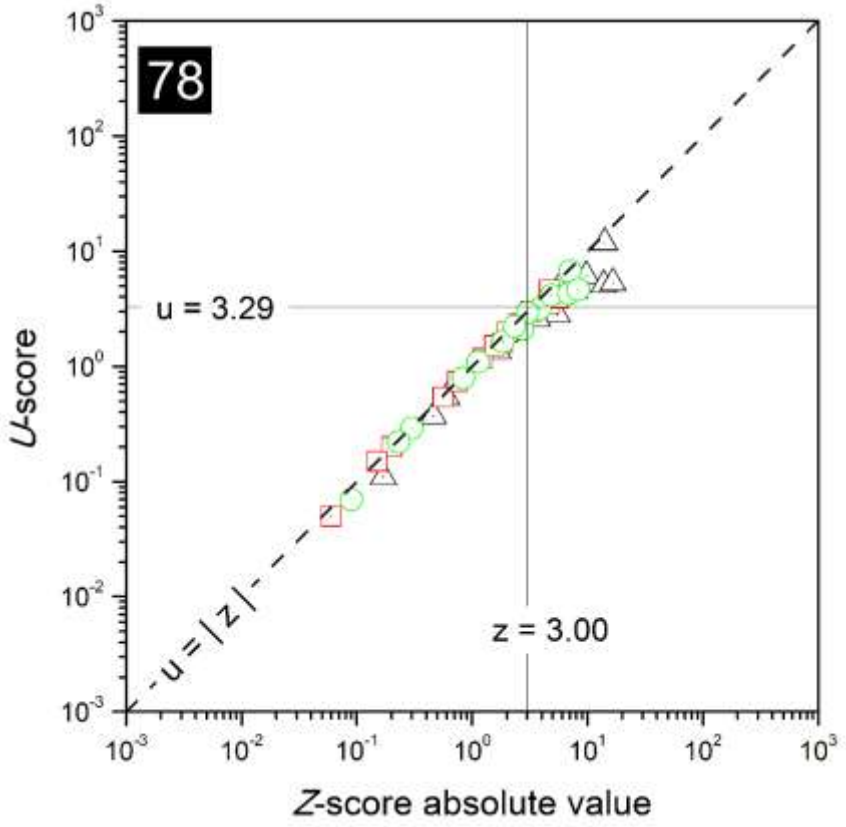

FIG. 73. Combined plots of z- and u-scores for the laboratory with code 78.

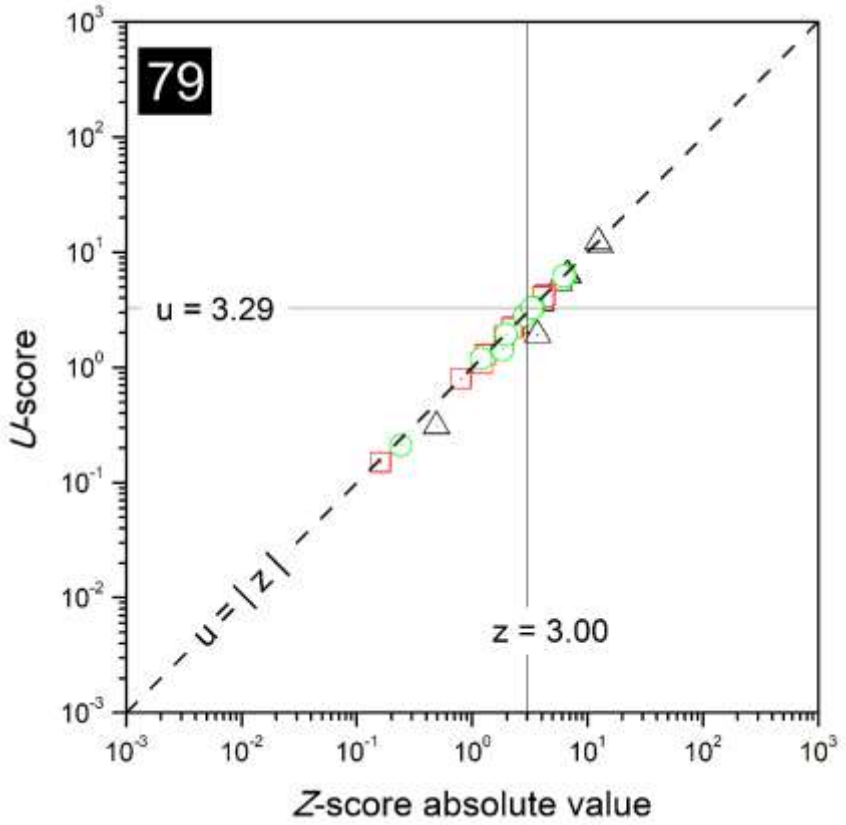

FIG. 74. Combined plots of z- and u-scores for the laboratory with code 79.

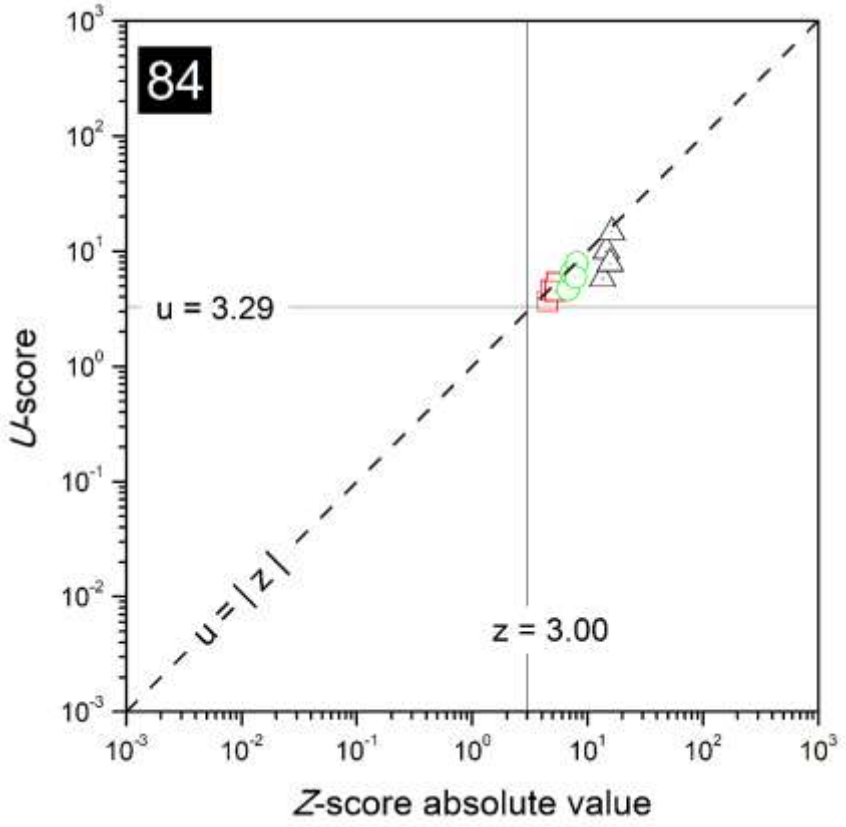

FIG. 75. Combined plots of z- and u-scores for the laboratory with code 84.

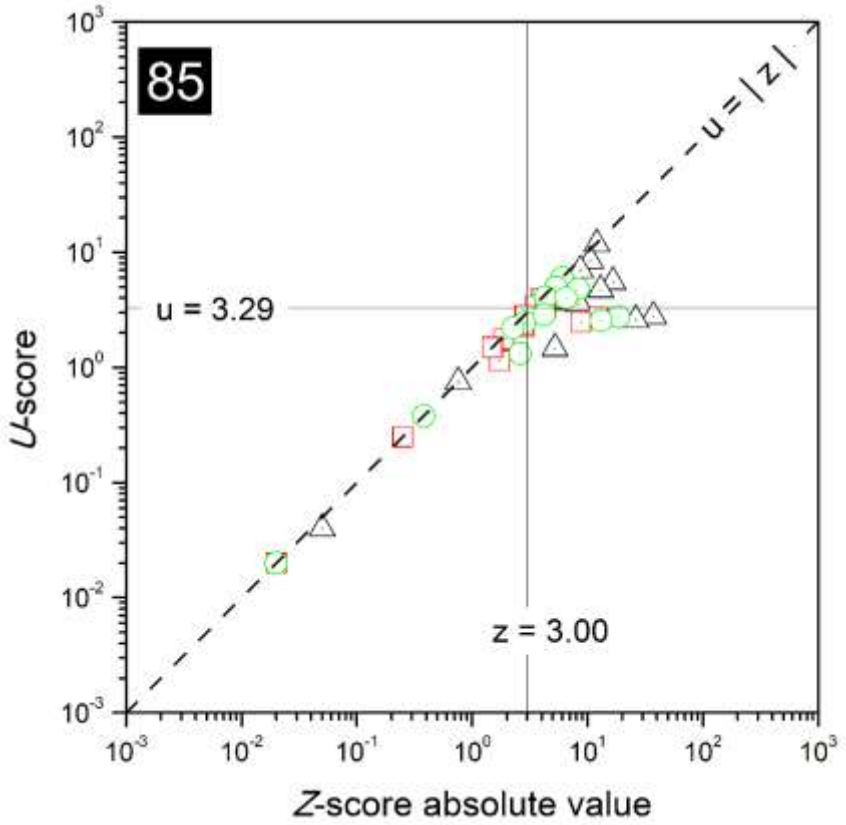

FIG. 76. Combined plots of z- and u-scores for the laboratory with code 85.

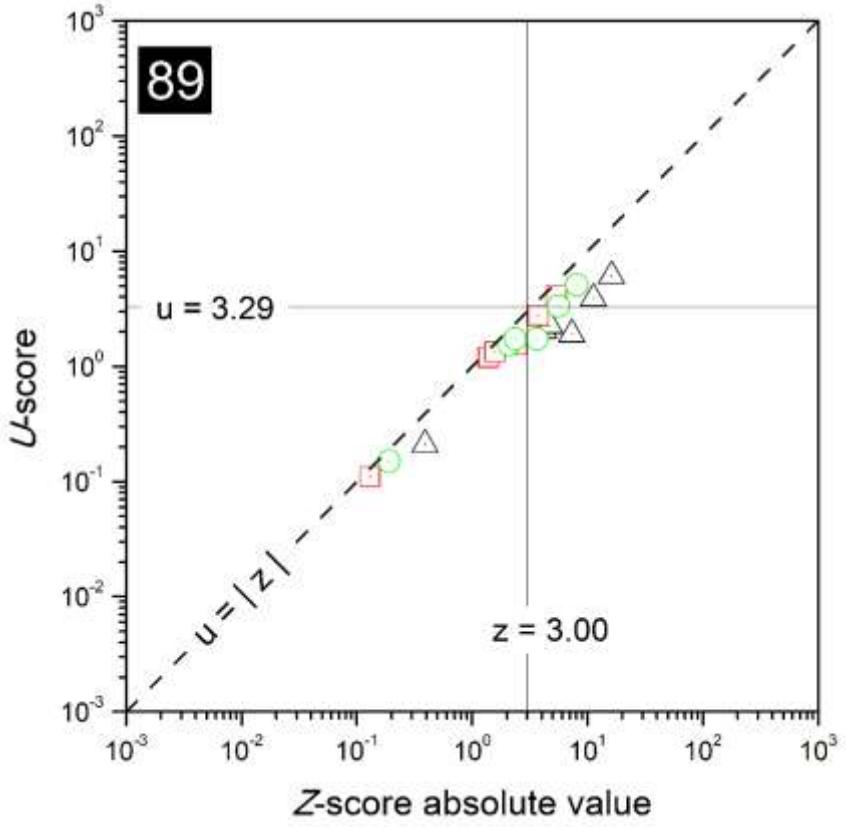

FIG. 77. Combined plots of z- and u-scores for the laboratory with code 89.

