Test Group Summary Report

C02B Metals in Water – High Range

March 2021 PT Round (Shipped May 17)

Issued: July 15, 2021

PTC | Proficiency Testing Canada

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1.0 The Proficiency Testing Report

The Proficiency Testing Report consists of two parts.

- *PTC Proficiency Testing Report*: This report contains participant-specific data and other confidential information. This report is emailed to participants at the end of the PT round.
- *Test Group Summary Report*: A Test Group Summary Report is created for each quantified test group at the end of the PT round. These reports contain more detailed information on the round than are found in the participant-specific PTC Proficiency Testing Report. These reports do not contain any confidential information and are made available on the PTC web site.

2.0 Definitions

The participant-specific PTC Proficiency Testing Report contains some terms that new participants may not be familiar with.

Code:	The registration code that is unique to each analyte that a participant is registered for.
App:	If a participant is accredited by CALA, this three-digit number is the appendix number that the accredited method is assigned to.
N:	The number of participants results that were used to calculate the summary statistics. This excludes qualified data (e.g., <) and any results that were flagged as outliers.
Assigned:	The Assigned Value is the robust mean of the reported results, outliers excluded. This is often referred to as the "target" value.
$\pm u$:	The uncertainty of the assigned value.
Reported:	The result reported by the participant.
s:	The Standard Deviation of Proficiency Assessment (SDPA). This value is used to determine the acceptance limits for the PT evaluation.
z-Score:	A value assigned to each reported result that is a measure of the degree to which it deviates from the Assigned Value.
Score:	The composite score of the four results reported for each analyte. It is normalized to a score out of 100.
Bias:	A flag assigned if bias is detected using the re-scaled *z*-score procedure.

3.0 Scoring System

Participant performance is evaluated for each proficiency testing sample by a quantitative method that is consistent with ISO/IEC 17043:2010 *Conformity assessment — General requirements for proficiency testing*, the *International Harmonized Protocol for Proficiency Testing of (Chemical) Analytical Laboratories* (2006), and ISO 13528:2015 *Statistical methods for use in proficiency testing by interlaboratory comparisons*.

The following is a brief description of the evaluation procedure used by PTC. The detailed evaluation procedure is described in PROC09 – PT Evaluation *Procedure*, which is available on the PTC website www.PTCanada.org).

3.1 HOMOGENEITY AND STABILITY ASSESSMENT

Homogeneity and stability are assessed using participant data. Regression analysis is performed on reported result against order of sample production (Homogeneity) and reported result against date of analysis (Stability). If the slope is significantly different than zero for either then the Standard Deviation of Proficiency Assessment (s) is increased to minimize the impact.

3.2 THE Z SCORE

A "z-score" is calculated for each reported result as follows:

$$z - Score = \frac{(x - \bar{X})}{SDPA}$$

where: x = participant result;
$\overline{X}$ = the Assigned Value;
SDPA = the Standard Deviation for Proficiency Assessment.

The assigned value $\overline{X}$ is generally estimated from the inter-laboratory Robust mean after outliers due to obvious gross errors (e.g., reported in wrong units) have been removed.

The Standard Deviation for Proficiency Assessment, s, is determined as follows:

- The inter-laboratory Robust standard deviation ($Stdev_{rob}$) is calculated using reported results, obvious outliers removed;
- The regression equation standard deviation ($Stdev_{reg}$) is estimated from regression equations derived from previous studies (see PROC11- *PT Regression Equations* for details);
- The SDPA is the higher of $Stdev_{rob}$ and $Stdev_{reg}$;
- When a laboratory reports its detection limit, s will be estimated using a pooled variance procedure that uses both the inter-laboratory data and the reported detection limit.

3.2 COMPOSITE (PT) SCORE

Since each PT round involves four or two separate samples of distinct concentration for each test, it is necessary to calculate a composite PT score for each test to determine overall performance. The composite score is calculated by first averaging the absolute *z*-scores for the four results and then calculating a final score as 100 + (-15 x avg |z|).

Acceptable PT Scores equal or exceed 70.

3.3 IDENTIFYING BIAS

The proficiency testing report provides flags for bias. These are determined using the re-scaled *z*-score procedure.

$$RSZ = \frac{\sum z}{\sqrt{N}}$$

where z = the z- score
N = the number of samples

Flags are assigned for each test group/parameter combination as follows:

RSZ ≥ -2 and ≤ 2	no flag assigned
RSZ > 2	H (High)
RSZ > 3	VH (Very High)
RSZ < -2	L (LOW)
RSZ < -3	VL (Very Low)

3.4 DEVIATIONS FROM EVALUATION PROCEDURE

Other than changes to the Standard Deviation of Proficiency Assessment due to homogeneity or stability flags, any deviation from the published evaluation procedure is described on the cover page(s) of the final *PTC Proficiency Testing Report*.

4.0 PT Round Specific Data Summary

The following pages provide more detailed information about the PT round indicated in the cover page of this report than is found in the participant-specific PTC Proficiency Testing Report. The graphical representations and the statistical summaries are based upon the data after outliers have been removed.

4.1 SUMMARY STATISTICS

In addition to some of the statistics found in the customer reports, this table includes additional summary statistics such as Median, different measures of dispersion, the number of outliers removed, the number of results in the Questionable range (|z| between 2 and 3) and the Unacceptable range (z > 3), and whether a data set was flagged for Homogeneity or Stability. This section also includes sorted scatter plots of the data for each sample.

4.2 z- SCORE PLOTS

The z-scores for each sample are ranked in increasing order and plotted. When the data is normally distributed, the plot should show a slight sigmoidal curve, with an equal number of points above zero as below. Each bar in these plots is colour-coded to indicate the analytical method used by the participant.

4.3 KERNEL DENSITY PLOTS

Kernel density plots are generated for each data set. These plots are a graphical way to represent the overall data distribution and are used to visualize possible deviations from normality and unimodality.

4.4 STABILITY AND HOMOGENEITY PLOTS

Plots of reported result against analysis date, and reported result against order of bottling are displayed, along with the regression line. These regression analyses are used to determine if the SDPA should be adjusted due to homogeneity or stability.

ALUMINUM

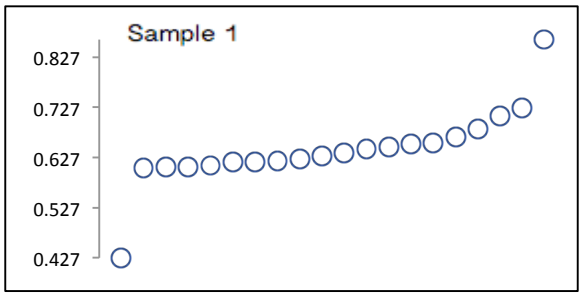
Summary Statistics

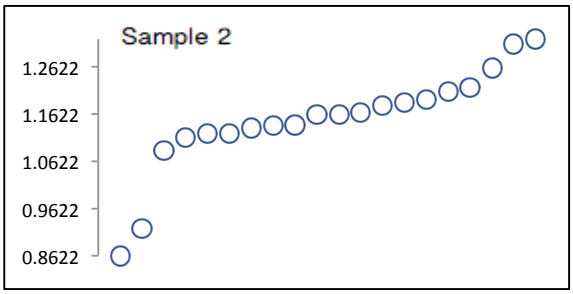
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	20	20	20	20
Median	0.633	1.16	0.861	0.380
Robust Mean	0.641	1.16	0.863	0.386
U	0.0111	0.0202	0.0119	0.0075
Robust Standard Deviation	0.0398	0.0724	0.0424	0.0267
Regression Standard Deviation	0.0480	0.0871	0.0647	0.0289
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0480	0.0871	0.0647	0.0289
Outliers	0	0	0	0
|z|>3.0	2	1	1	2
2<|z|<3	0	1	0	0

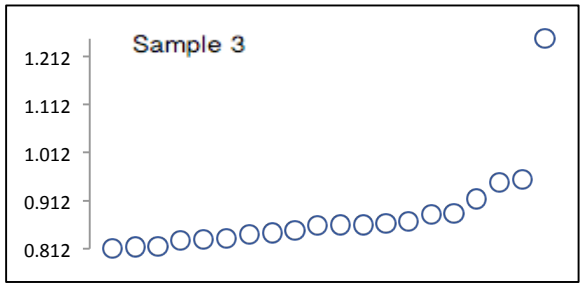
Methods Used

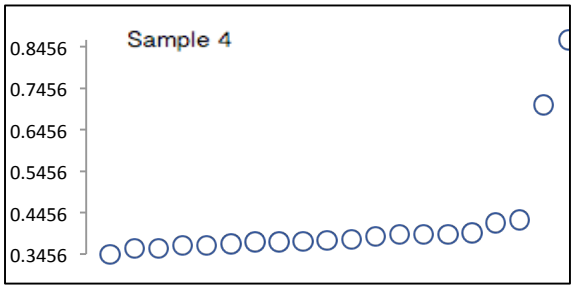
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	20	20	20	20

All summary stats and the plots below are based on the data excluding any flagged outliers