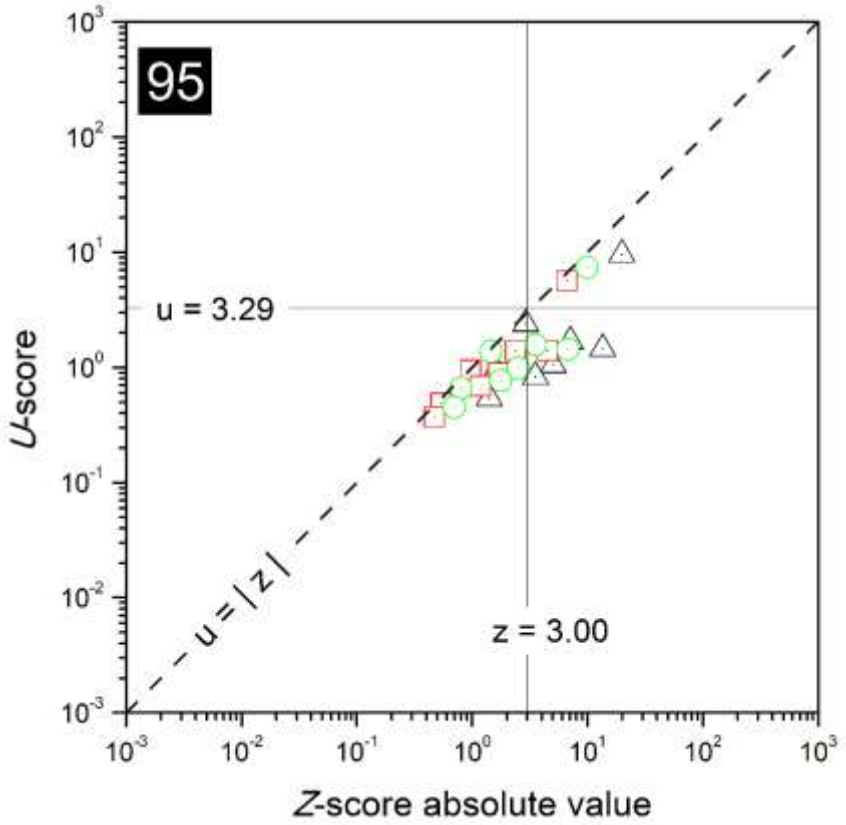

FIG. 78. Combined plots of z- and u-scores for the laboratory with code 95.

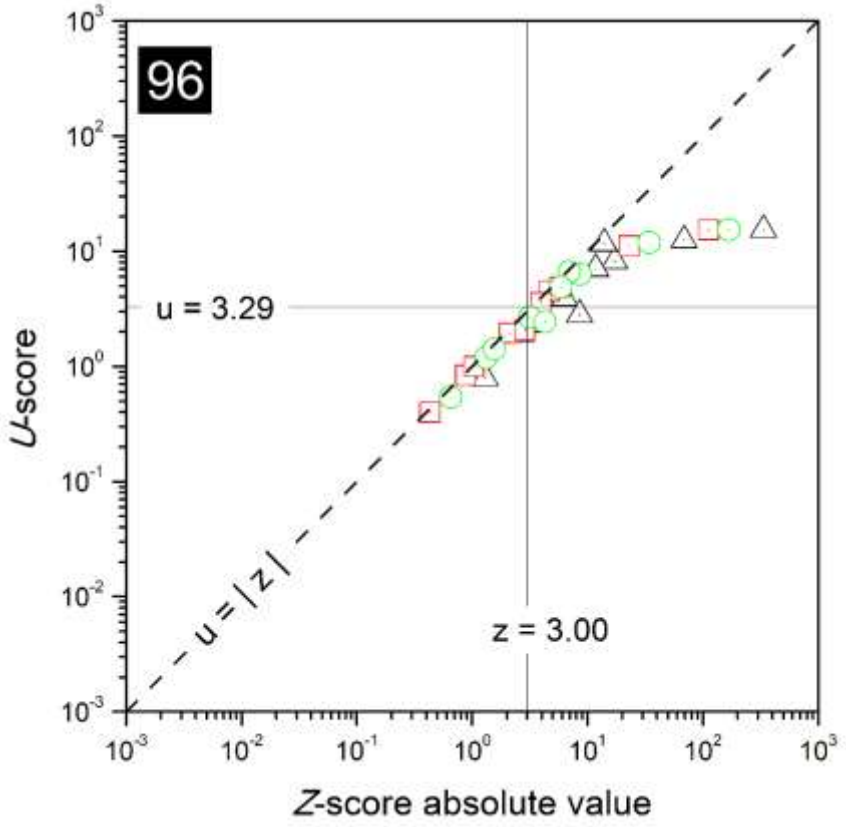

FIG. 79. Combined plots of z- and u-scores for the laboratory with code 96.

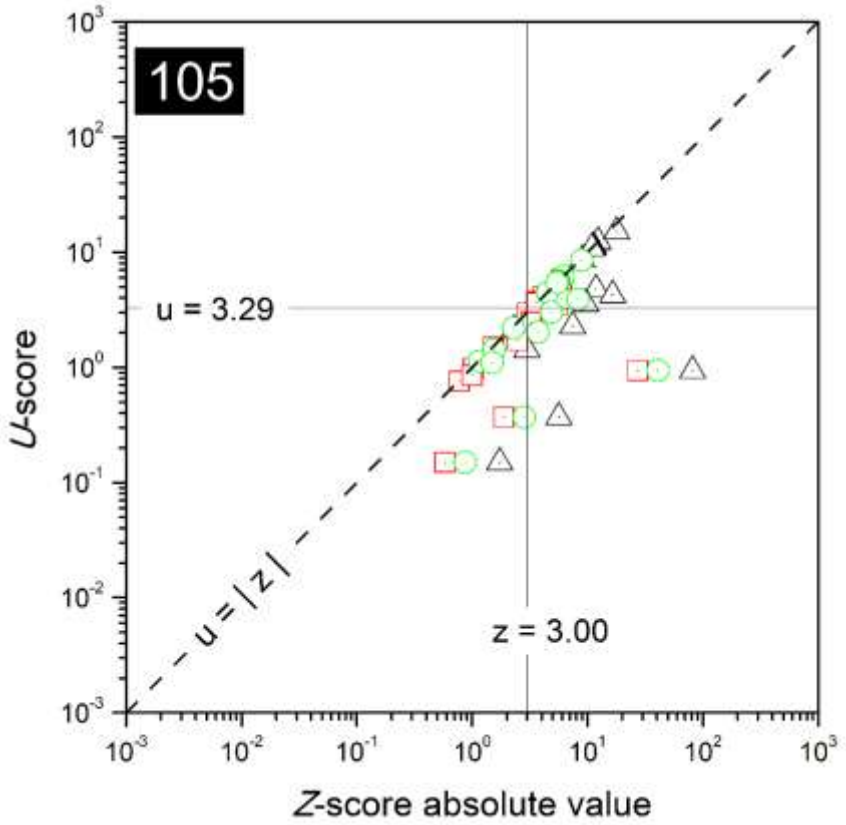

FIG. 80. Combined plots of z- and u-scores for the laboratory with code 105.

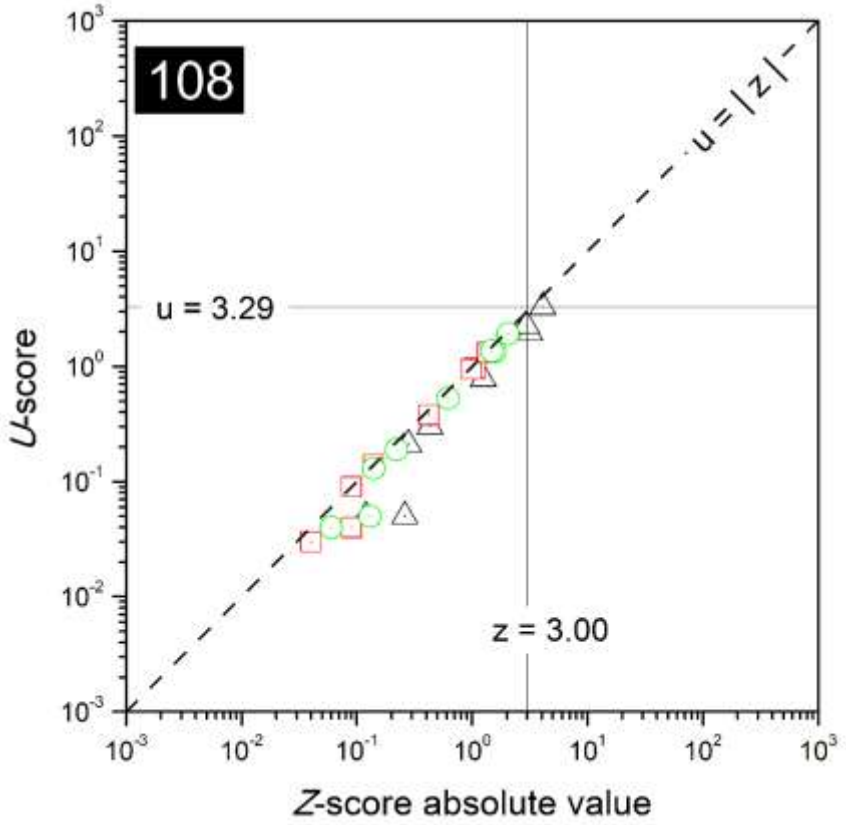

FIG. 81. Combined plots of z- and u-scores for the laboratory with code 108.

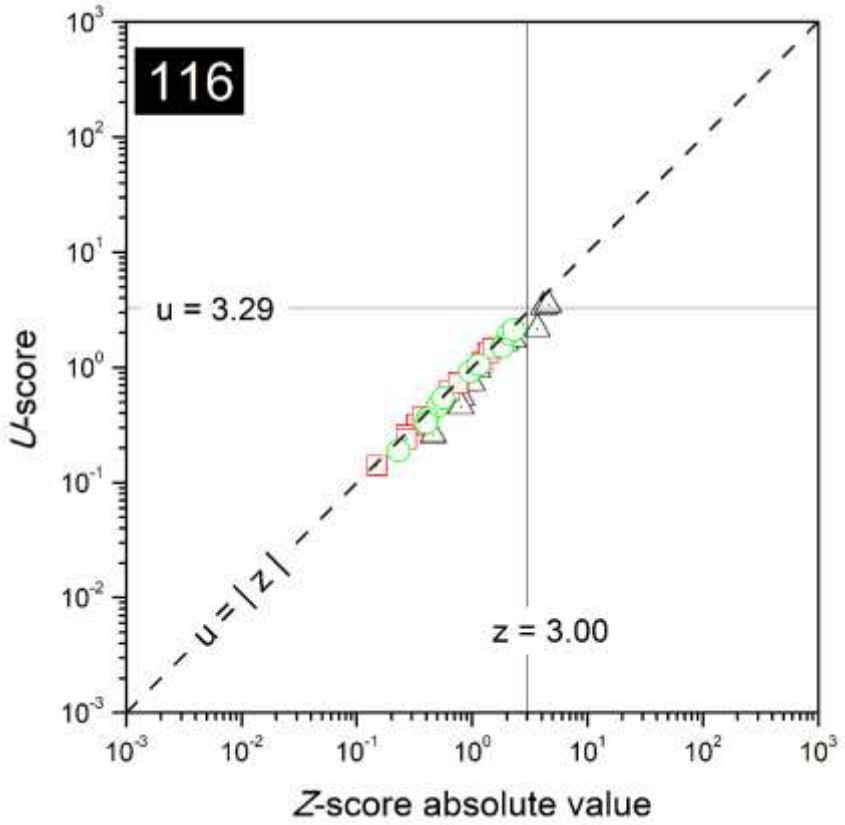

FIG. 82. Combined plots of z- and u-scores for the laboratory with code 116.

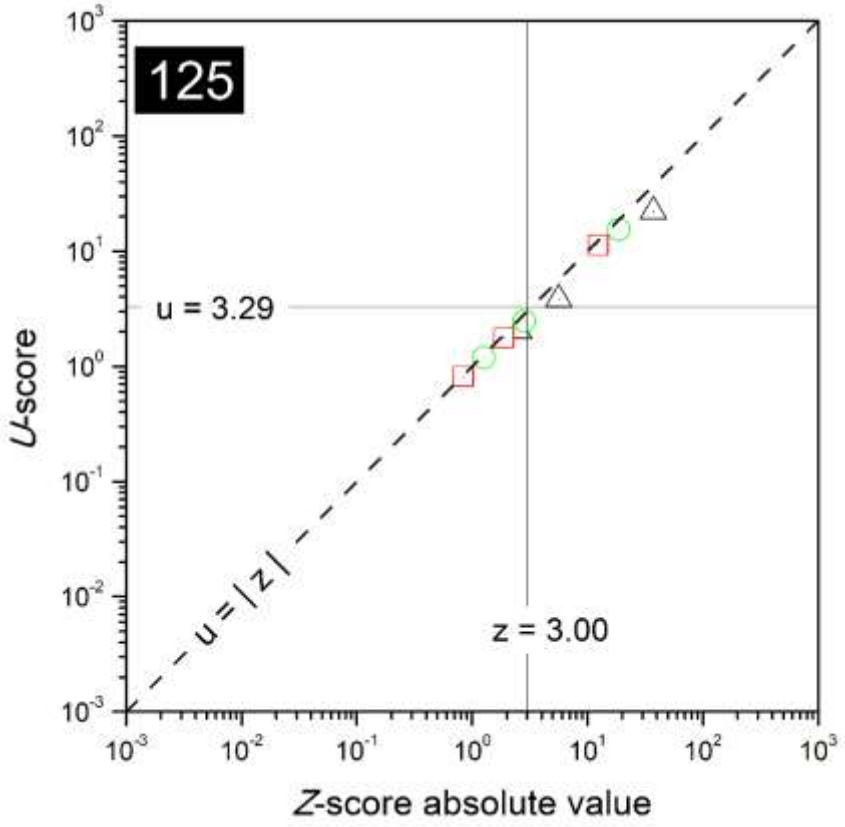

FIG. 83. Combined plots of z- and u-scores for the laboratory with code 125.

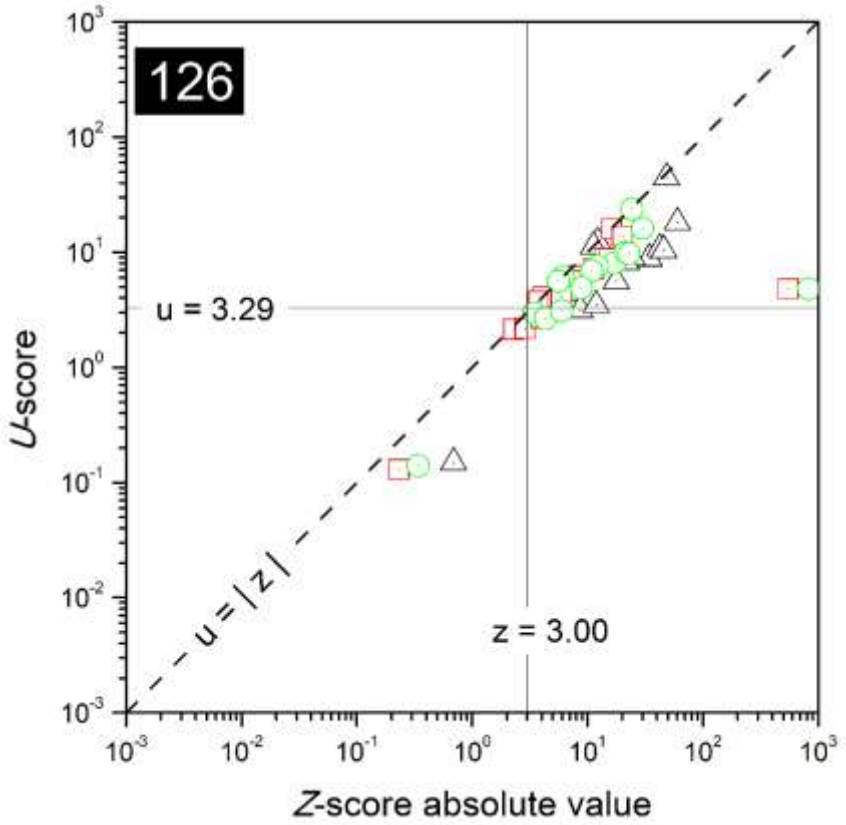

FIG. 84. Combined plots of z- and u-scores for the laboratory with code 126.

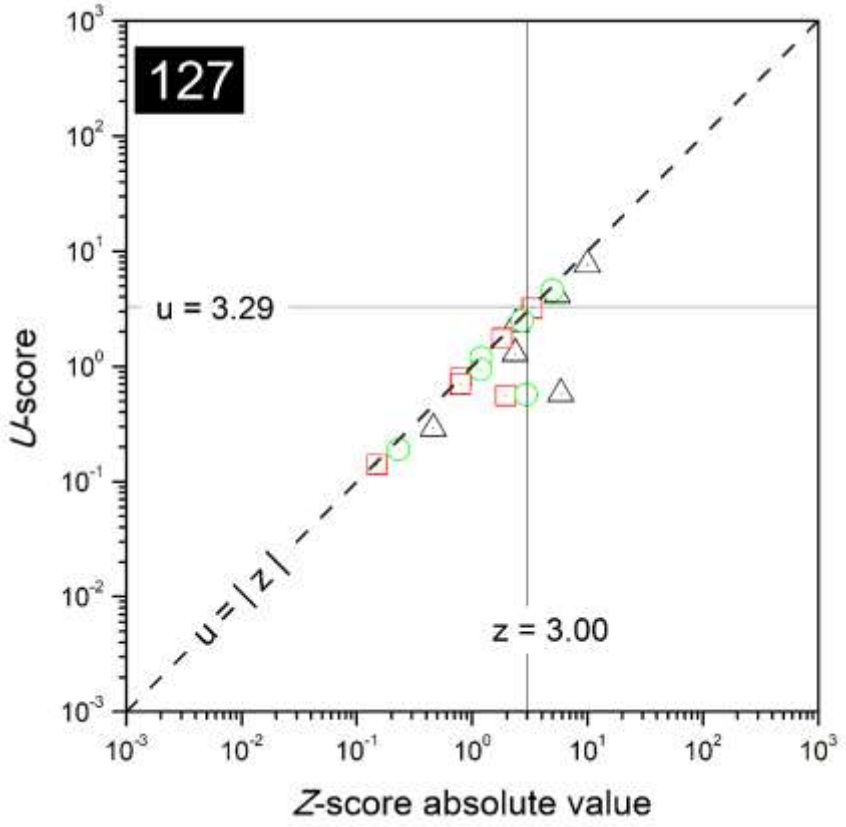

FIG. 85. Combined plots of z- and u-scores for the laboratory with code 127.

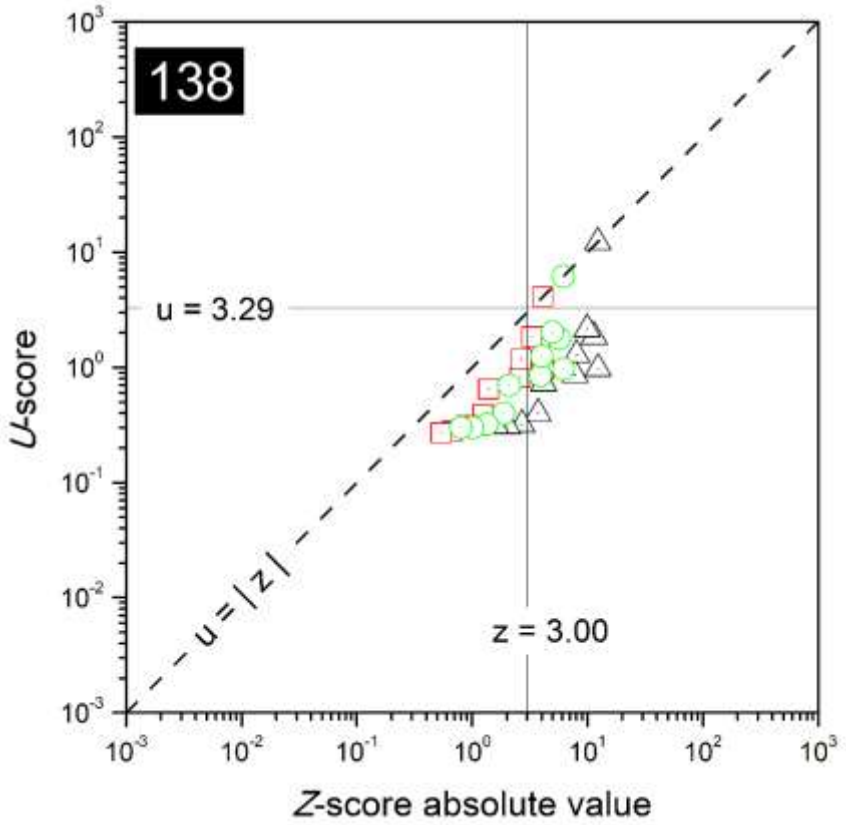

FIG. 86. Combined plots of z- and u-scores for the laboratory with code 138.

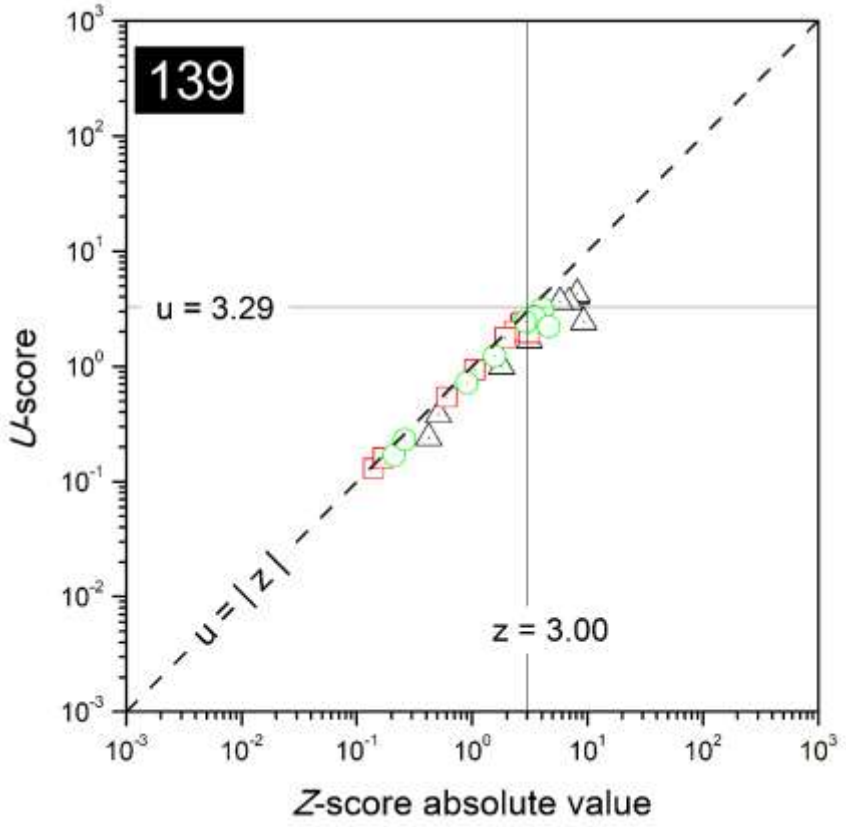

FIG. 87. Combined plots of z- and u-scores for the laboratory with code 139.

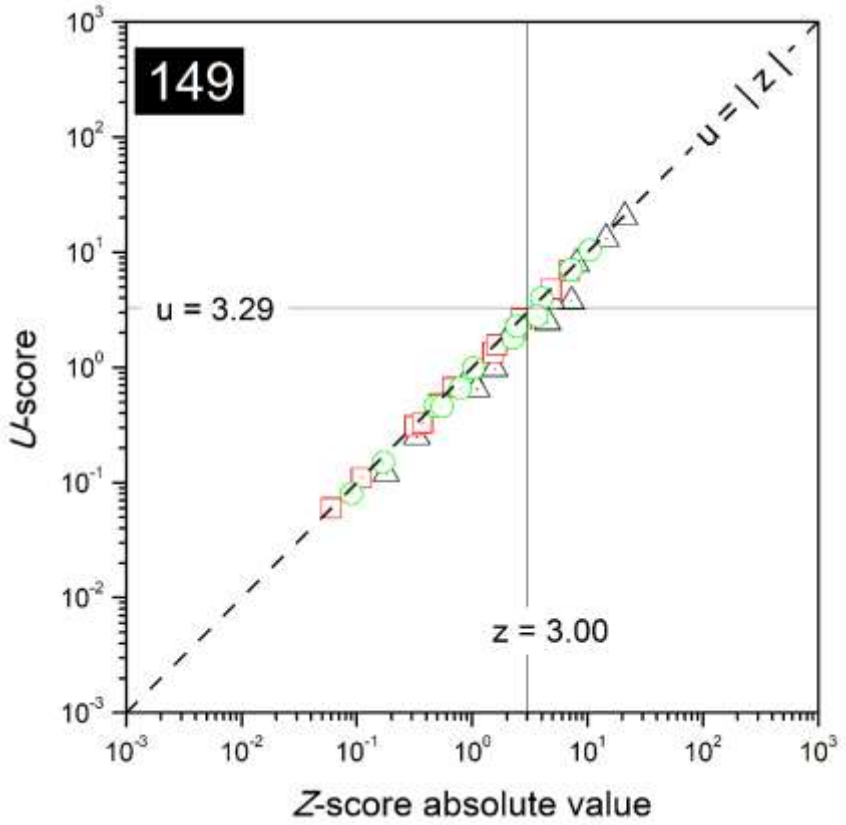

FIG. 88. Combined plots of z- and u-scores for the laboratory with code 149.