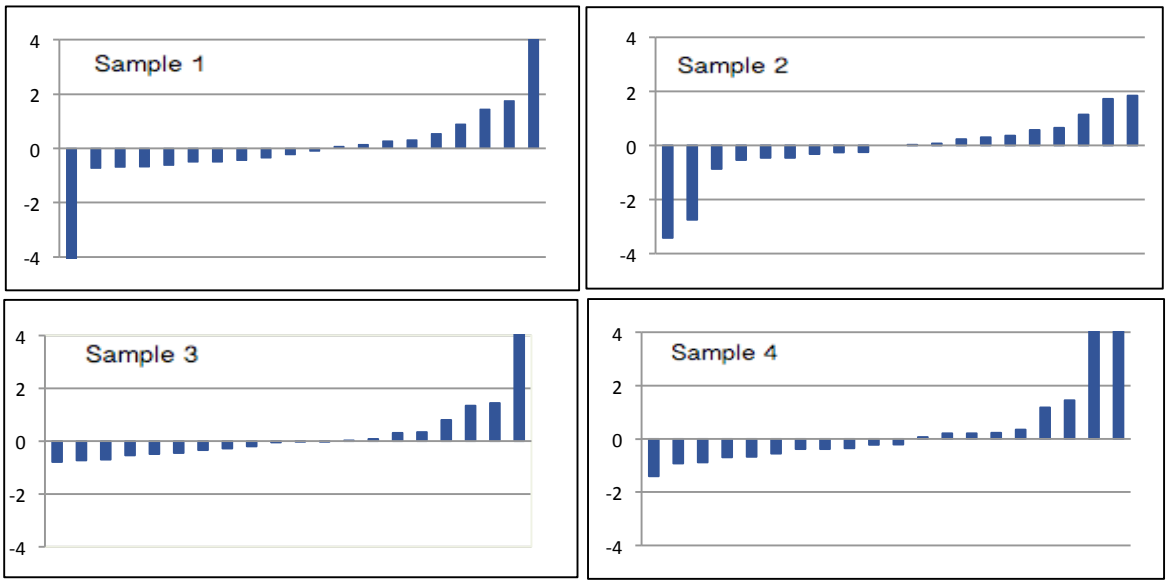




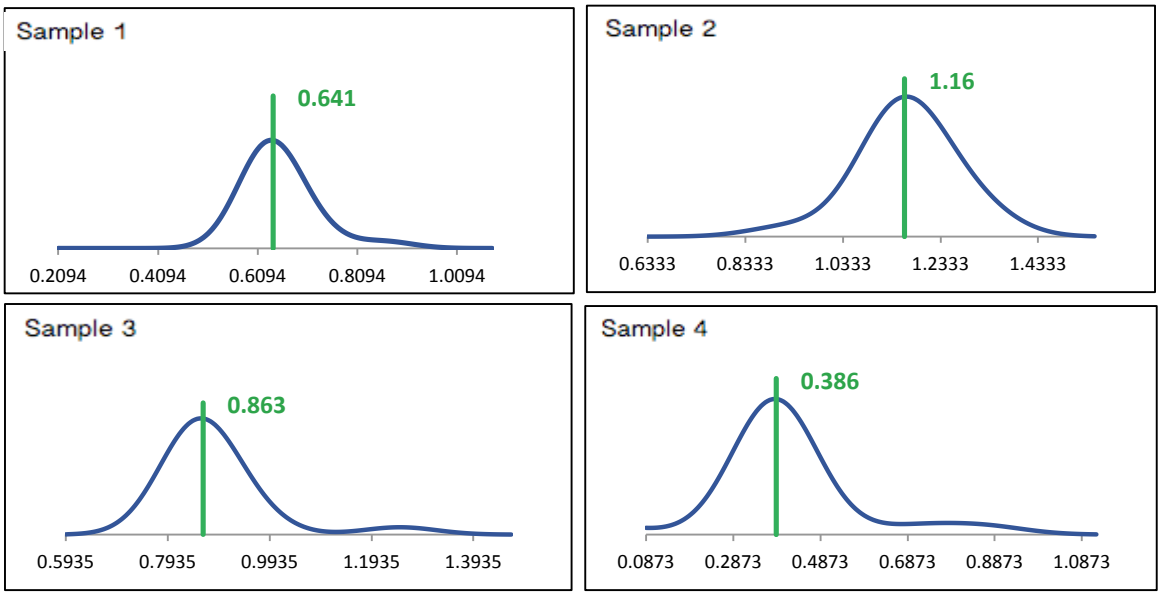


ALUMINUM

z-Score Plots

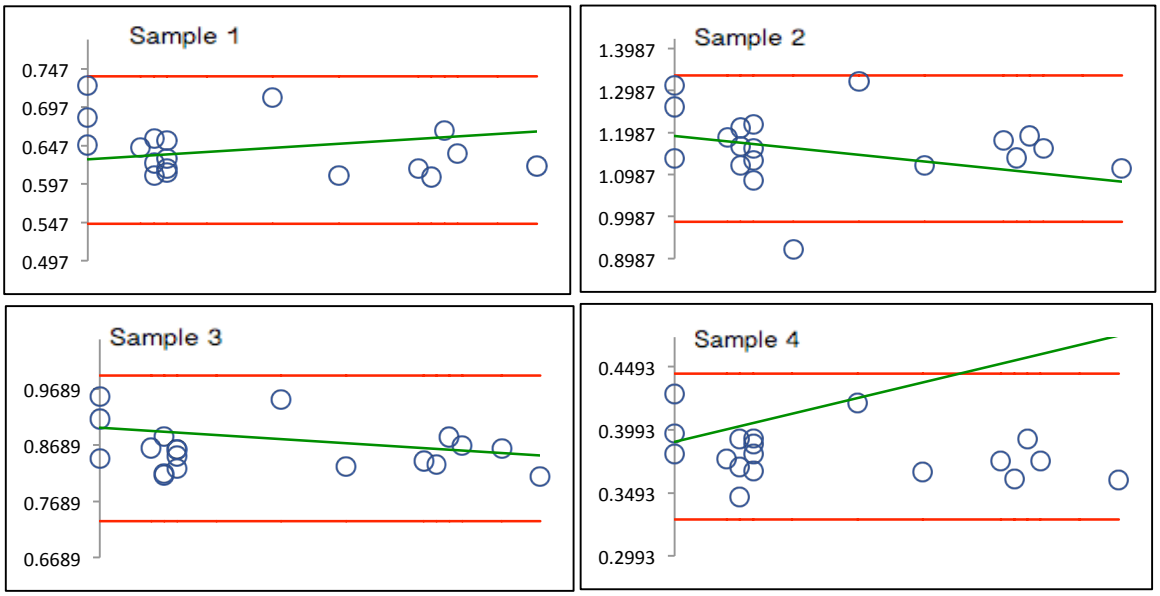


Kernel Density Plots



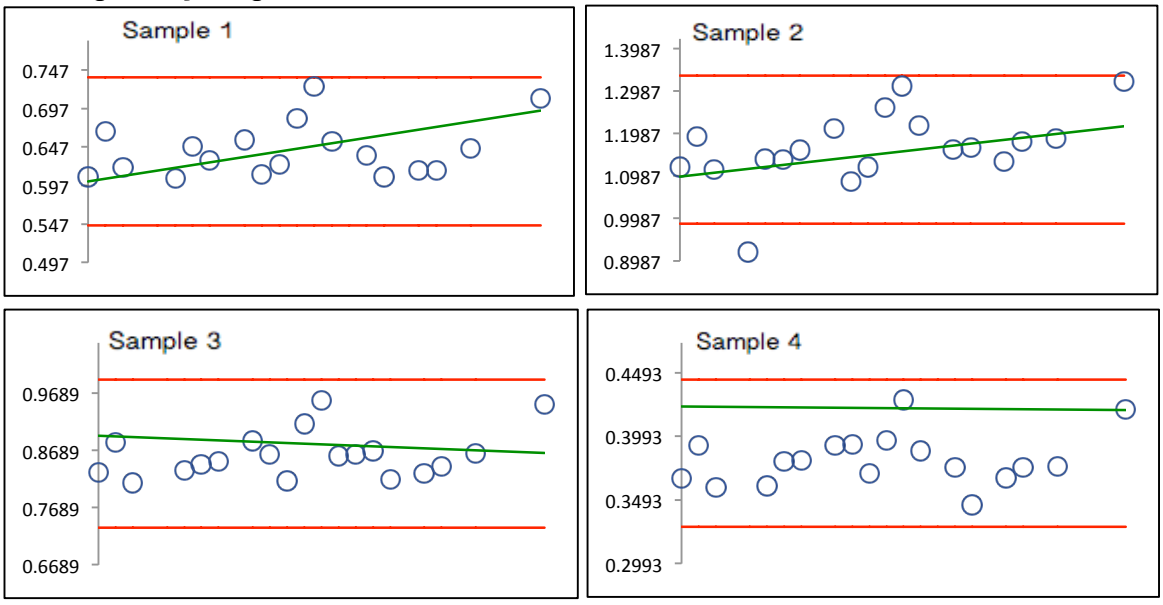
ALUMINUM

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

BARIUM

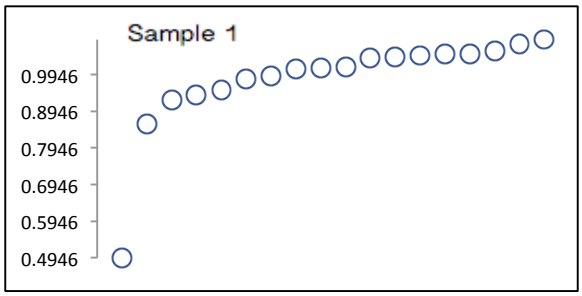
Summary Statistics

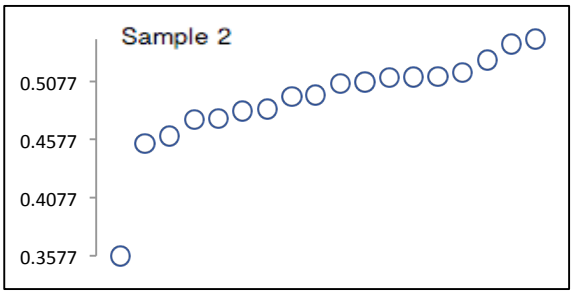
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	18	18	18	18
Median	1.01	0.501	0.339	0.798
Robust Mean	1.00	0.497	0.336	0.793
U	0.0197	0.0091	0.0062	0.0126
Robust Standard Deviation	0.0667	0.0308	0.0210	0.0429
Regression Standard Deviation	0.0754	0.0373	0.0252	0.0595
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0754	0.0373	0.0252	0.0595
Outliers	1	1	1	1
|z|>3.0	1	1	2	2
2<|z|<3	0	0	0	0

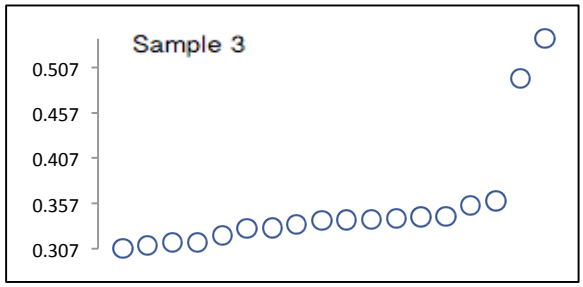
Methods Used

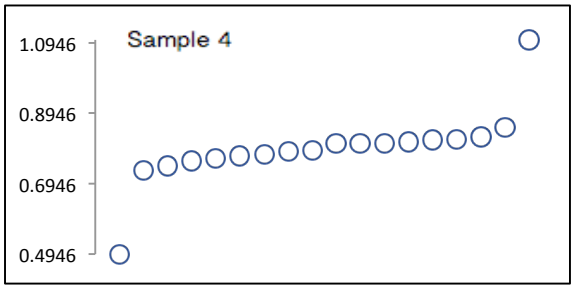
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	18	18	18	18

All summary stats and the plots below are based on the data excluding any flagged outliers



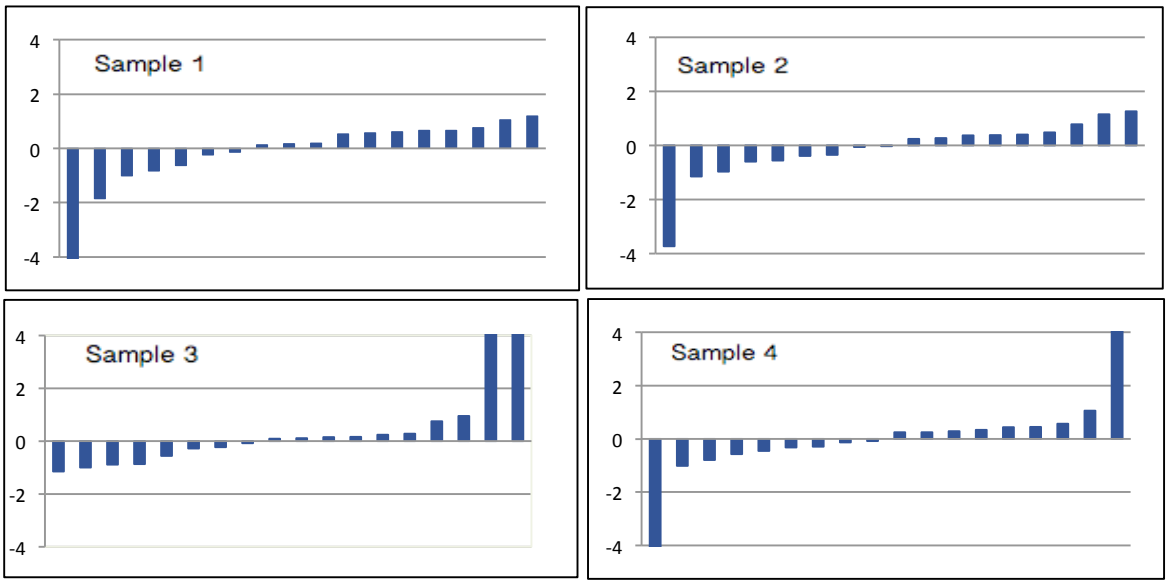




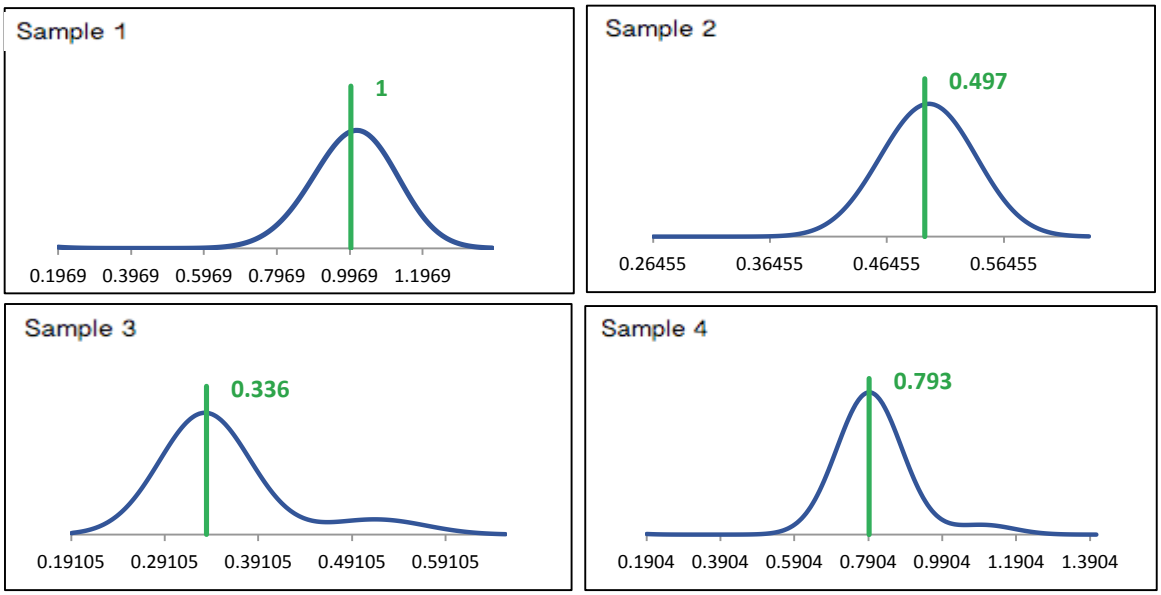


BARIUM

z-Score Plots

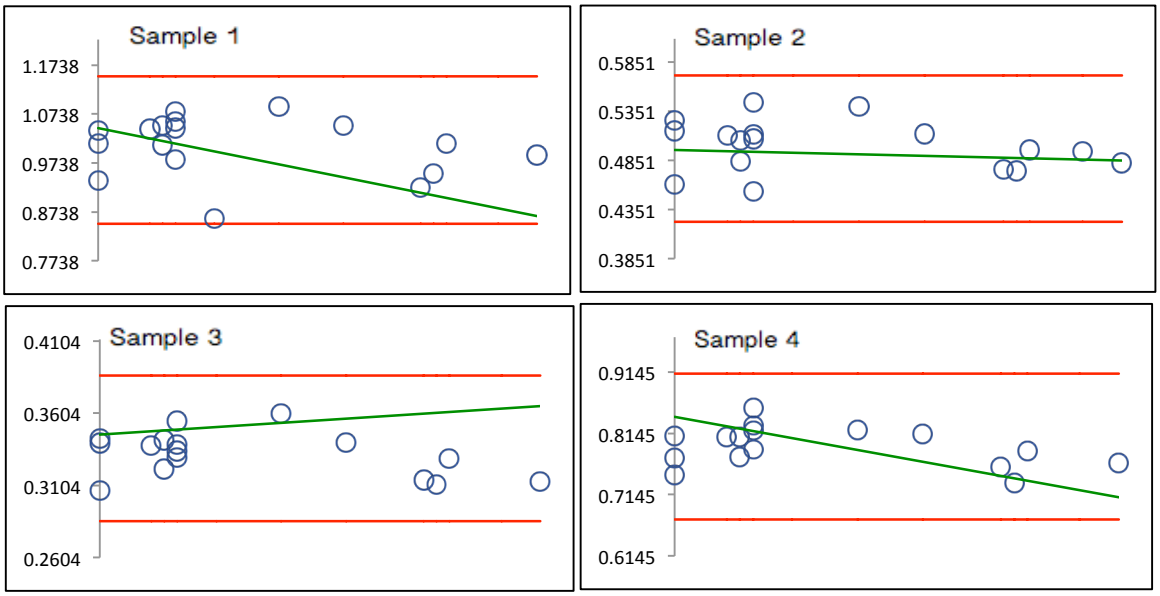


Kernel Density Plots



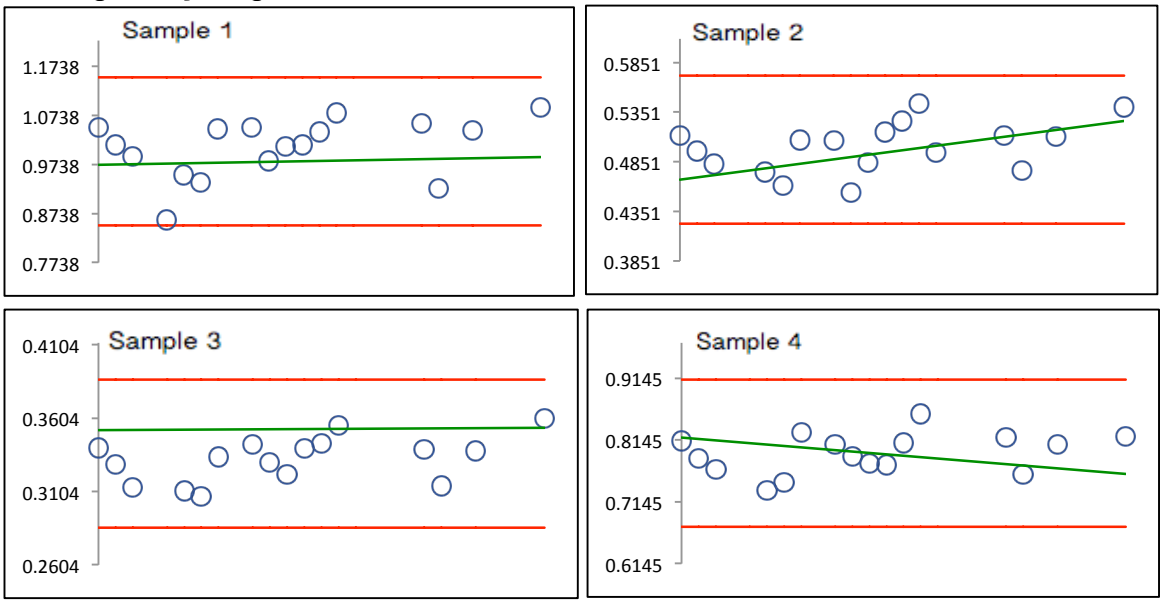
BARIUM

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

BORON

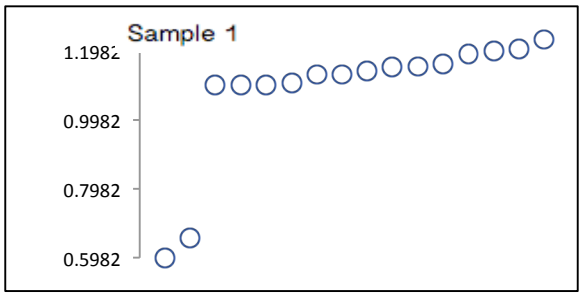
Summary Statistics

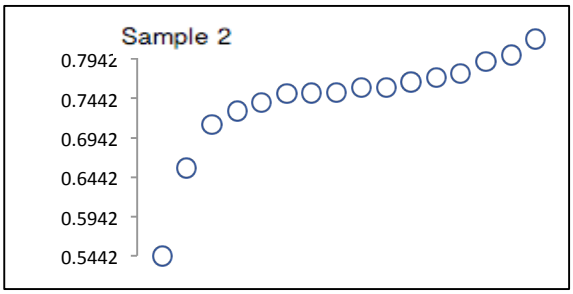
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	16	16	16	16
Median	1.14	0.755	0.521	0.565
Robust Mean	1.14	0.753	0.523	0.572
U	0.0185	0.0119	0.0089	0.0102
Robust Standard Deviation	0.0592	0.0381	0.0284	0.0326
Regression Standard Deviation	0.0852	0.0565	0.0392	0.0429
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0852	0.0565	0.0392	0.0429
Outliers	0	0	0	0
|z|>3.0	2	1	2	1
2<|z|<3	0	0	0	0