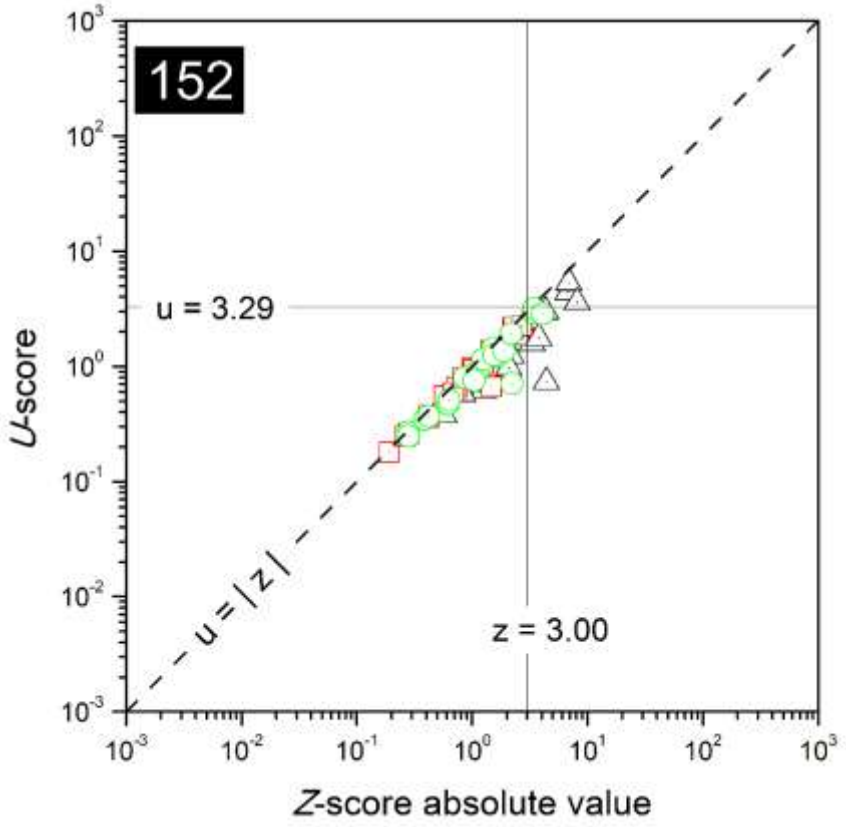

FIG. 89. Combined plots of z- and u-scores for the laboratory with code 152.

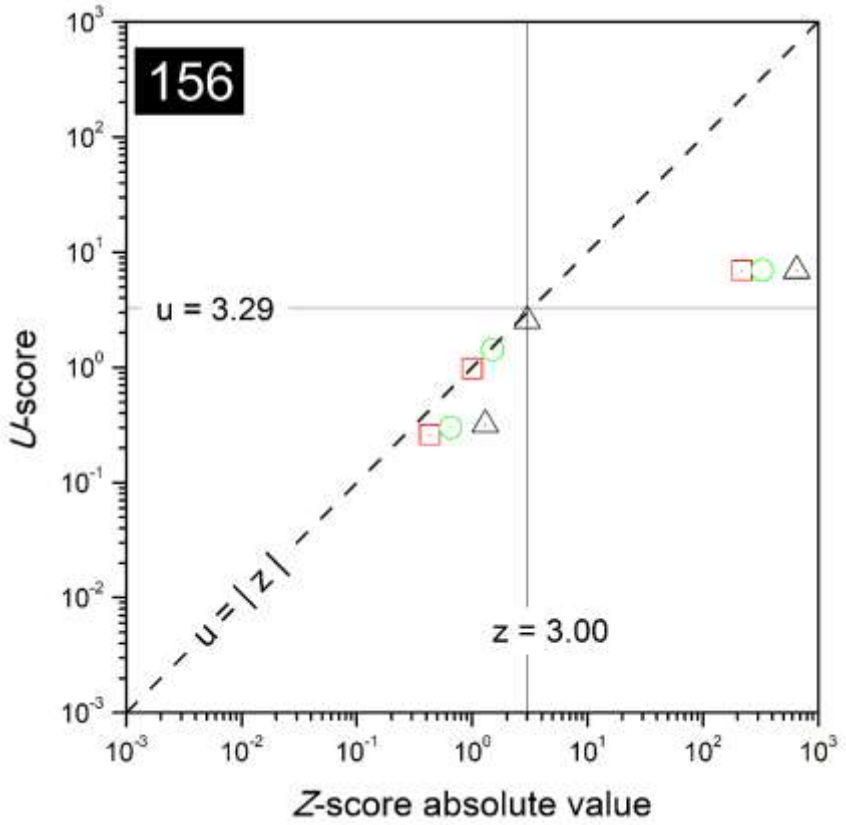

FIG. 90. Combined plots of z- and u-scores for the laboratory with code 156.

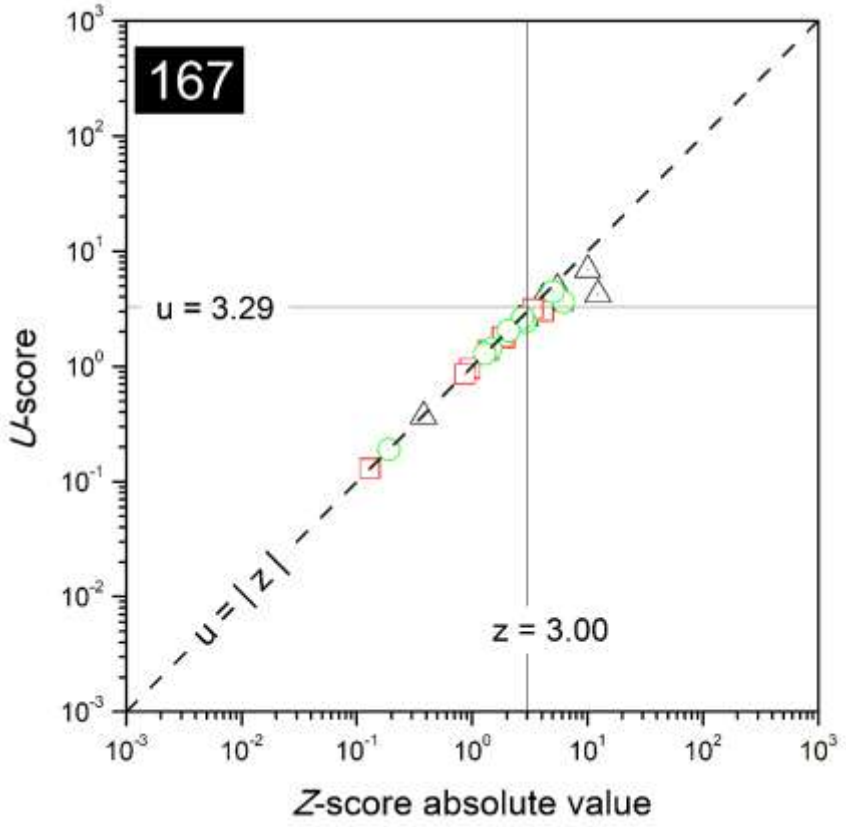

FIG. 91. Combined plots of z- and u-scores for the laboratory with code 167.

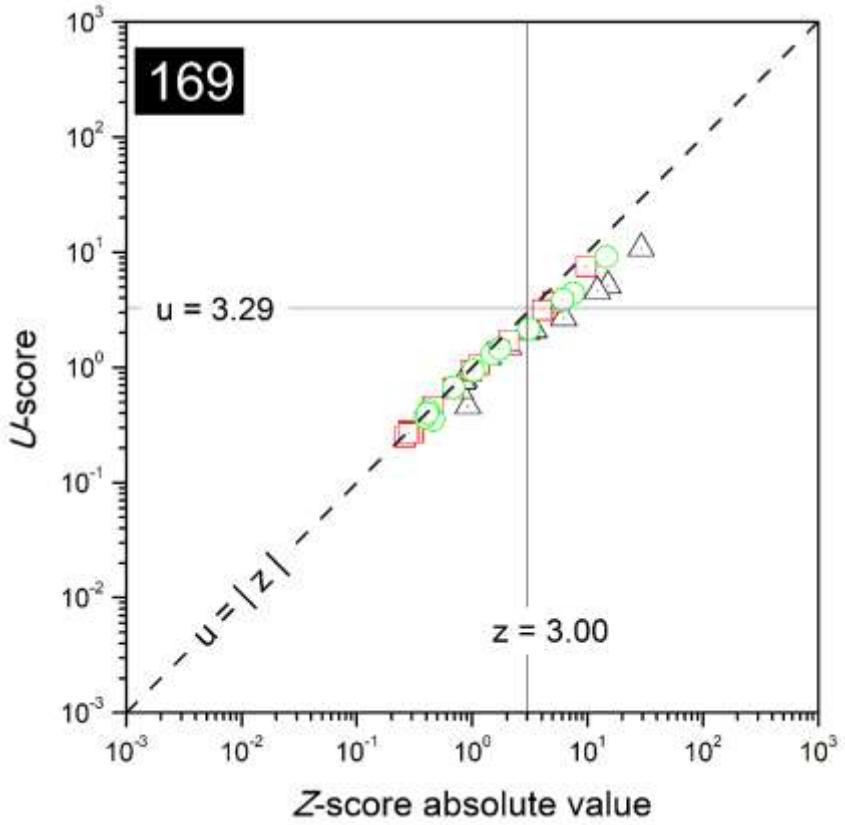

FIG. 92. Combined plots of z- and u-scores for the laboratory with code 169.

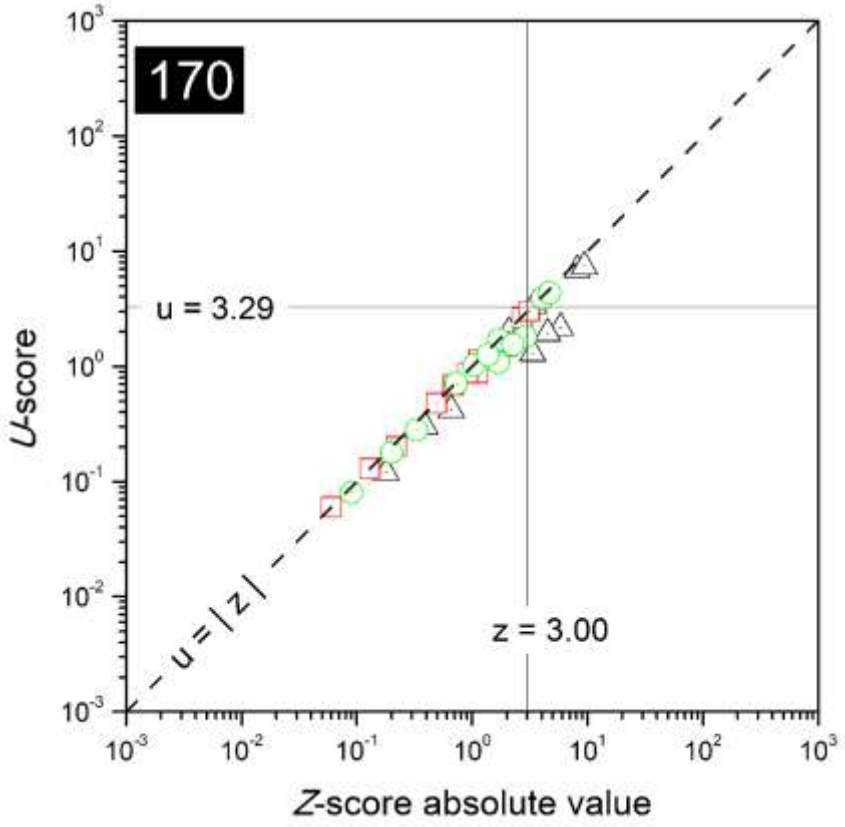

FIG. 93. Combined plots of z- and u-scores for the laboratory with code 170.

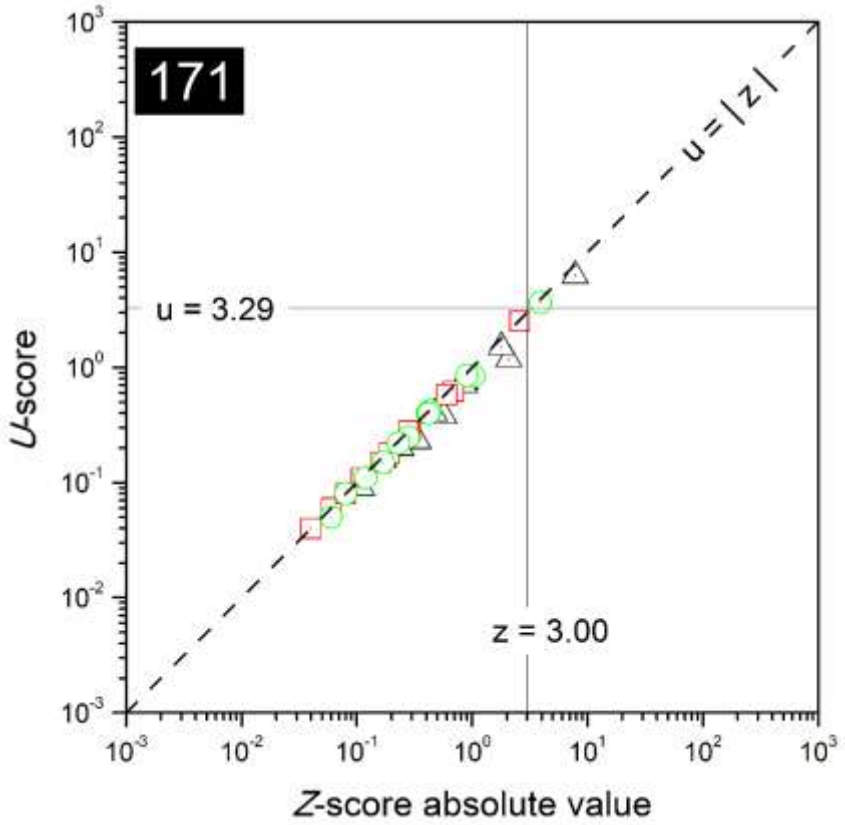

FIG. 94. Combined plots of z- and u-scores for the laboratory with code 171.

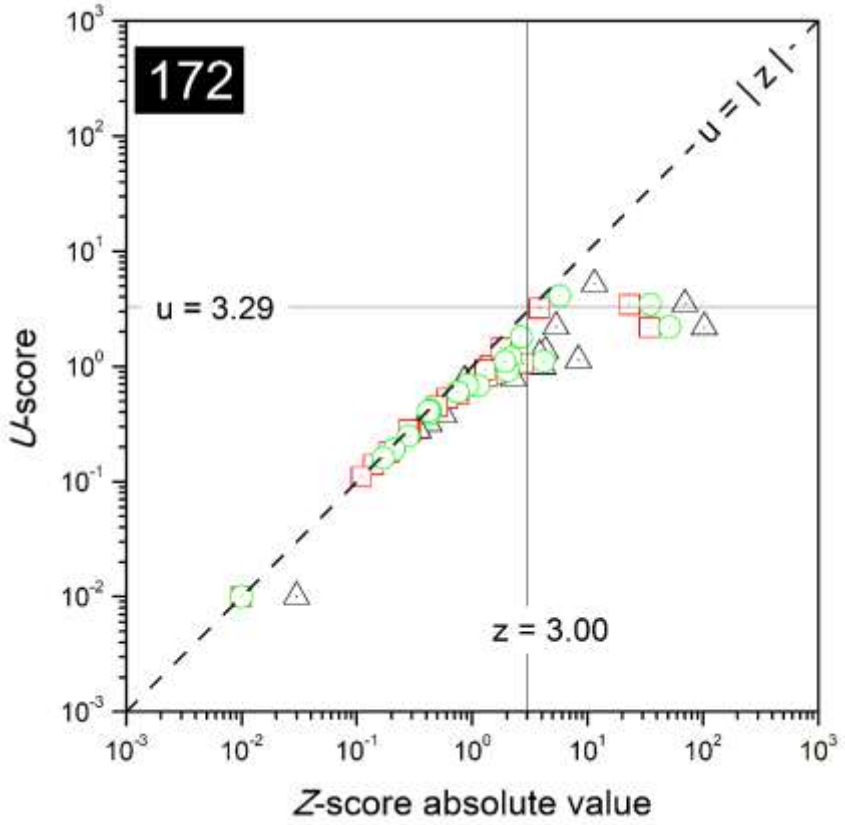

FIG. 95. Combined plots of z- and u-scores for the laboratory with code 172.

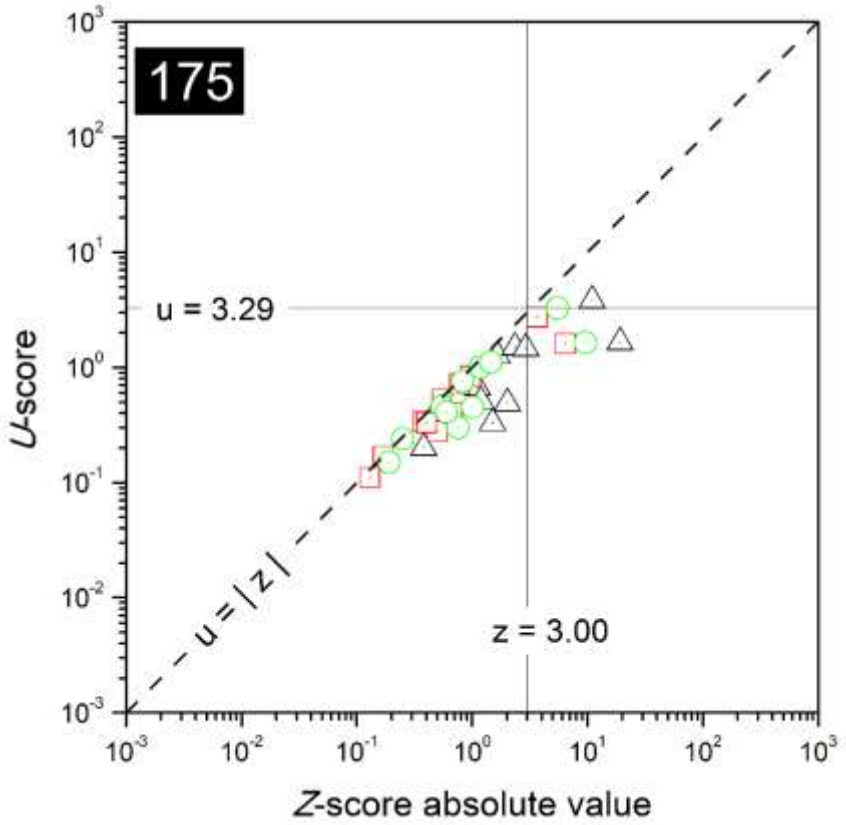

FIG. 96. Combined plots of z- and u-scores for the laboratory with code 175.

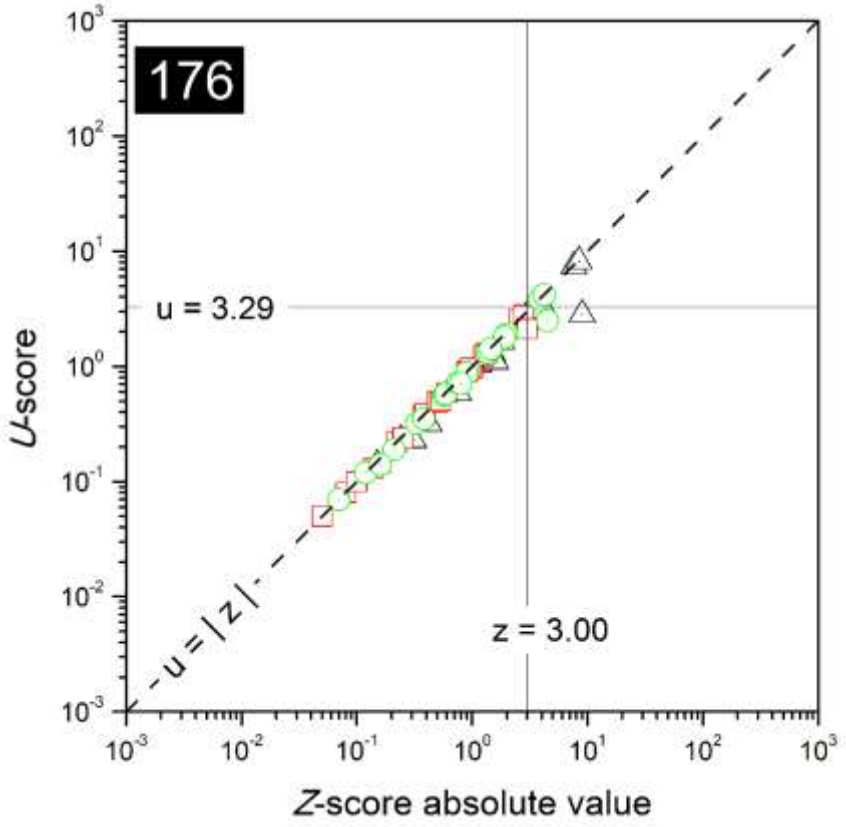

FIG. 97. Combined plots of z- and u-scores for the laboratory with code 176.

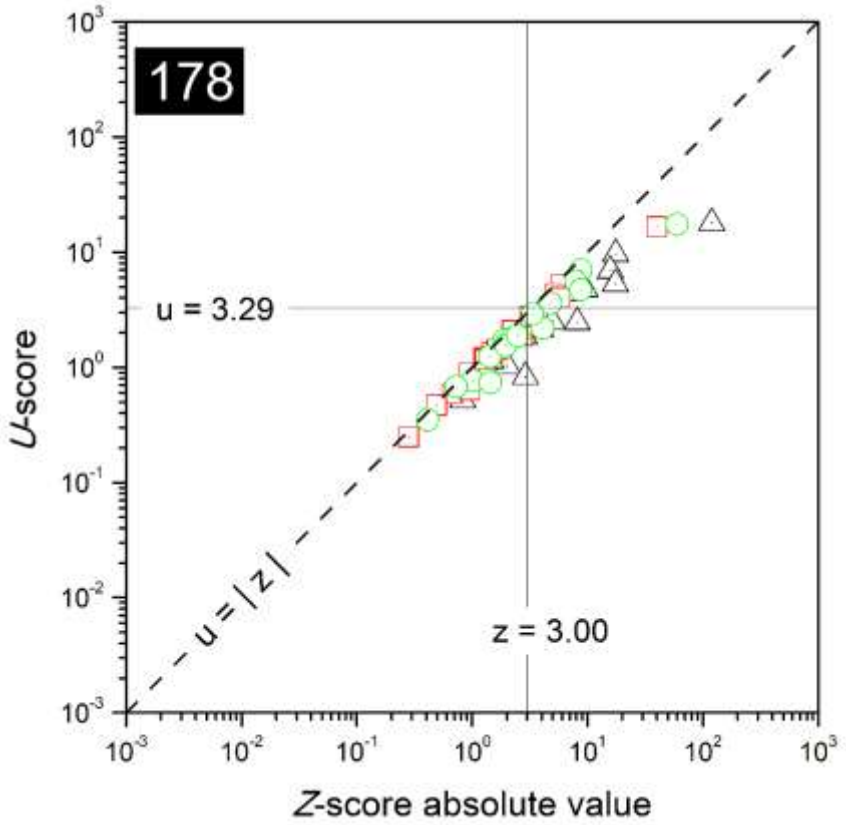

FIG. 98. Combined plots of z- and u-scores for the laboratory with code 178.