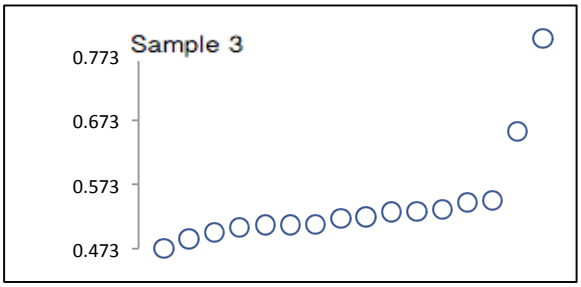
Methods Used

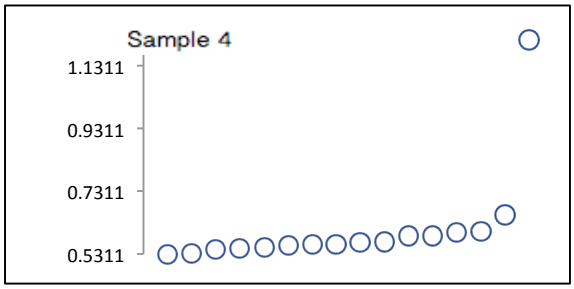
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	16	16	16	16

All summary stats and the plots below are based on the data excluding any flagged outliers



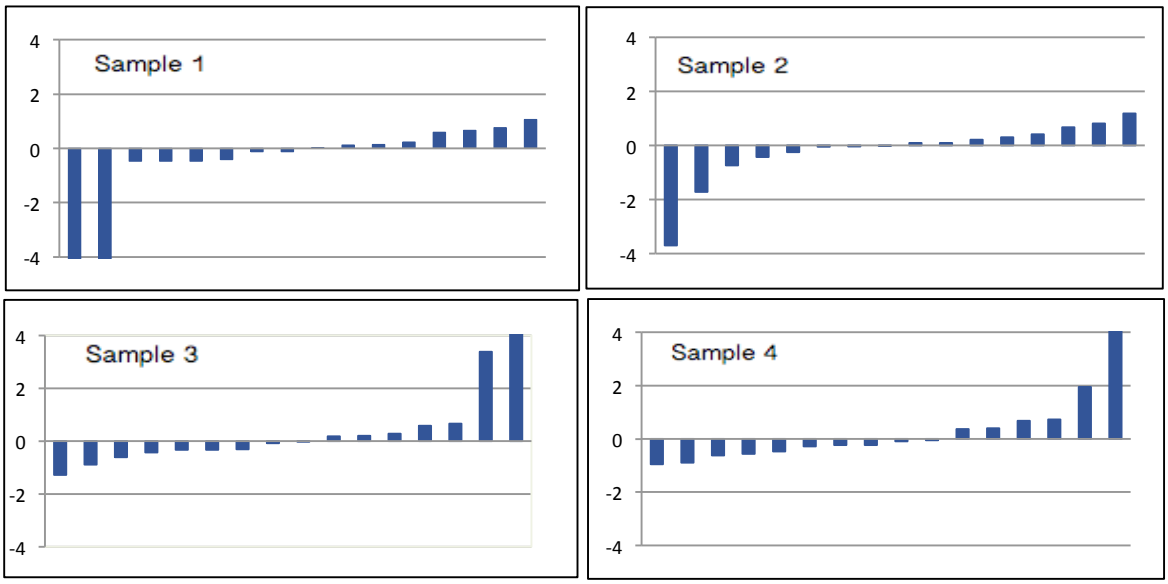




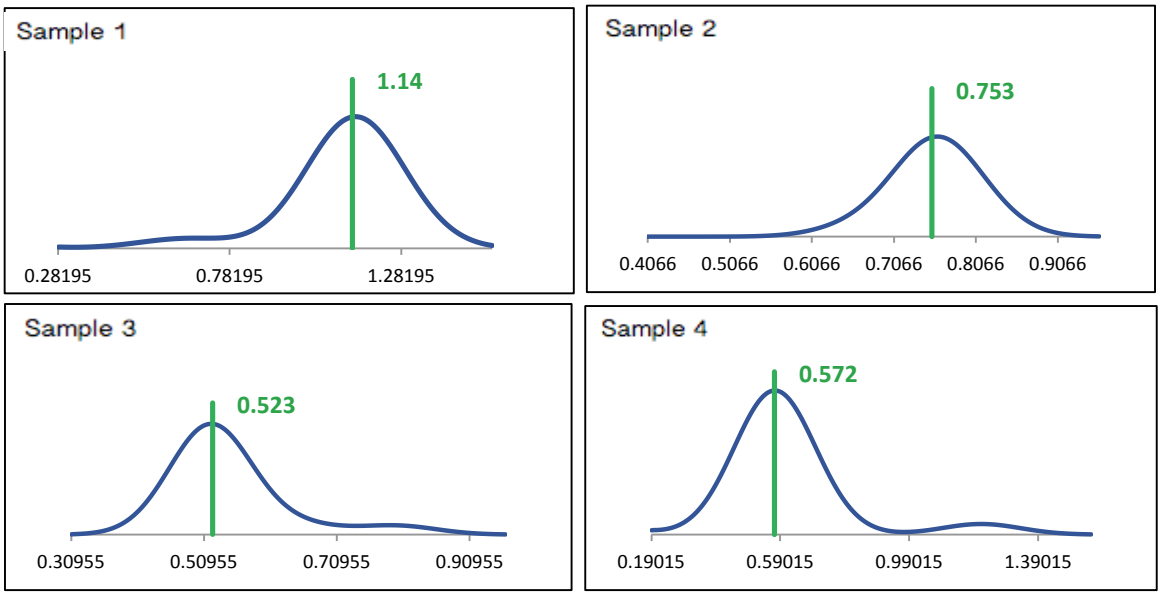


BORON

z-Score Plots

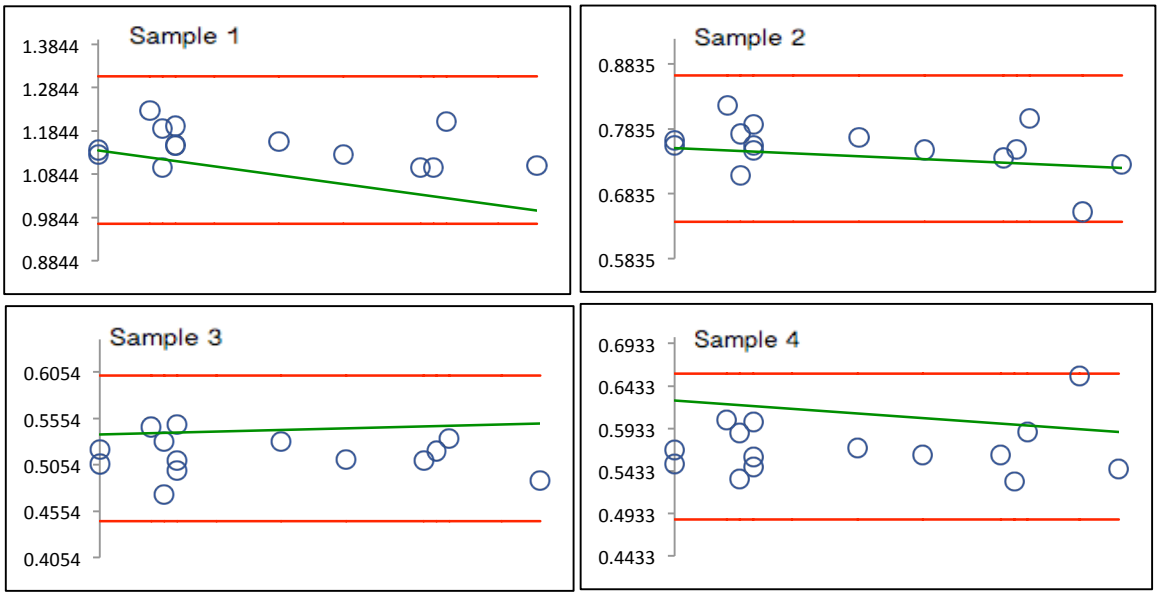


Kernel Density Plots



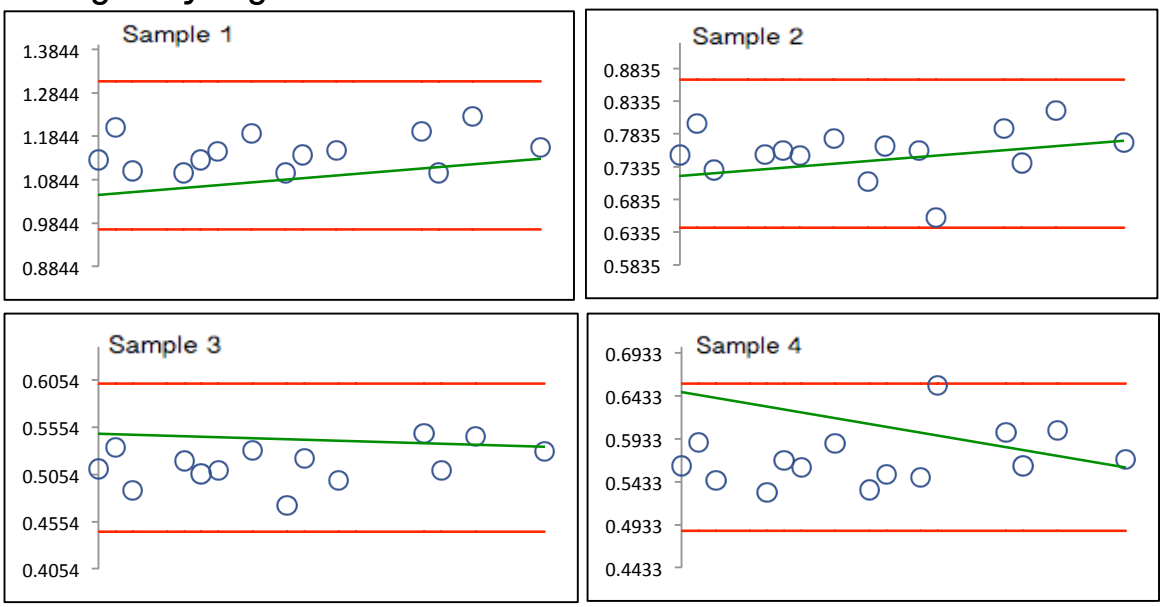
BORON

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

CHROMIUM

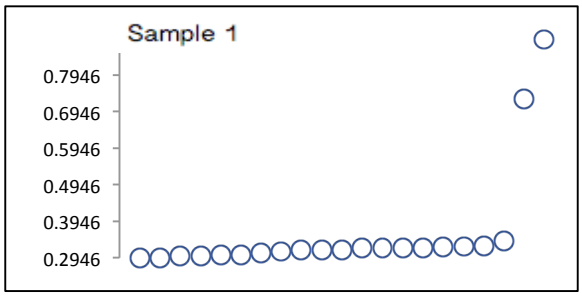
Summary Statistics

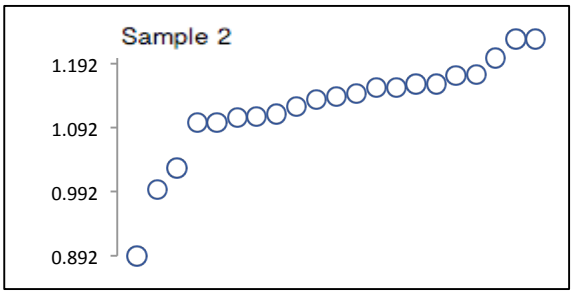
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	21	21	21	21
Median	0.317	1.14	0.929	0.678
Robust Mean	0.316	1.14	0.929	0.676
U	0.0045	0.0155	0.0105	0.0072
Robust Standard Deviation	0.0163	0.0568	0.0386	0.0263
Regression Standard Deviation	0.0237	0.0852	0.0697	0.0507
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0237	0.0852	0.0697	0.0507
Outliers	0	0	0	0
|z|>3.0	2	0	1	2
2<|z|<3	0	1	0	0

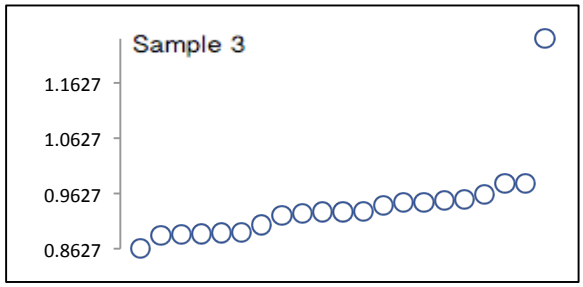
Methods Used

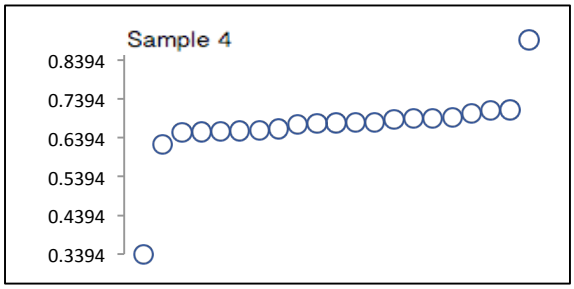
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	21	21	21	21

All summary stats and the plots below are based on the data excluding any flagged outliers