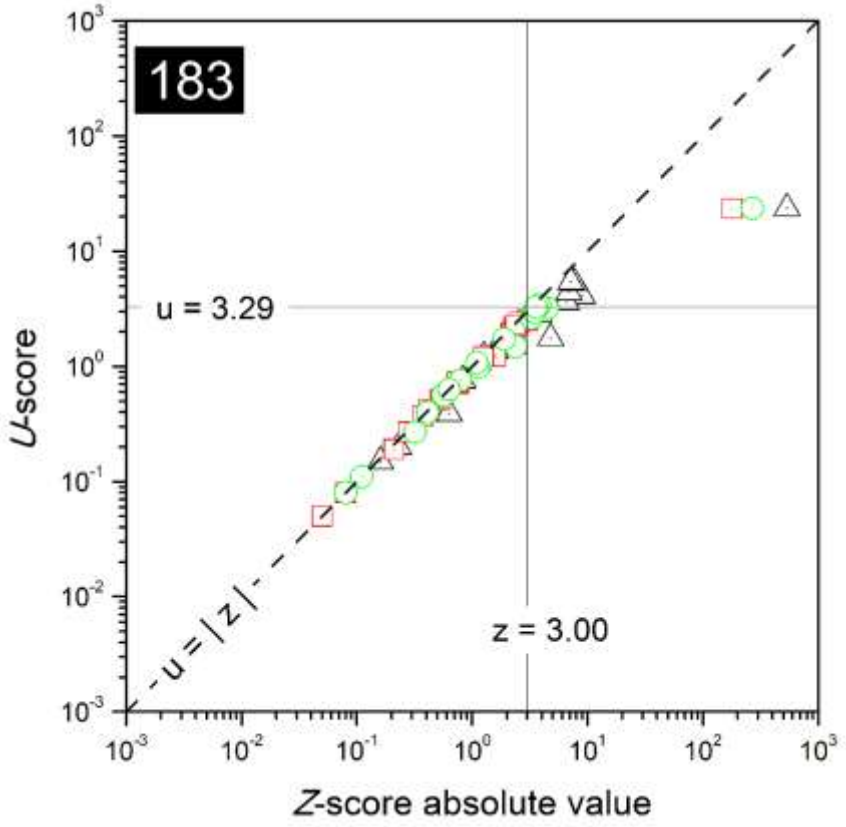

FIG. 99. Combined plots of z- and u-scores for the laboratory with code 183.

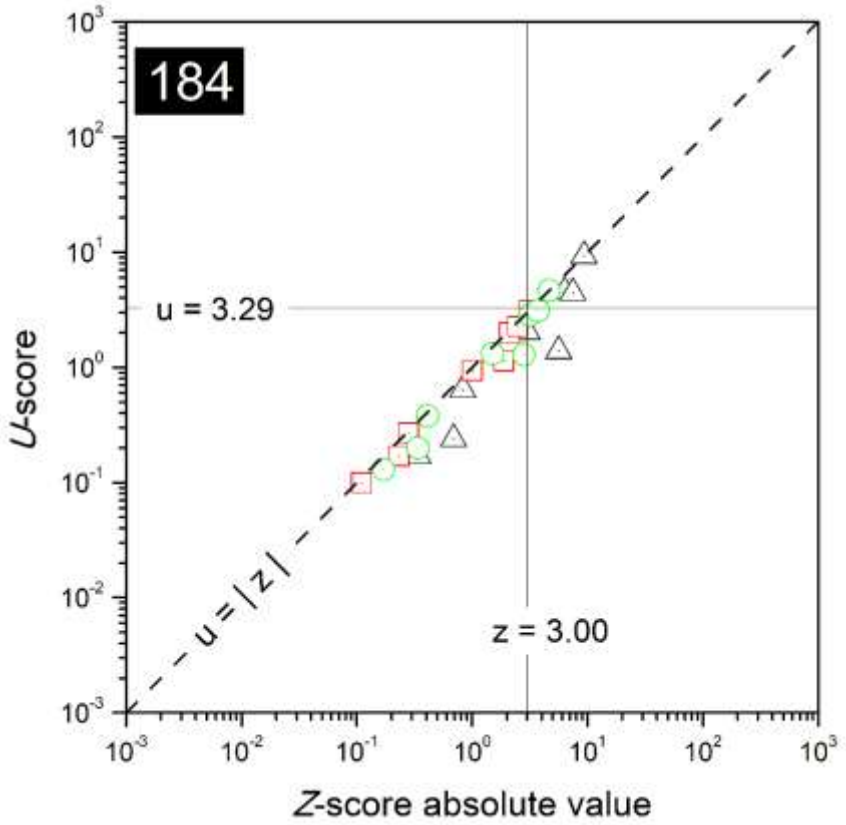

FIG. 100. Combined plots of z- and u-scores for the laboratory with code 184.

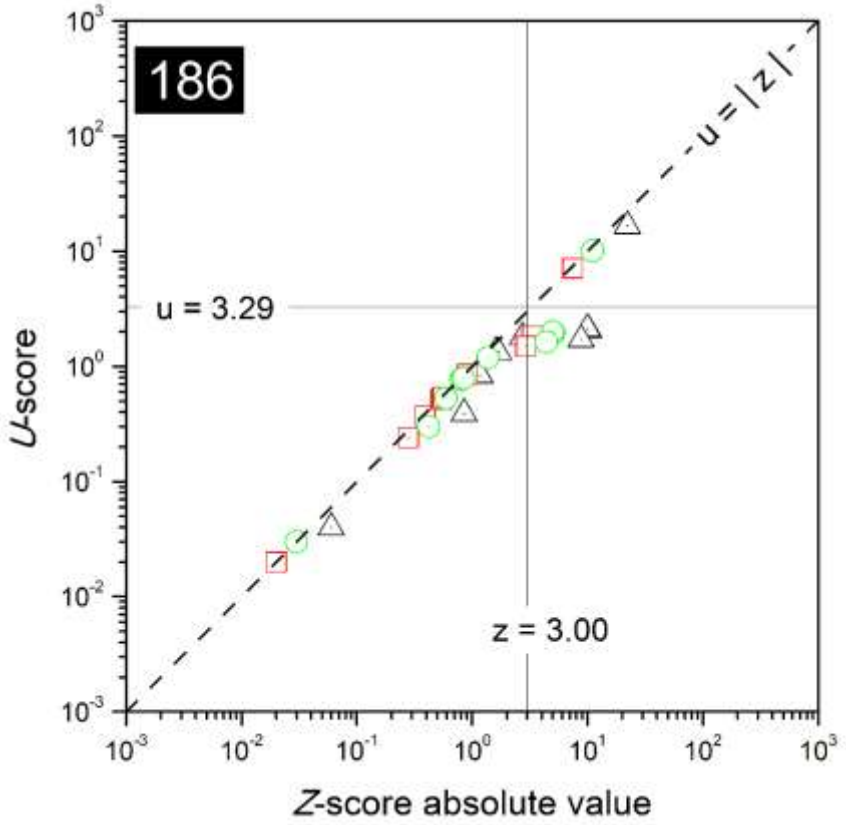

FIG. 101. Combined plots of z- and u-scores for the laboratory with code 186.

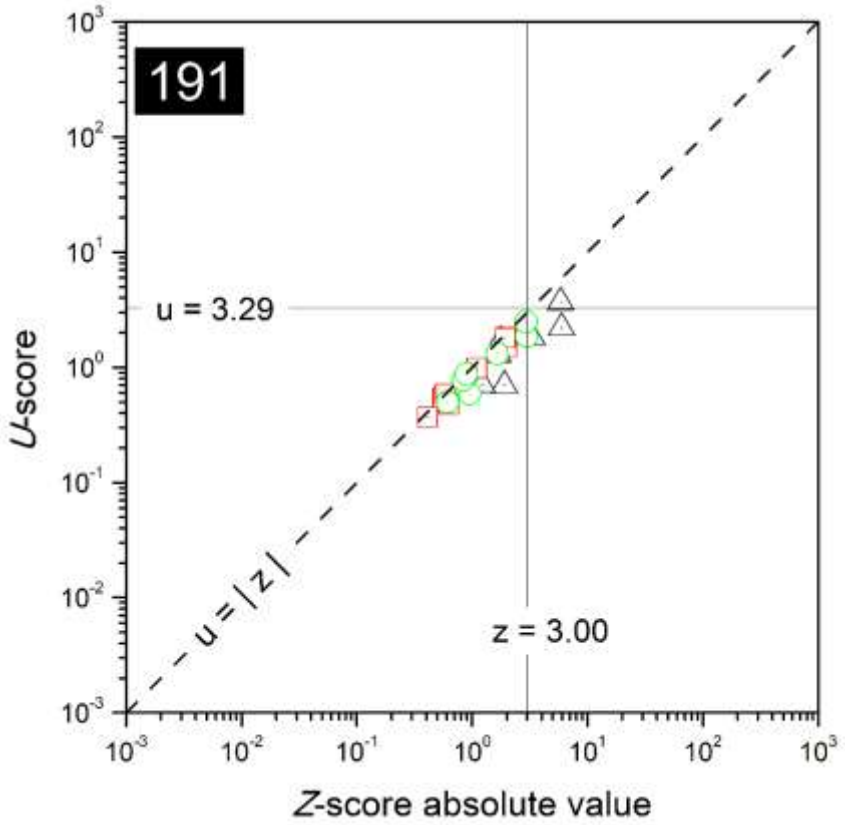

FIG. 102. Combined plots of z- and u-scores for the laboratory with code 191.

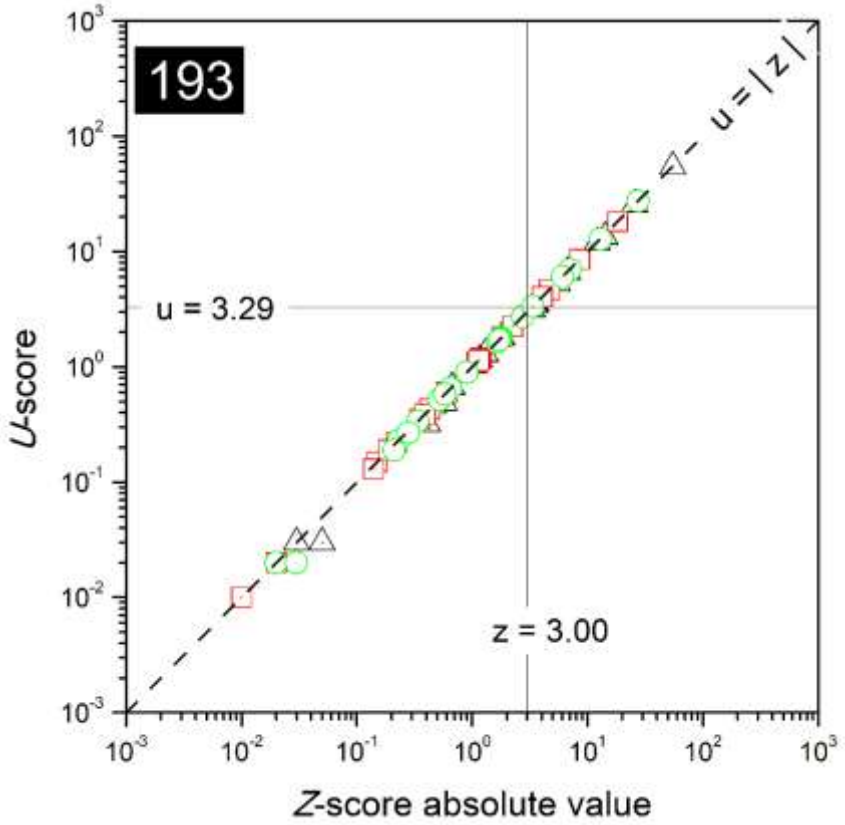

FIG. 103. Combined plots of z- and u-scores for the laboratory with code 193.

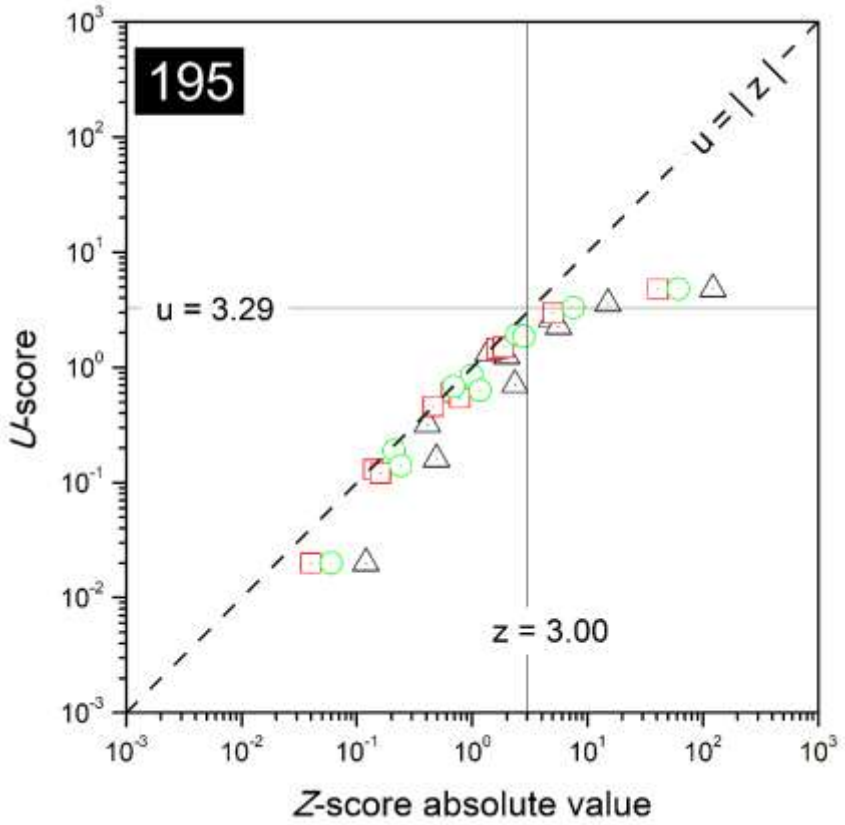

FIG. 104. Combined plots of z- and u-scores for the laboratory with code 195.

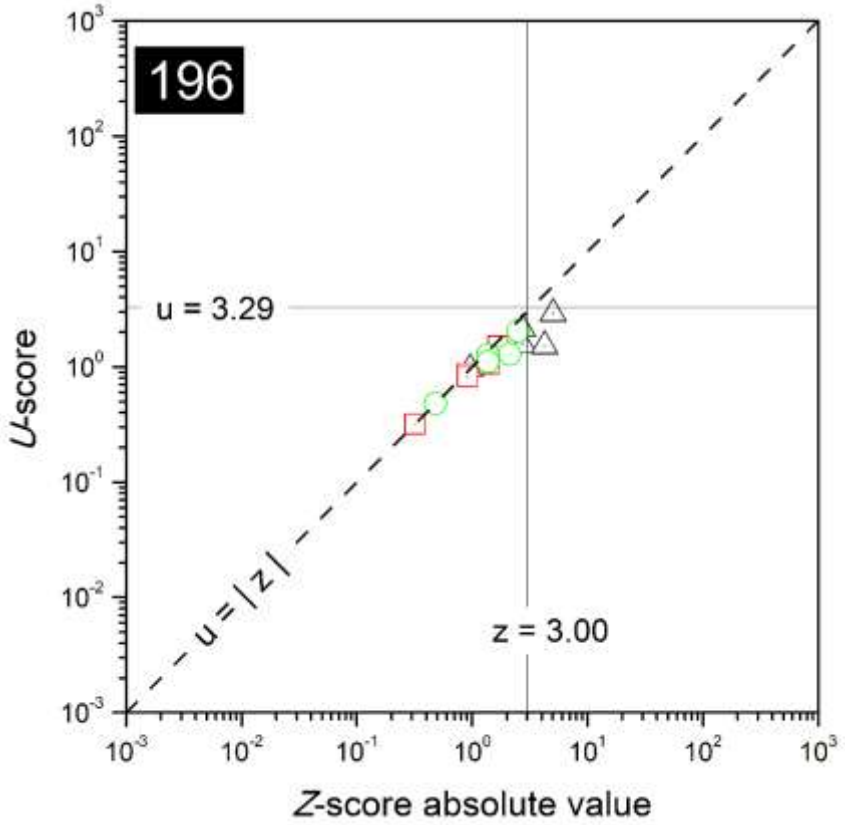

FIG. 105. Combined plots of z- and u-scores for the laboratory with code 196.

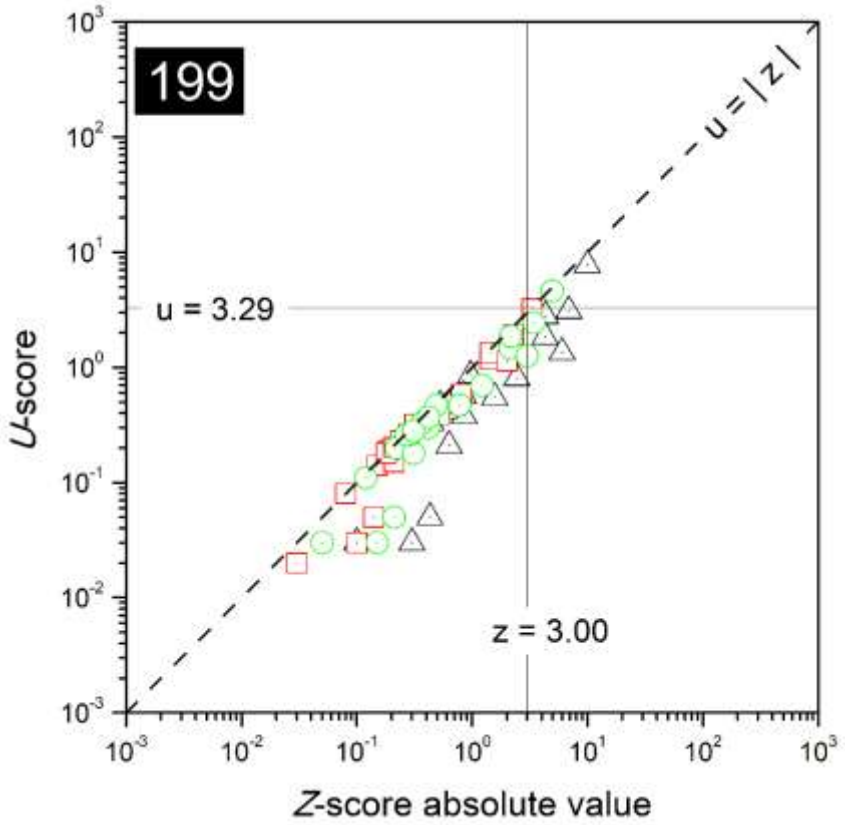

FIG. 106. Combined plots of z- and u-scores for the laboratory with code 199.

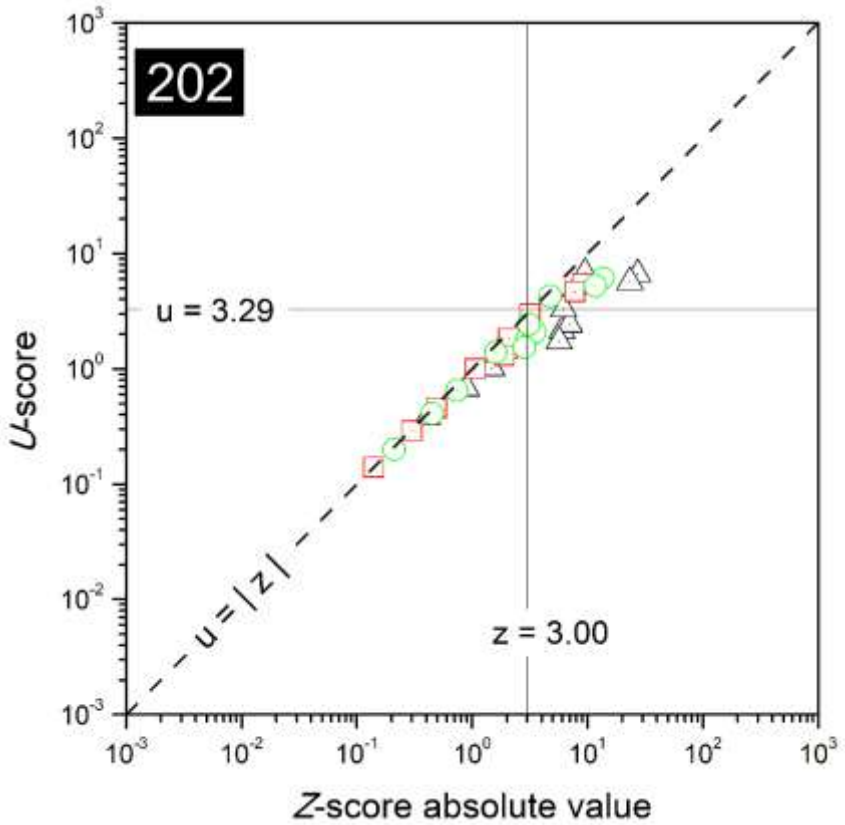

FIG. 107. Combined plots of z- and u-scores for the laboratory with code 202.

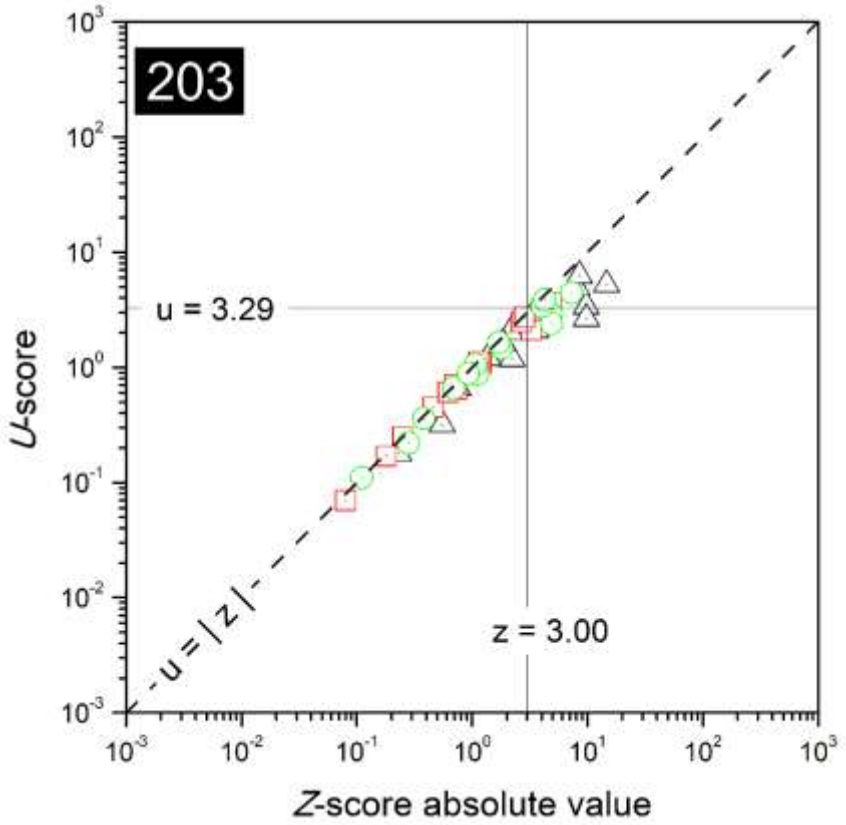

FIG. 108. Combined plots of z- and u-scores for the laboratory with code 203.

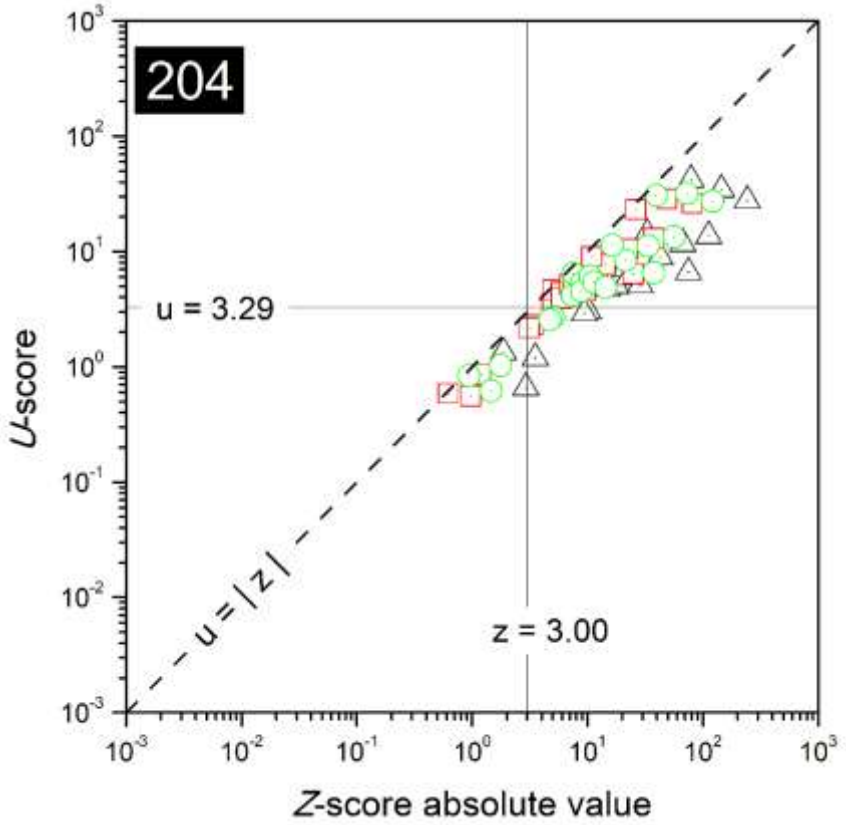

FIG. 109. Combined plots of z- and u-scores for the laboratory with code 204.