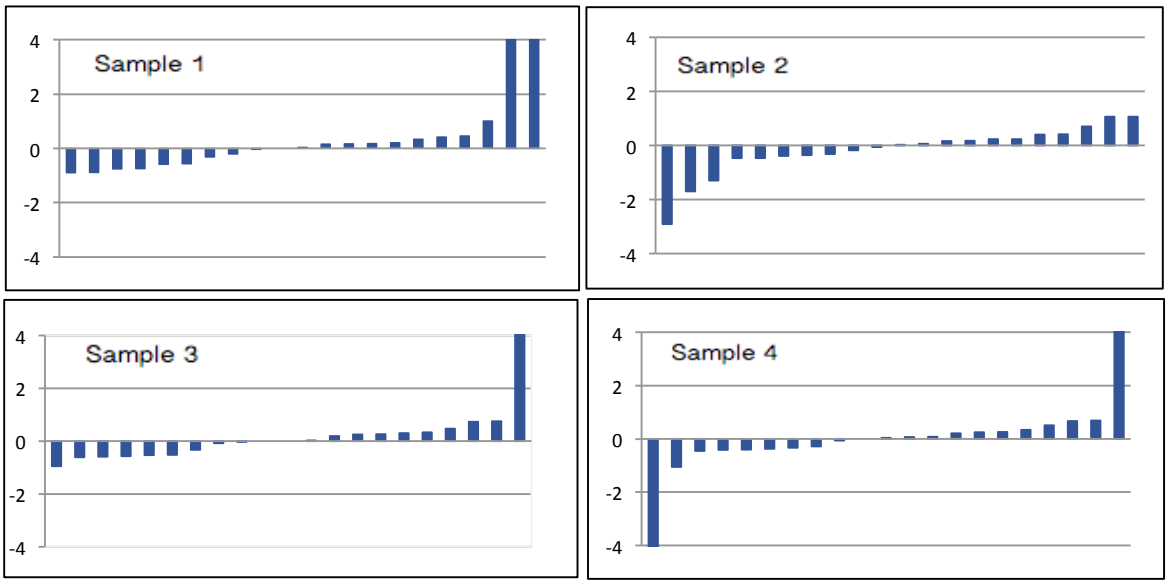




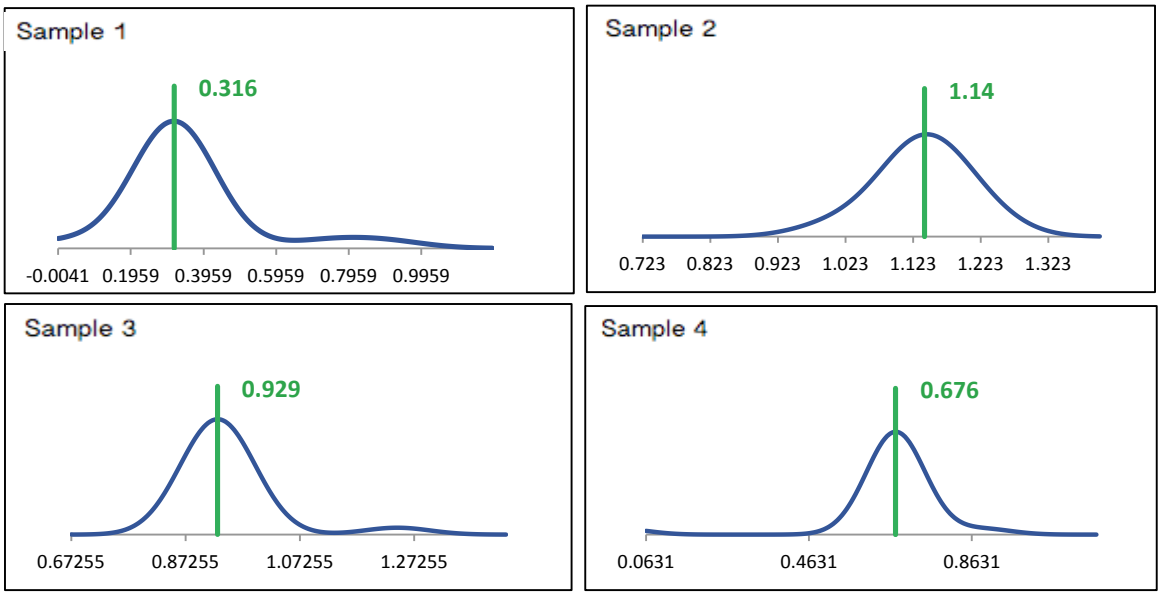


CHROMIUM

z-Score Plots

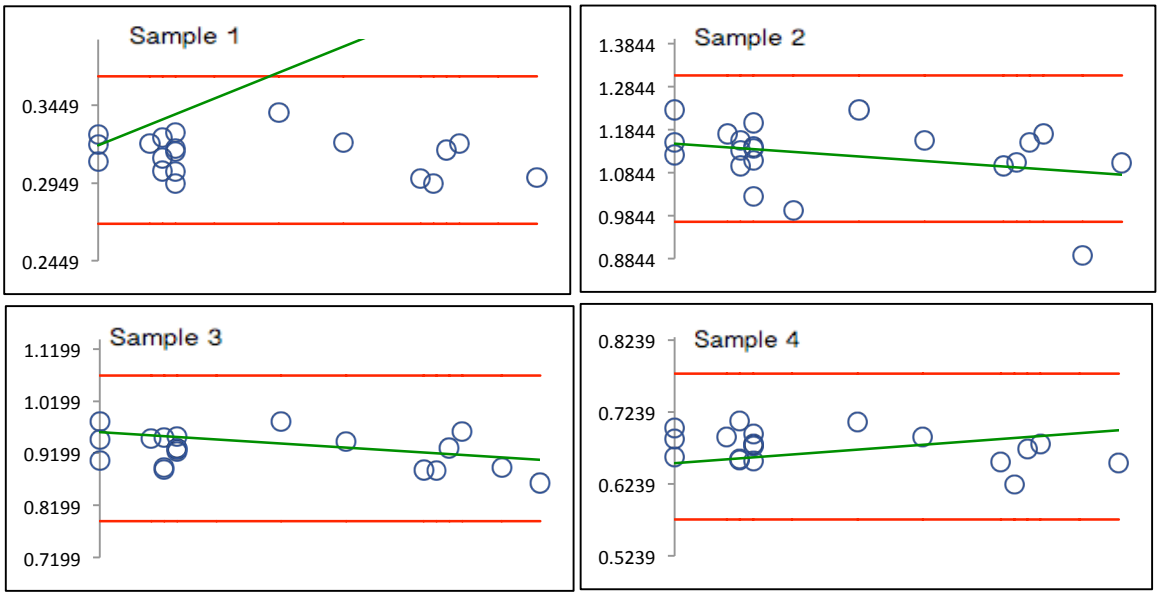


Kernel Density Plots



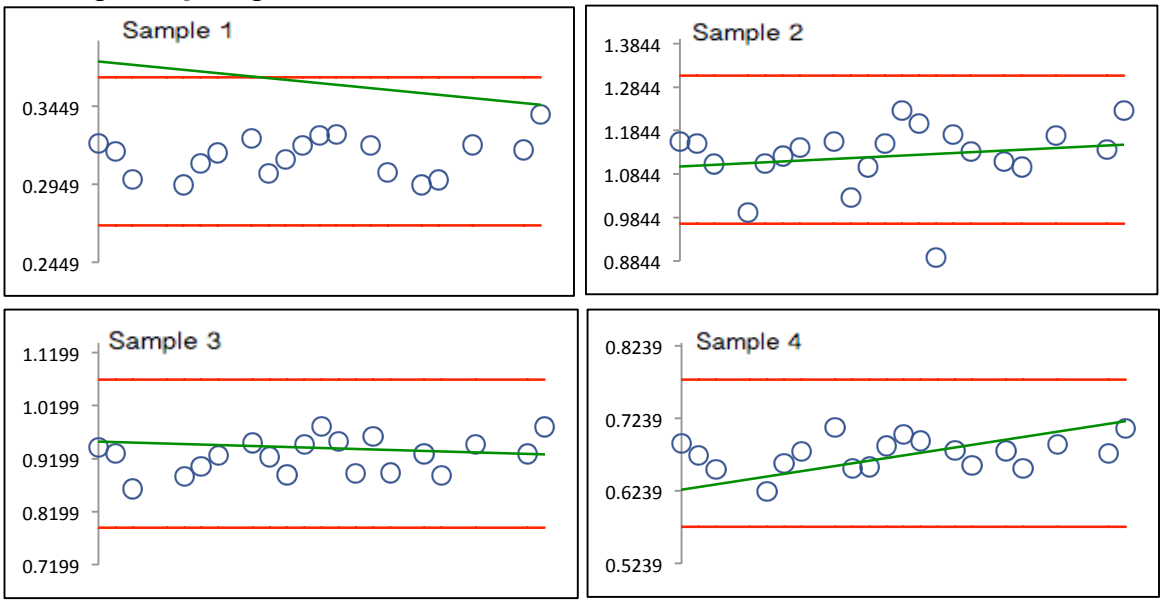
CHROMIUM

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

COBALT

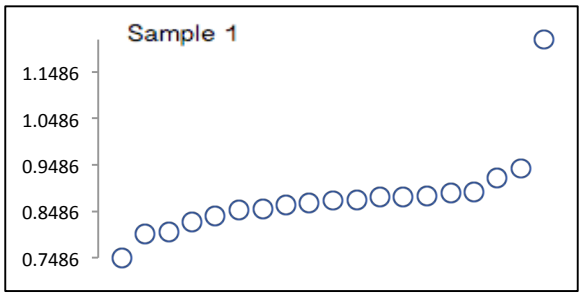
Summary Statistics

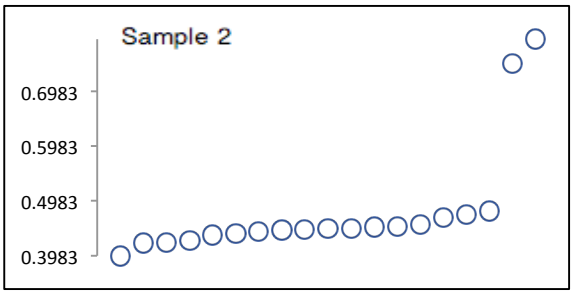
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	19	19	19	19
Median	0.872	0.448	0.749	1.14
Robust Mean	0.866	0.449	0.743	1.13
U	0.0132	0.0070	0.0086	0.0159
Robust Standard Deviation	0.0459	0.0245	0.0301	0.0555
Regression Standard Deviation	0.0649	0.0337	0.0558	0.0845
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0649	0.0337	0.0558	0.0845
Outliers	0	0	0	0
|z|>3.0	1	2	1	1
2<|z|<3	0	0	0	1

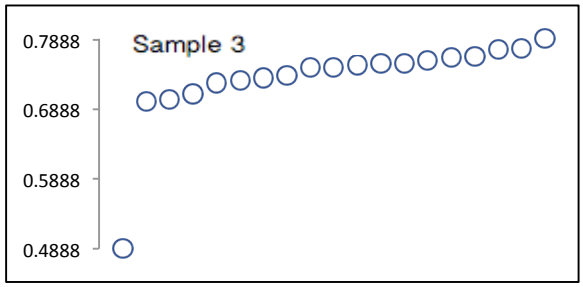
Methods Used

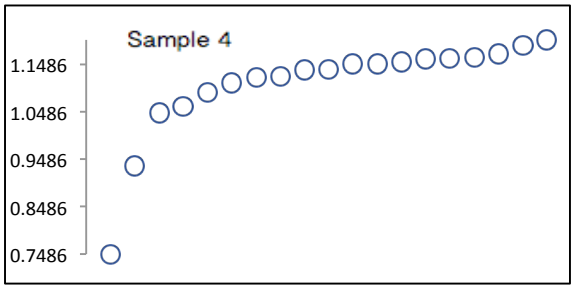
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	19	19	19	19

All summary stats and the plots below are based on the data excluding any flagged outliers