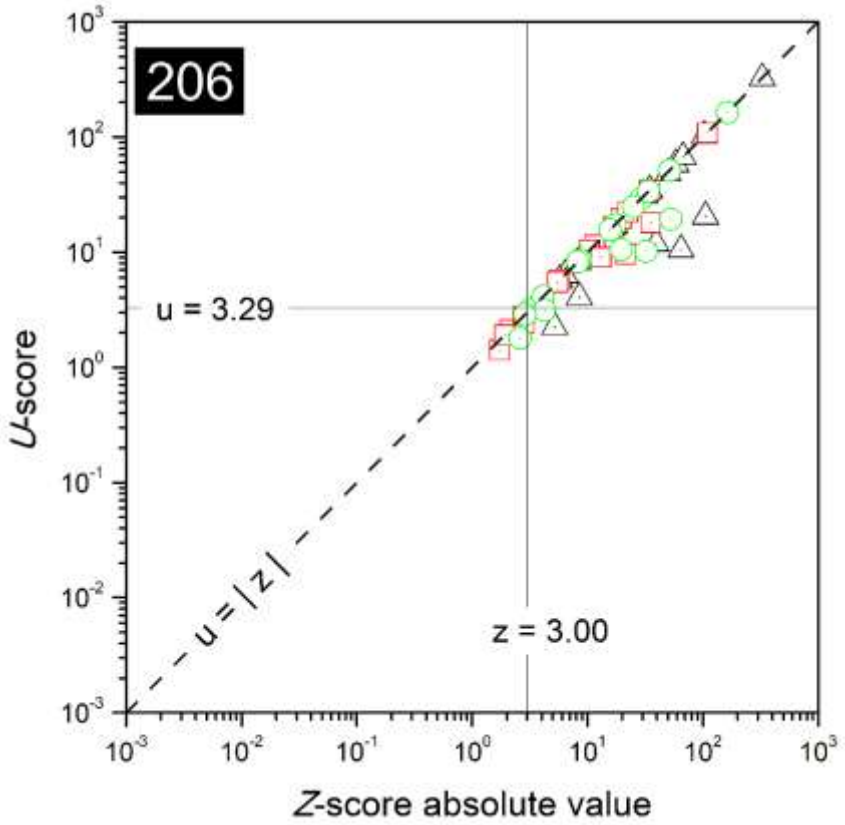

FIG. 110. Combined plots of z- and u-scores for the laboratory with code 206.

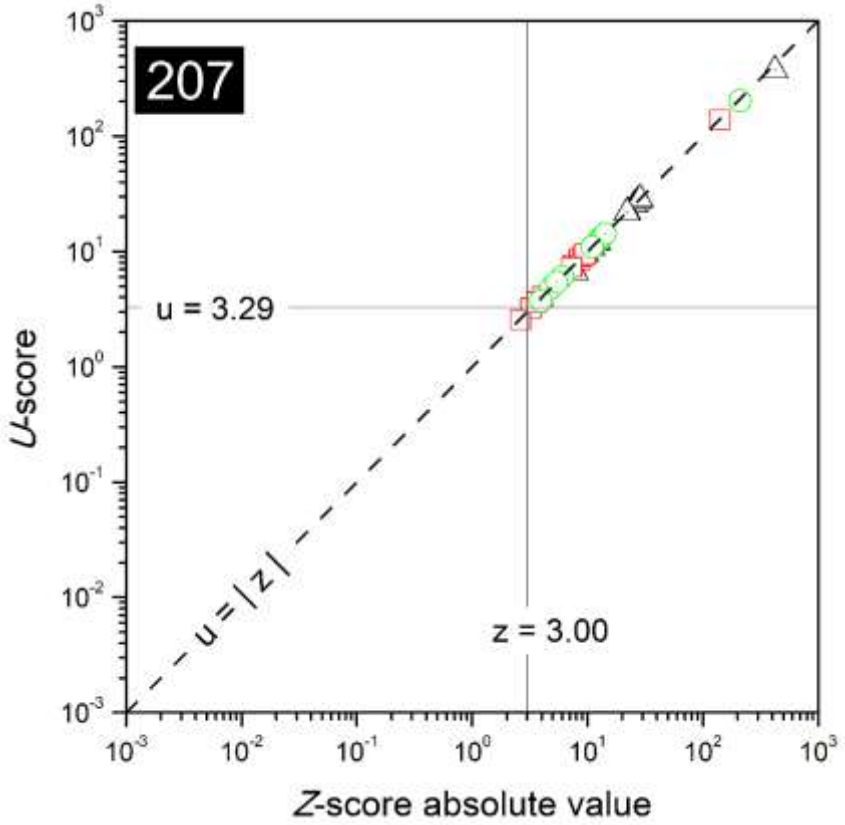

FIG. 111. Combined plots of z- and u-scores for the laboratory with code 207.

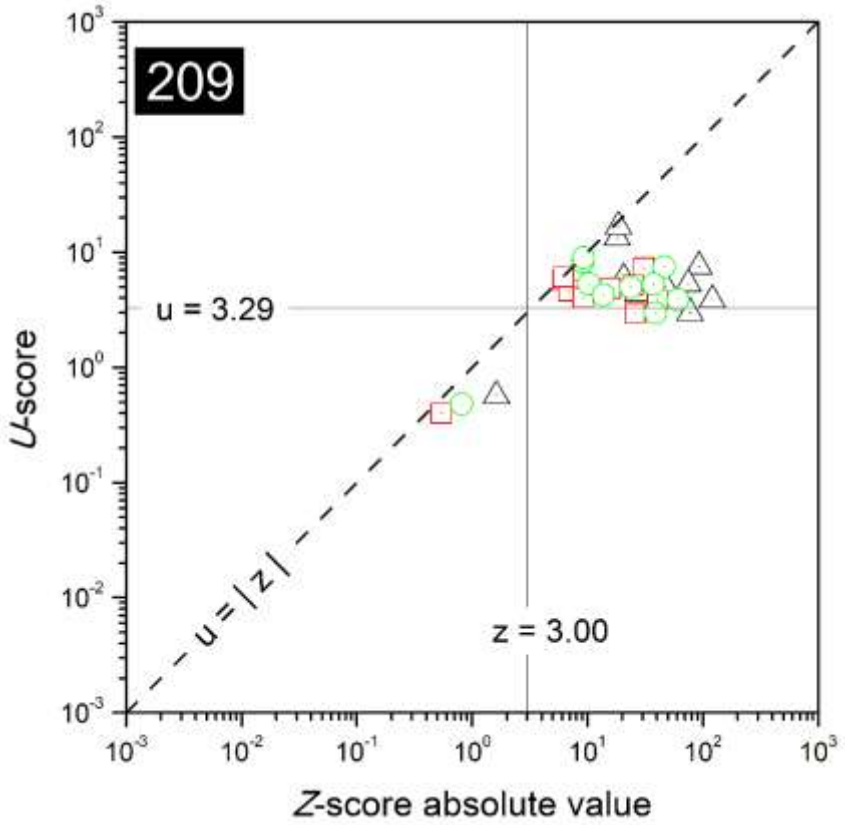

FIG. 112. Combined plots of z- and u-scores for the laboratory with code 209.

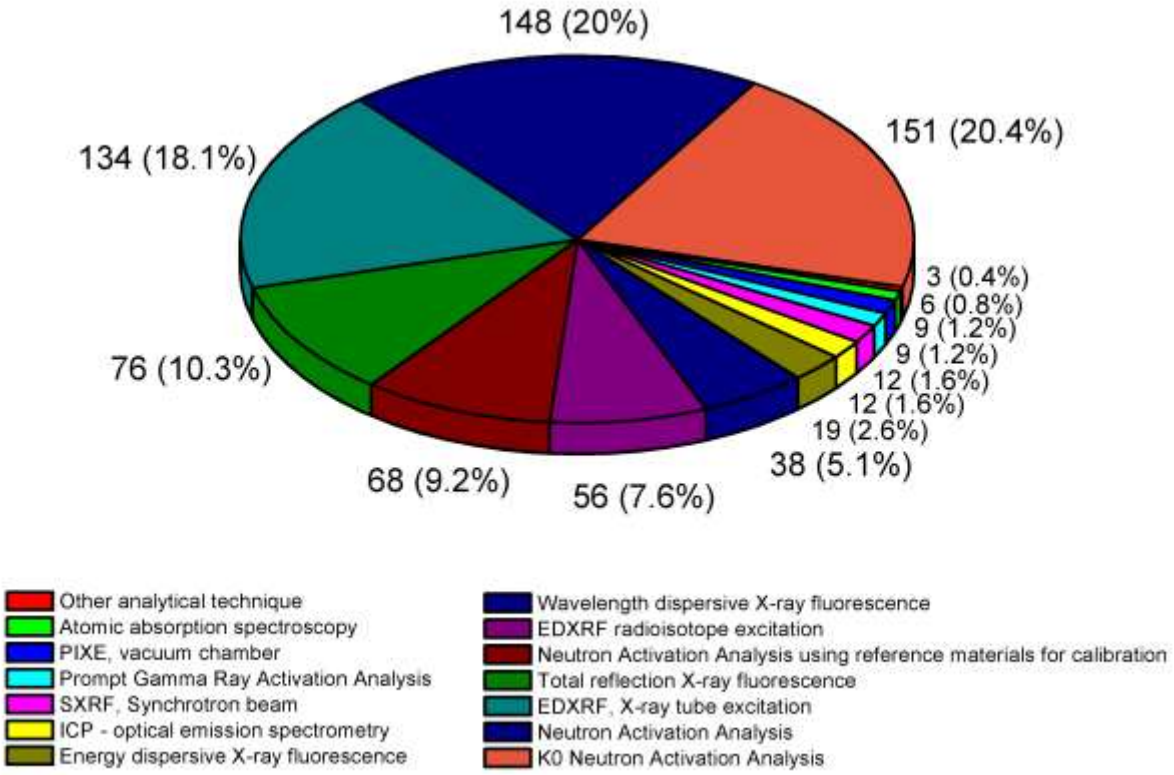

FIG. 113. Utilization of analytical techniques. For each analytical technique the number of submitted results is shown. The percent values relate to the total number of 741 submitted results.

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GLOSSARY

The definitions of terms used in the proficiency testing schemes are provided. Although this terminology might be known to the participants or can be found elsewhere [8-10] the terms used in this report are clearly defined to avoid any ambiguity.

Proficiency testing: evaluation of participant performance against pre-established criteria by means of interlaboratory comparisons.

True value: the actual concentration of the analyte in the matrix.

Assigned value: the value of the concentration of the analyte in the matrix used as the true value by the proficiency testing coordinator in the statistical treatment of results (or the best available estimate).

Target value for standard deviation: a numerical value for the standard deviation of a measurement result, which has been designated as a target for measurement quality.

Consensus value: the mean value of the reported laboratory results after the removal of outliers.

Standard deviation of the consensus value: the standard deviation of the mean value of the reported laboratory results after the removal of outliers.

Certified Reference Material: A reference material, accompanied by a certificate, one or more of whose property values are certified by a procedure which establishes traceability to an accurate realization of the unit in which the property values are expressed, and for which each certified value is accompanied by an uncertainty at a stated level of confidence.

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