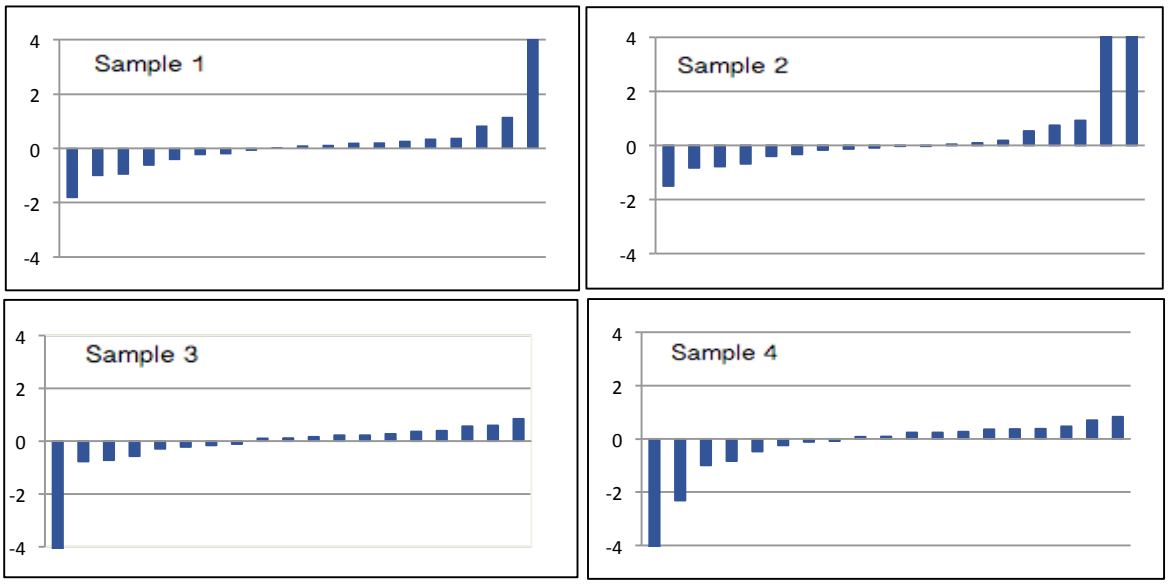




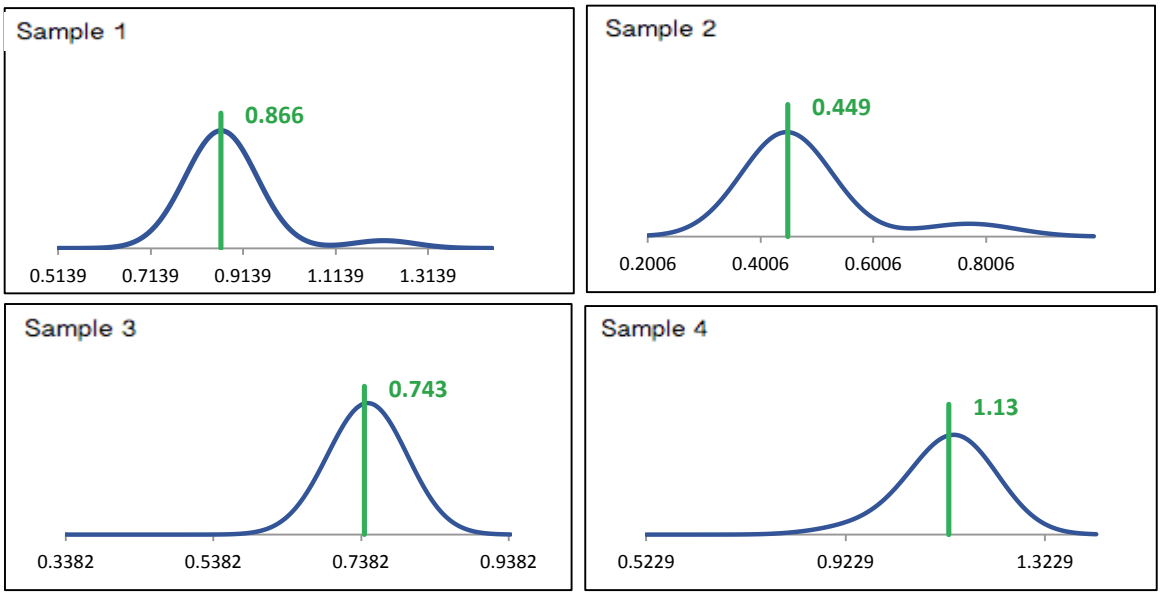


COBALT

z-Score Plots

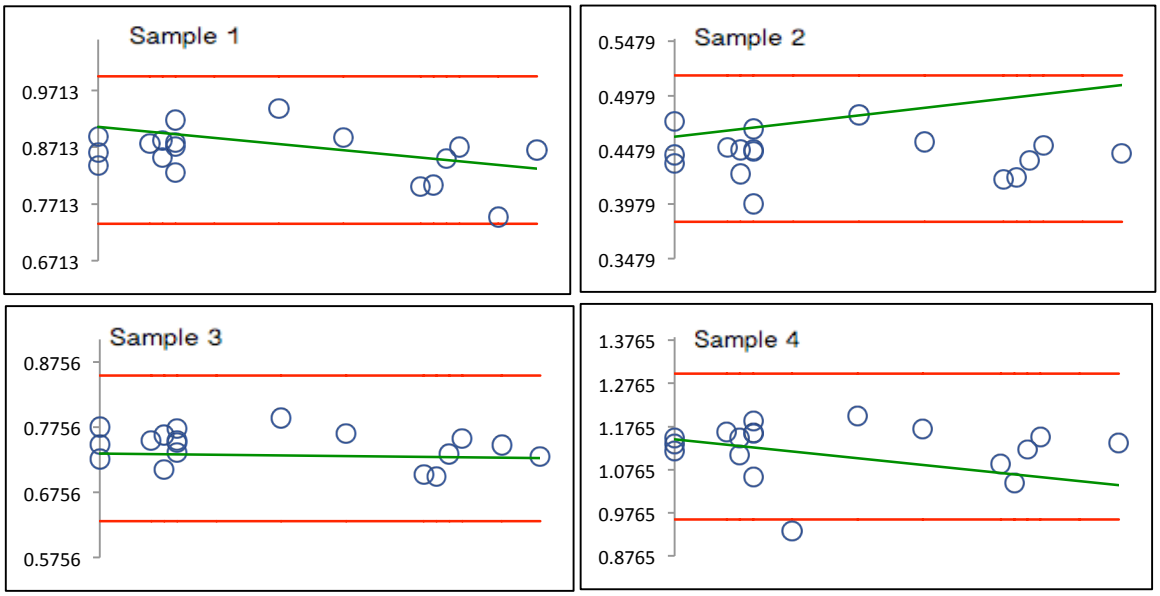


Kernel Density Plots



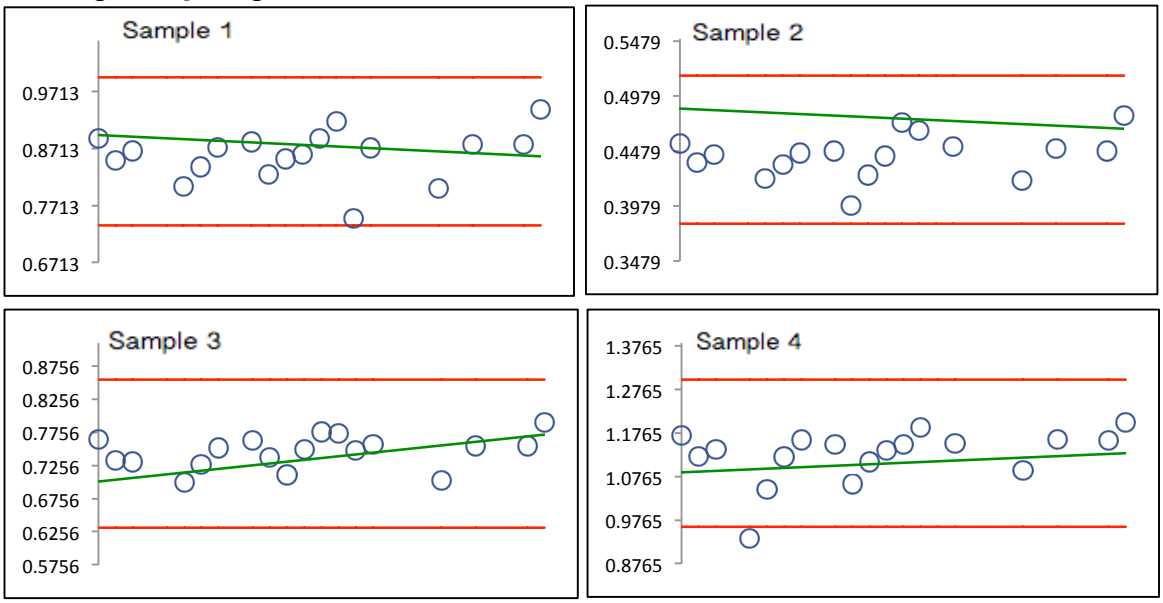
COBALT

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

COPPER

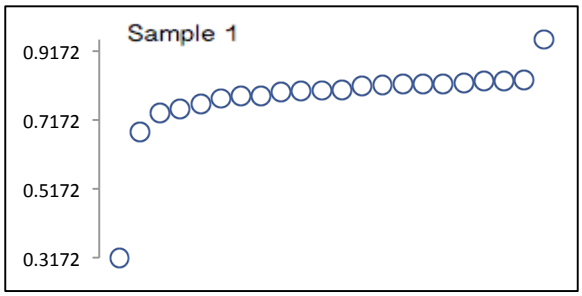
Summary Statistics

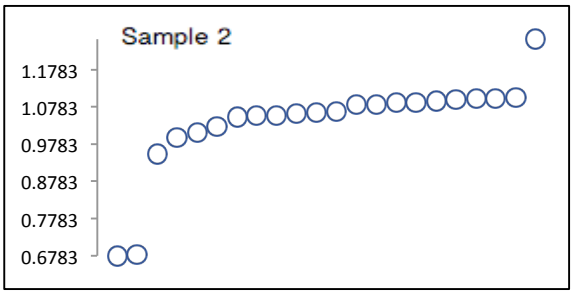
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	22	22	22	22
Median	0.804	1.06	0.629	0.282
Robust Mean	0.798	1.06	0.628	0.283
U	0.0100	0.0135	0.0076	0.0037
Robust Standard Deviation	0.0375	0.0508	0.0284	0.0140
Regression Standard Deviation	0.0599	0.0795	0.0471	0.0212
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0599	0.0795	0.0471	0.0212
Outliers	0	0	0	0
|z|>3.0	1	2	1	2
2<|z|<3	1	1	0	0

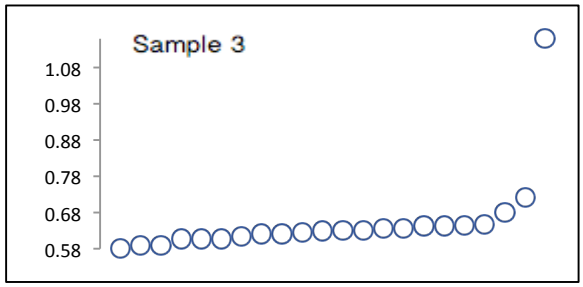
Methods Used

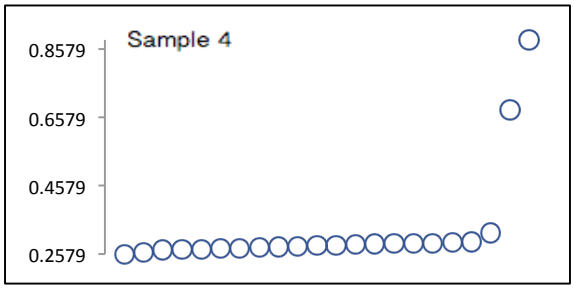
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	22	22	22	22

All summary stats and the plots below are based on the data excluding any flagged outliers



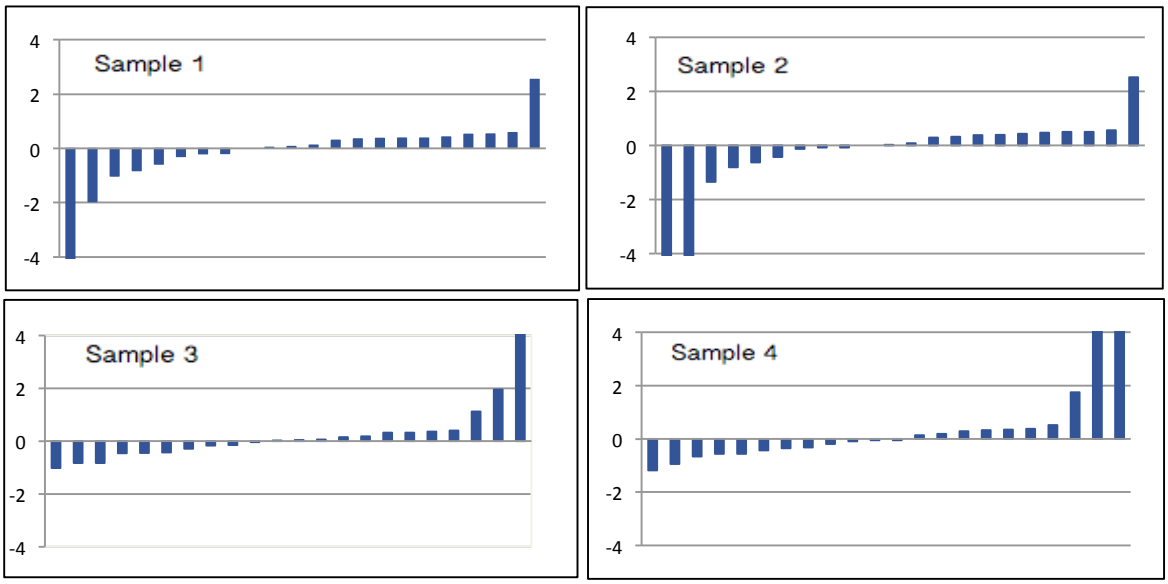




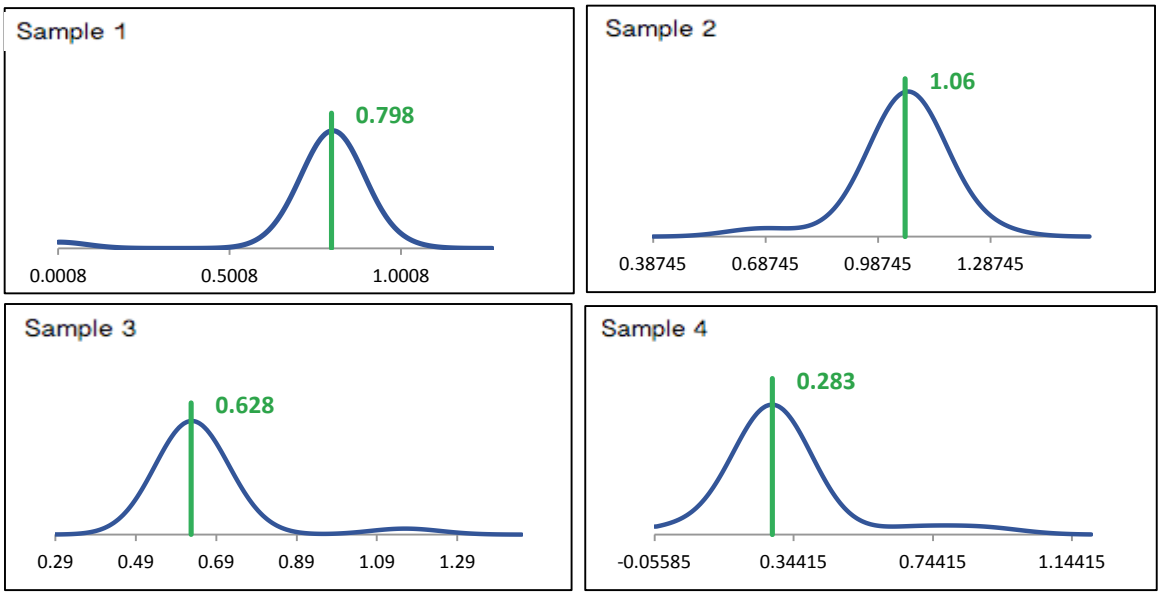


COPPER

z-Score Plots

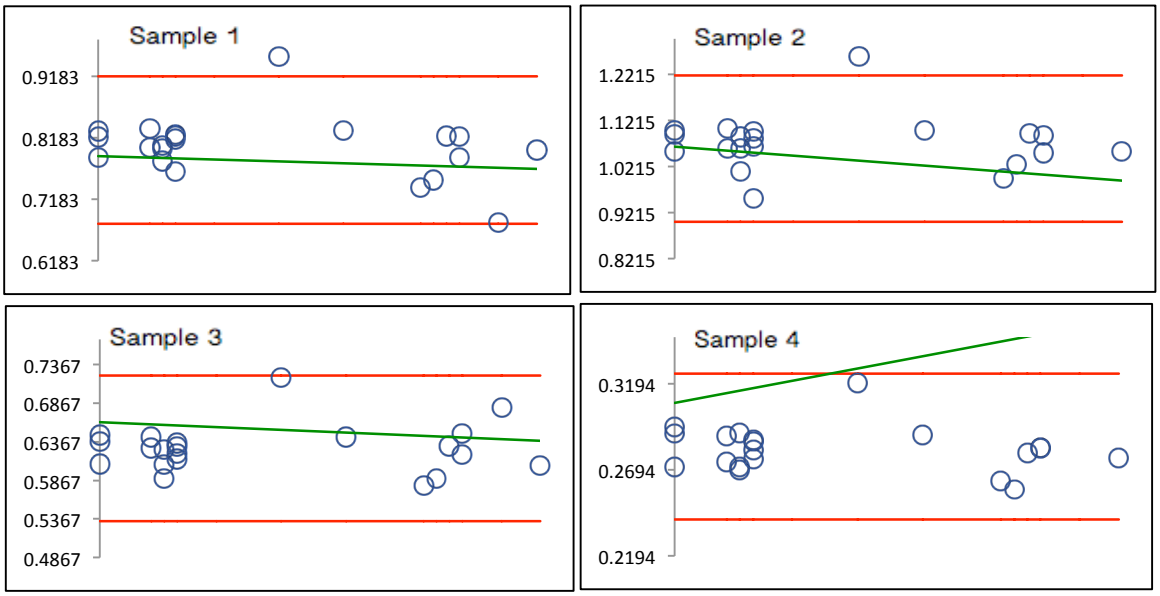


Kernel Density Plots



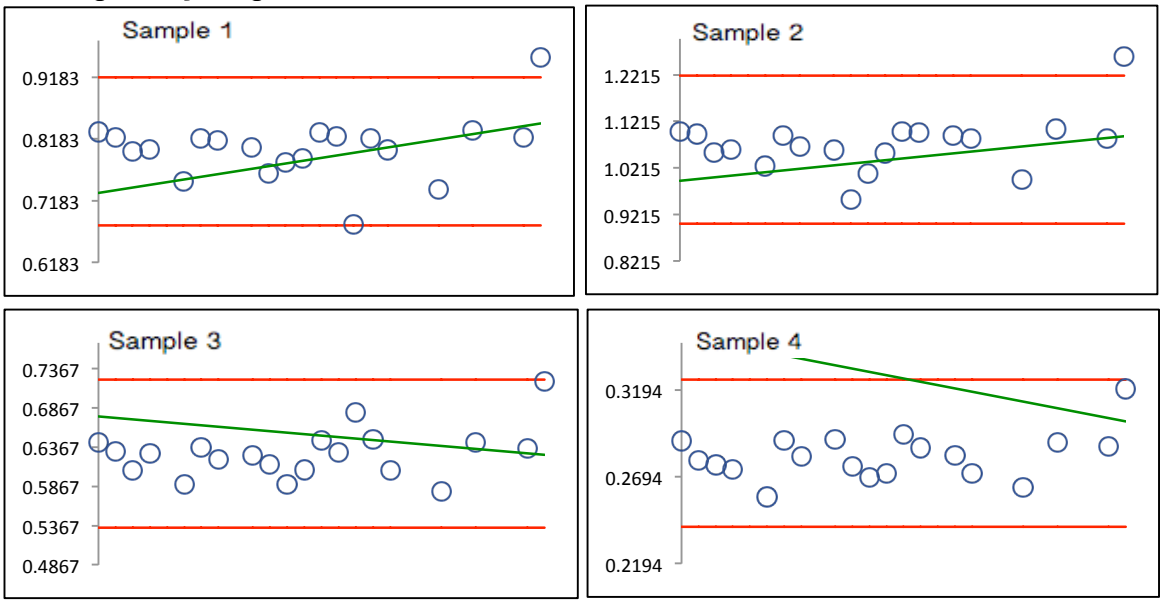
COPPER

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

IRON

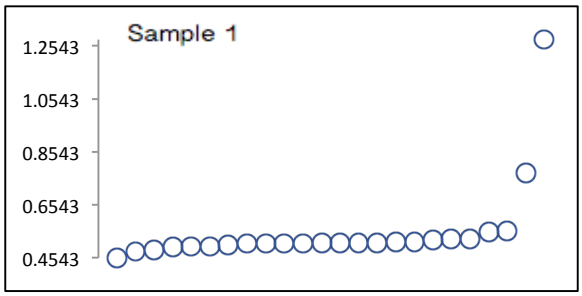
Summary Statistics

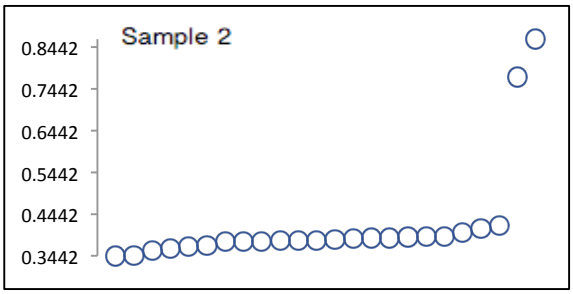
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	24	24	24	24
Median	0.510	0.382	0.822	1.20
Robust Mean	0.512	0.383	0.821	1.20
U	0.0058	0.0053	0.0090	0.0138
Robust Standard Deviation	0.0226	0.0209	0.0353	0.0542
Regression Standard Deviation	0.0384	0.0287	0.0616	0.0899
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0384	0.0287	0.0616	0.0899
Outliers	1	1	1	1
|z|>3.0	2	2	1	2
2<|z|<3	0	0	0	0

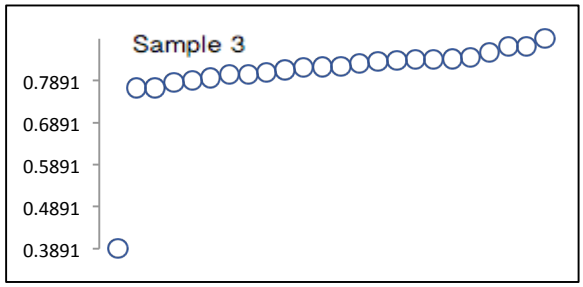
Methods Used

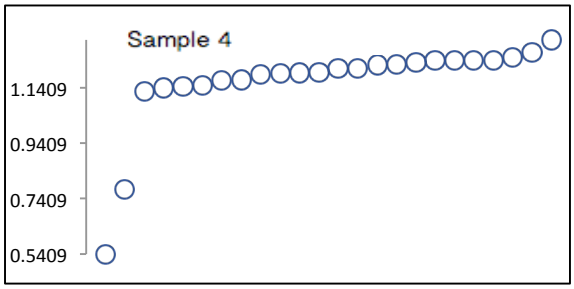
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	23	23	23	23
COLOR	1	1	1	1

All summary stats and the plots below are based on the data excluding any flagged outliers



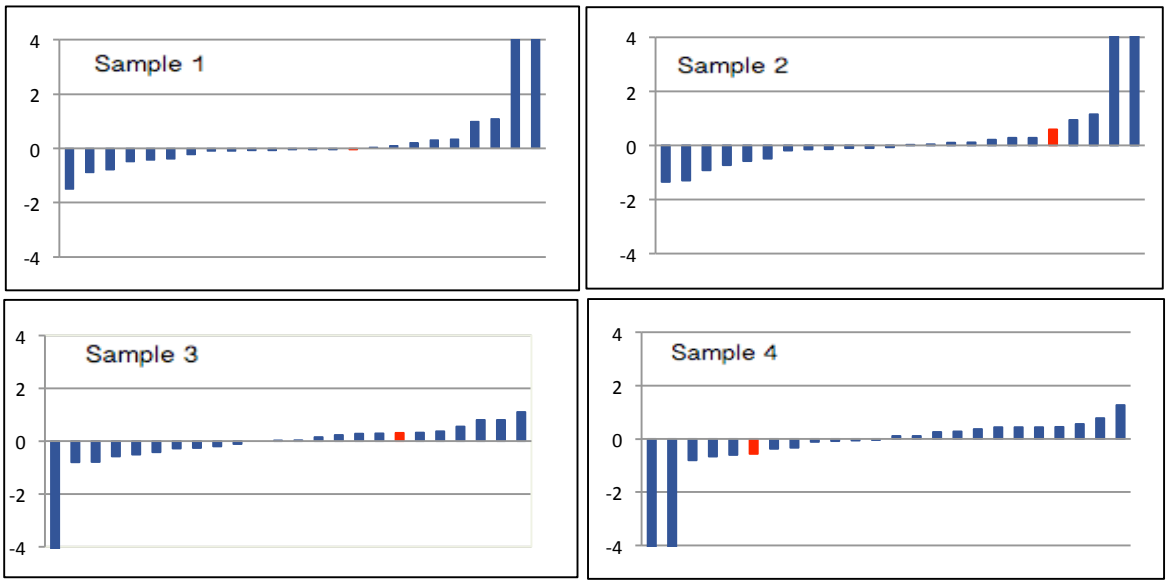




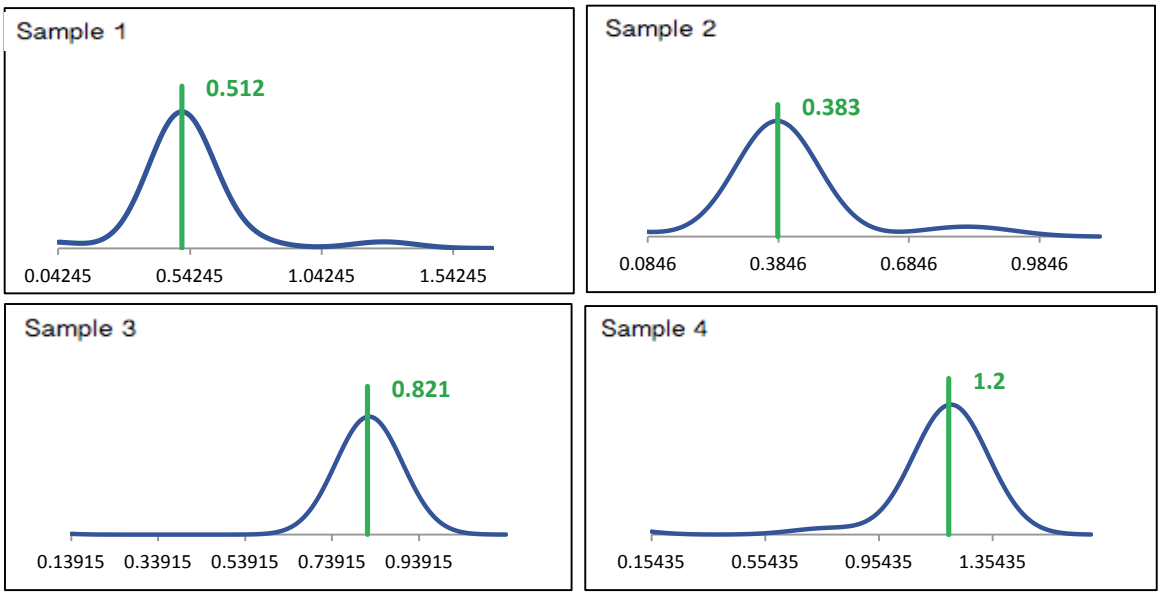


IRON

z-Score Plots

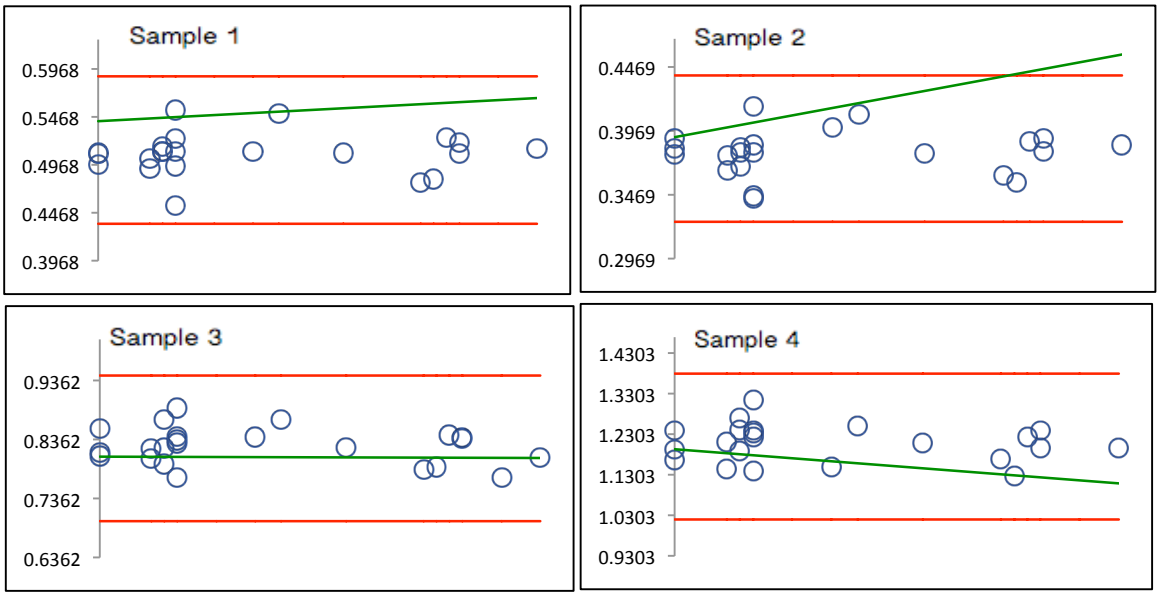


Kernel Density Plots



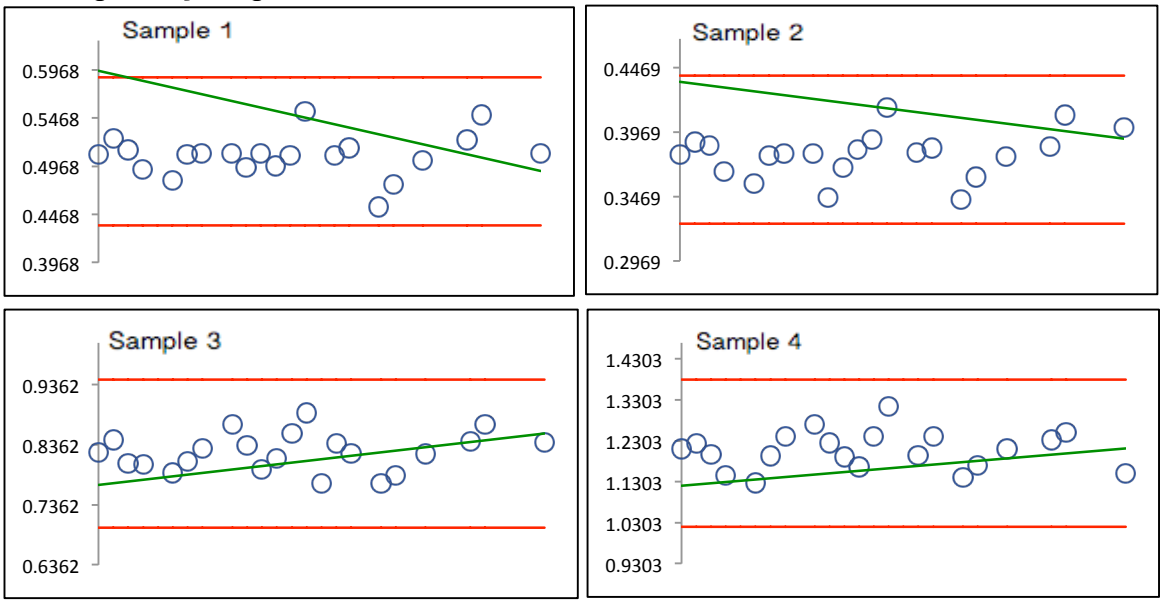
IRON

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

LEAD

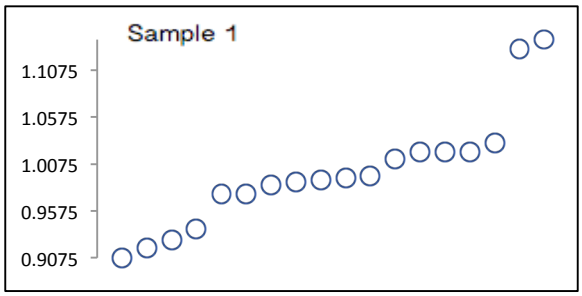
Summary Statistics

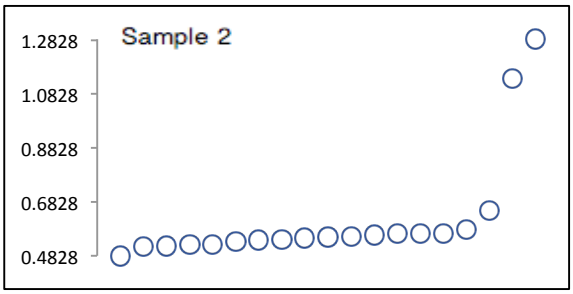
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	18	19	18	17
Median	0.992	0.553	1.23	0.487
Robust Mean	0.991	0.553	1.22	0.486
U	0.0153	0.0100	0.0161	0.0052
Robust Standard Deviation	0.0519	0.0350	0.0545	0.0172
Regression Standard Deviation	0.0743	0.0415	0.0913	0.0365
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0743	0.0415	0.0913	0.0365
Outliers	1	0	1	2
|z|>3.0	0	2	0	0
2<|z|<3	1	1	0	0

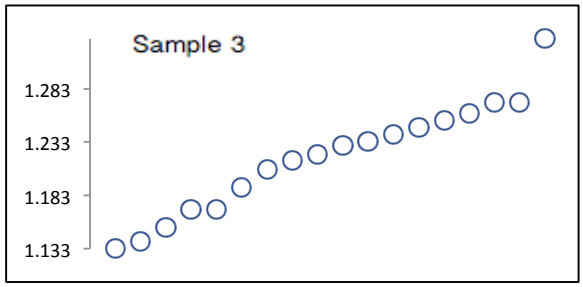
Methods Used

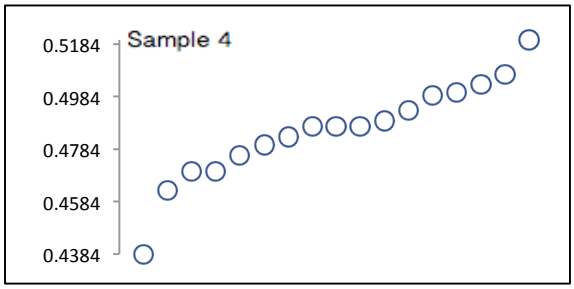
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	17	18	17	16
ICP/MS	1	1	1	1

All summary stats and the plots below are based on the data excluding any flagged outliers



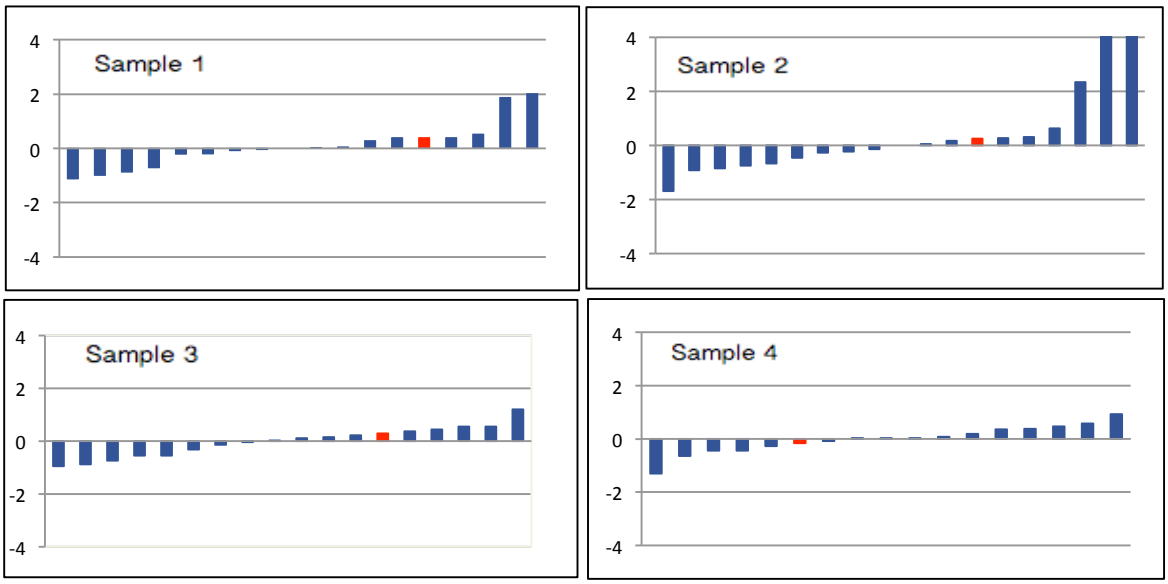




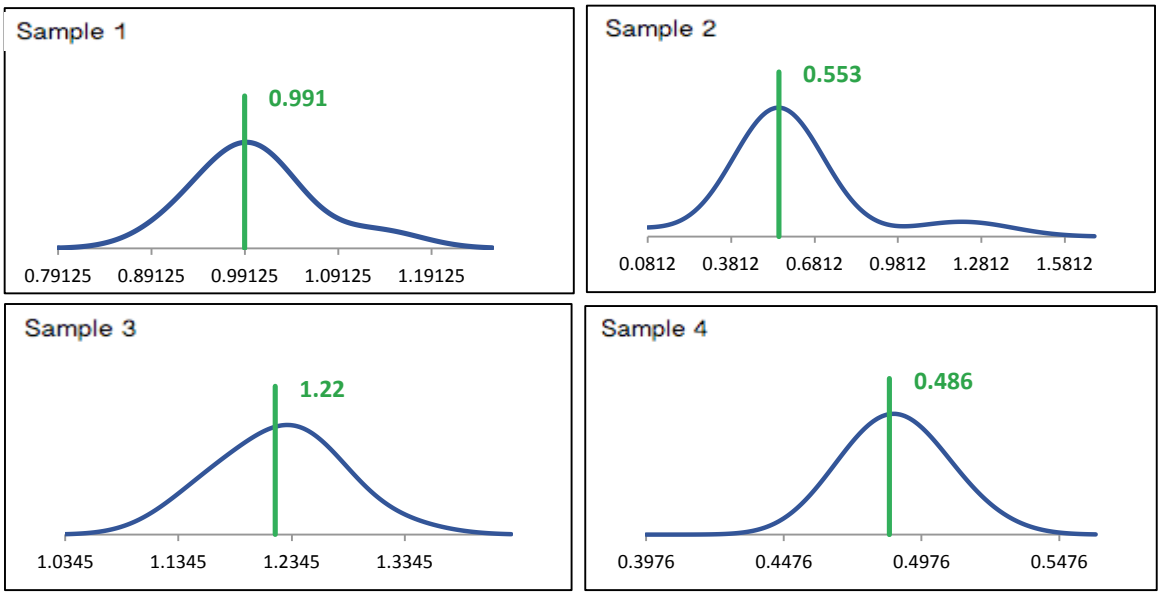


LEAD

z-Score Plots

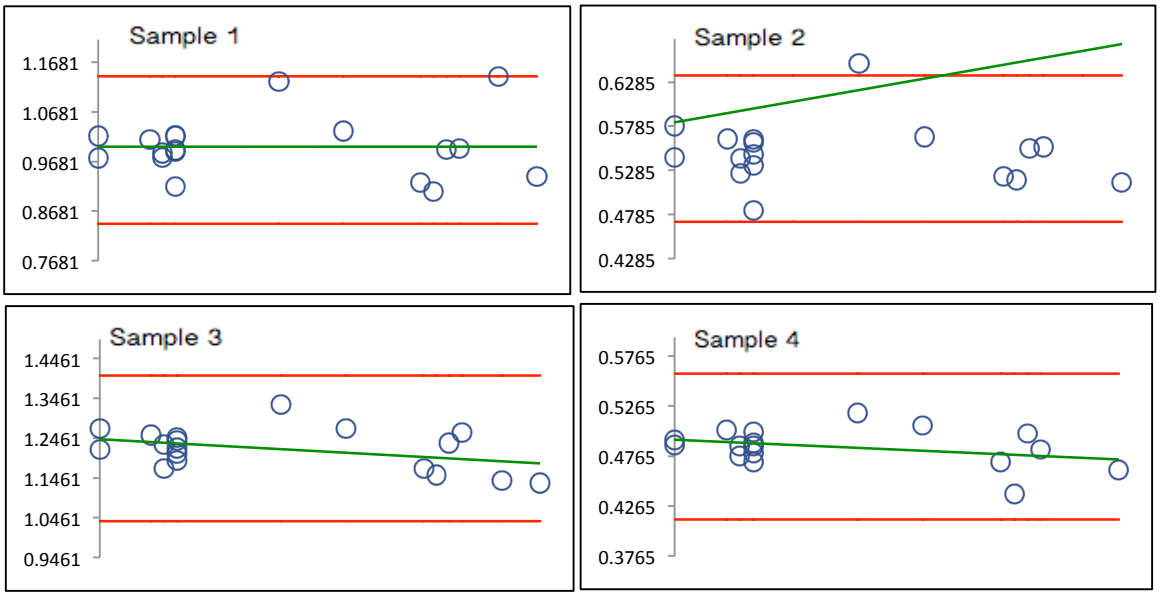


Kernel Density Plots



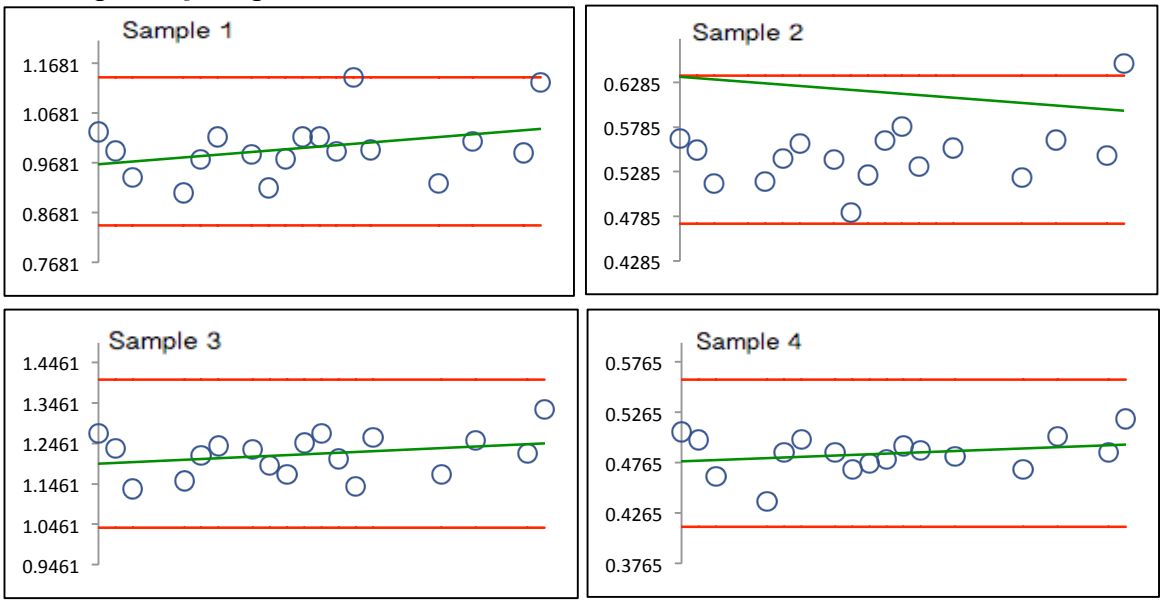
LEAD

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

MANGANESE

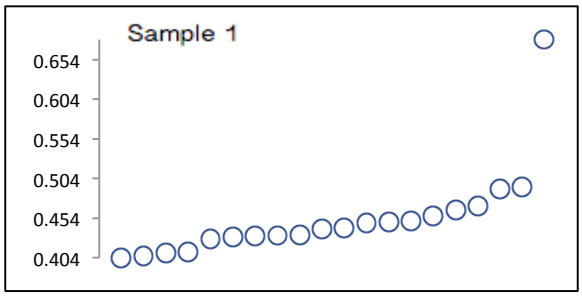
Summary Statistics

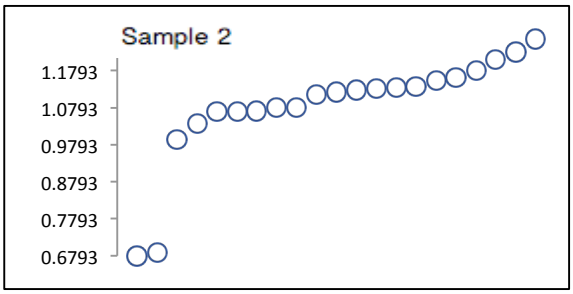
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	20	21	20	20
Median	0.441	1.12	0.642	0.834
Robust Mean	0.444	1.11	0.645	0.837
U	0.0085	0.0230	0.0097	0.0126
Robust Standard Deviation	0.0305	0.0842	0.0346	0.0450
Regression Standard Deviation	0.0333	0.0832	0.0484	0.0627
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0333	0.0842	0.0484	0.0627
Outliers	1	0	1	1
|z|>3.0	1	2	0	0
2<|z|<3	0	0	0	1

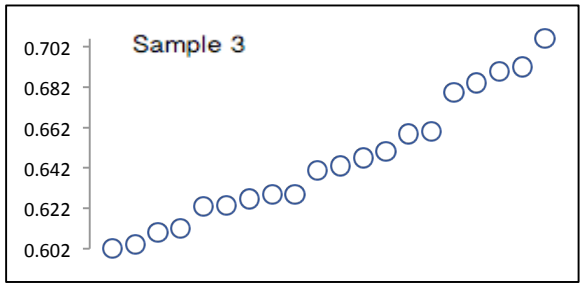
Methods Used

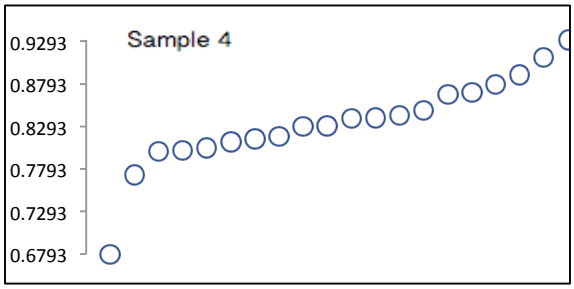
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	20	21	20	20

All summary stats and the plots below are based on the data excluding any flagged outliers



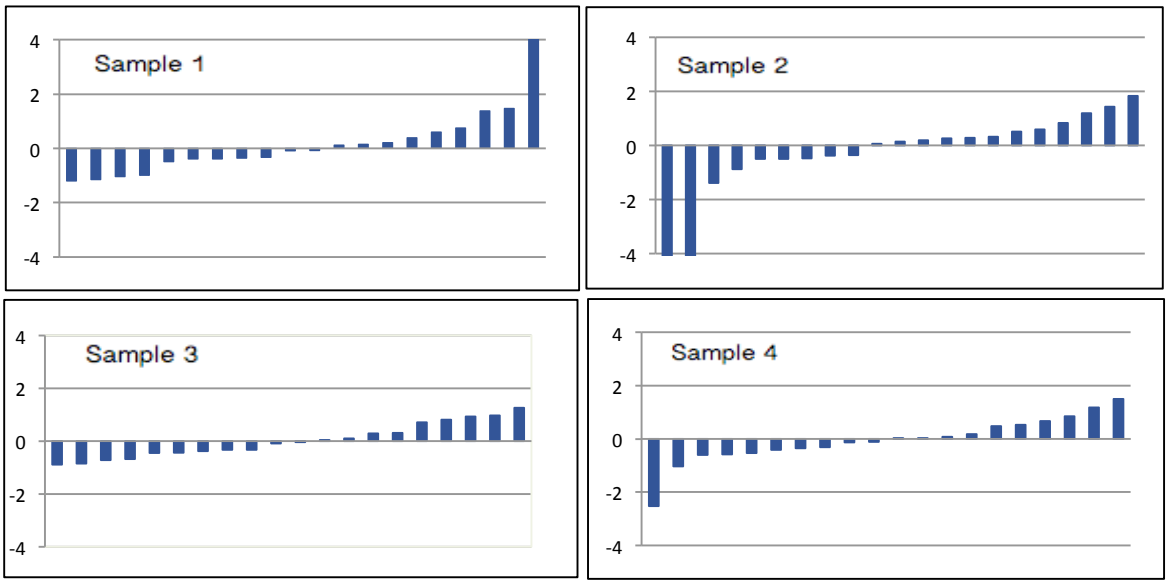




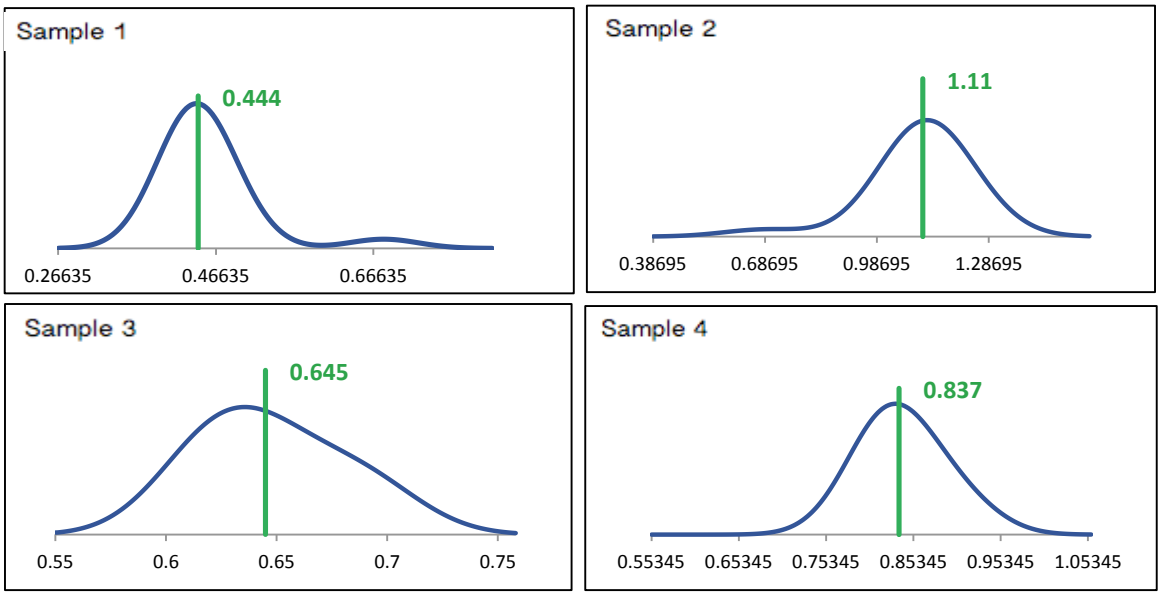


MANGANESE

z-Score Plots

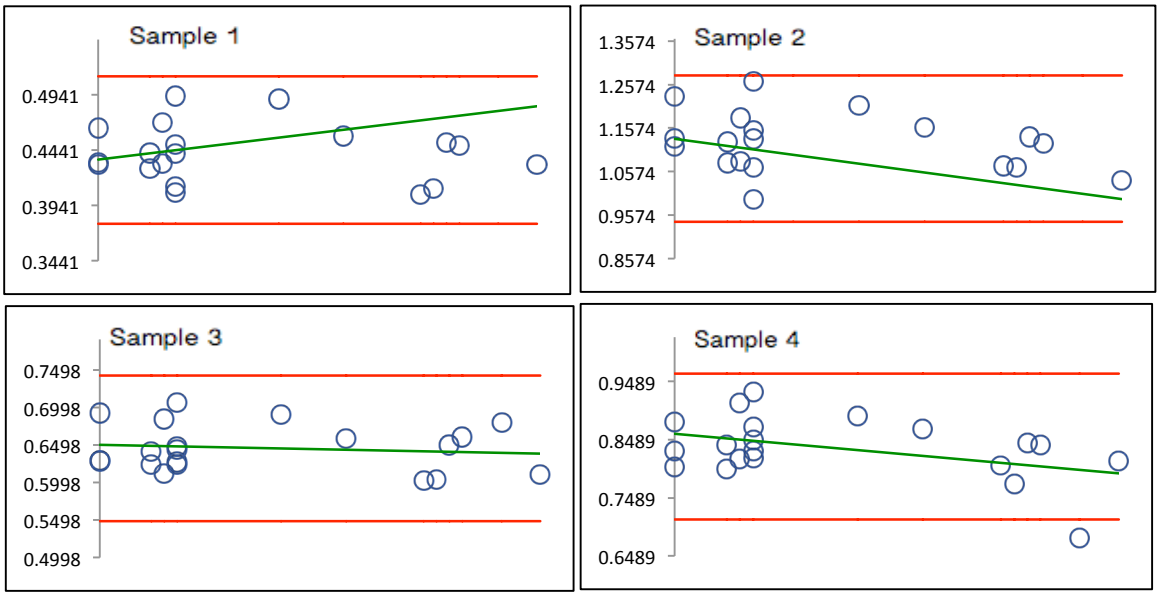


Kernel Density Plots



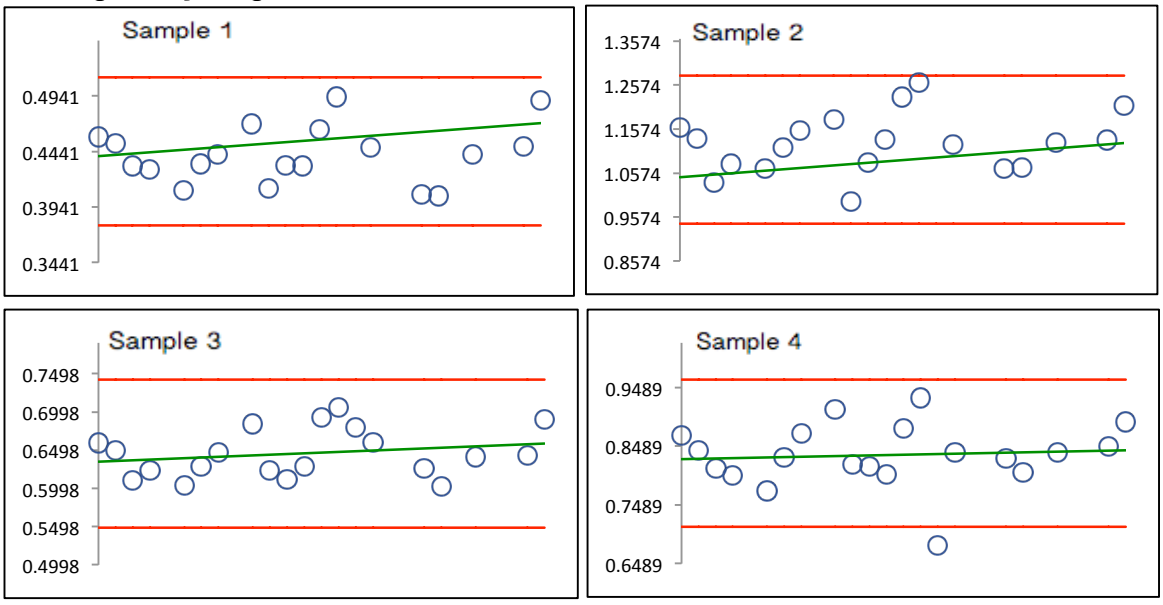
MANGANESE

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

MOLYBDENUM

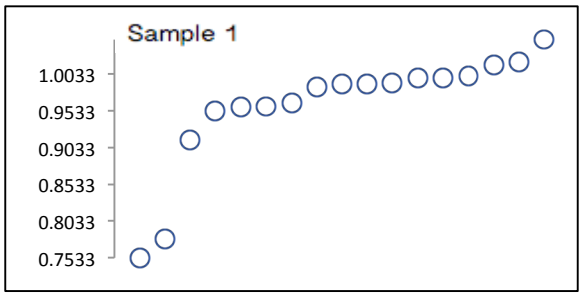
Summary Statistics

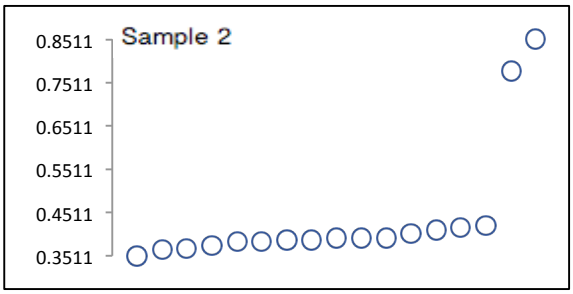
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	17	17	16	17
Median	0.990	0.392	0.787	0.698
Robust Mean	0.976	0.394	0.783	0.697
U	0.0132	0.0077	0.0093	0.0067
Robust Standard Deviation	0.0436	0.0254	0.0299	0.0222
Regression Standard Deviation	0.0732	0.0295	0.0587	0.0523
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0732	0.0295	0.0587	0.0523
Outliers	0	0	1	0
|z|>3.0	1	2	0	1
2<|z|<3	1	0	0	0

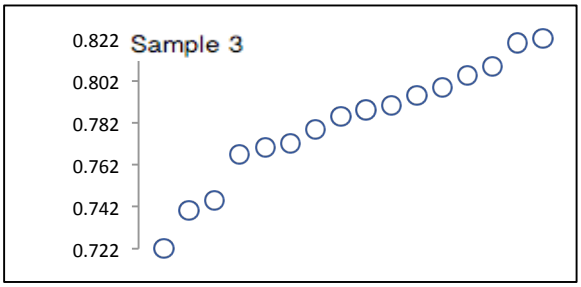
Methods Used

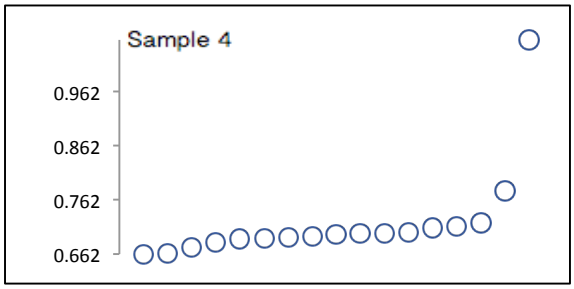
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	17	17	16	17

All summary stats and the plots below are based on the data excluding any flagged outliers



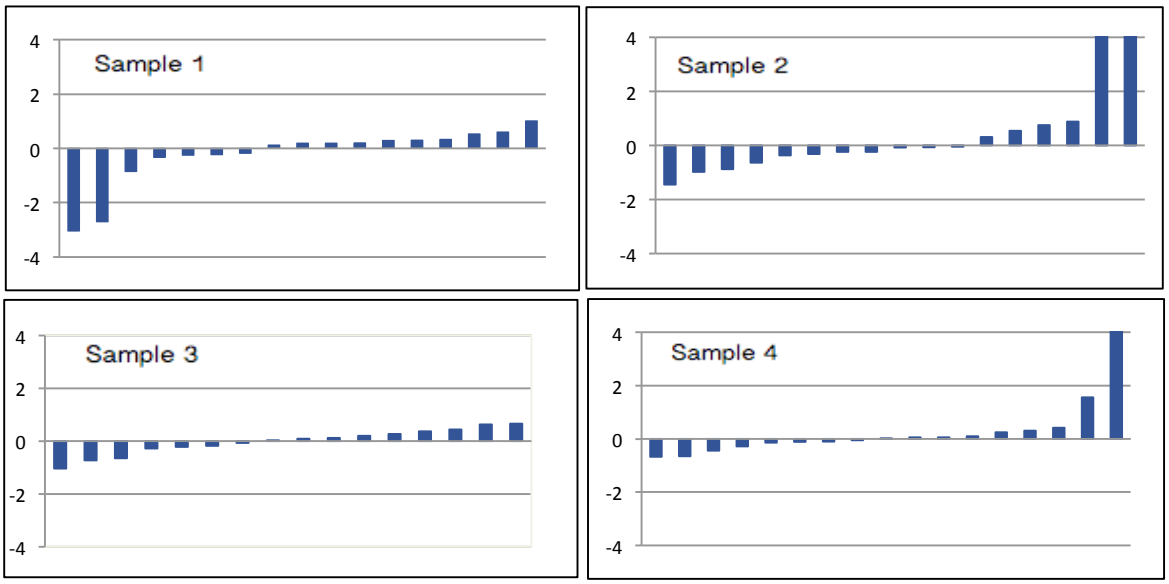




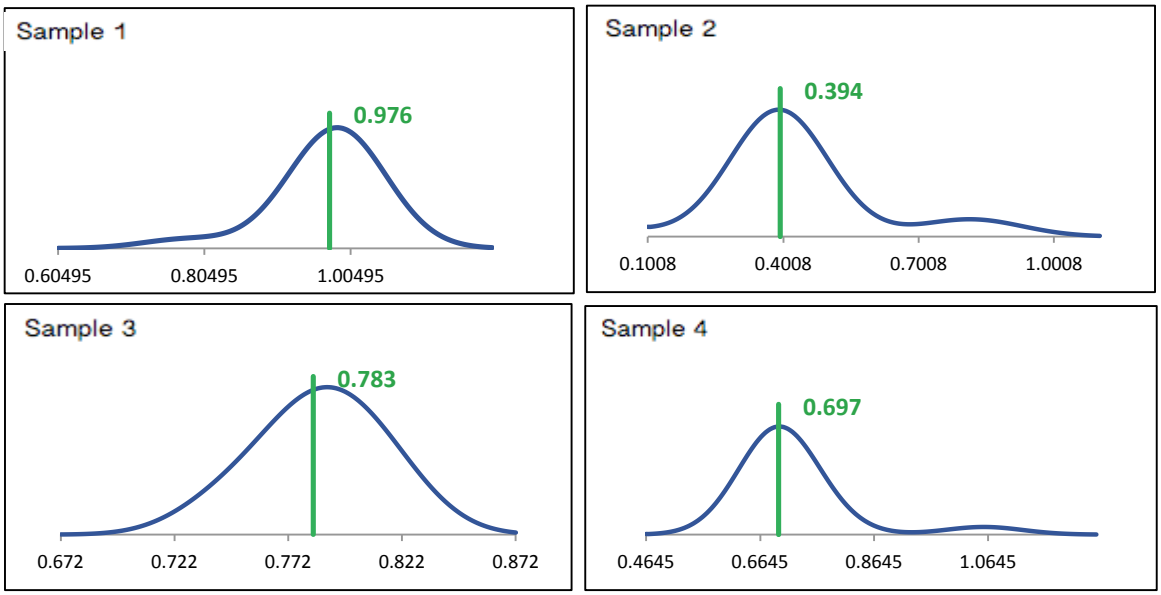


MOLYBDENUM

z-Score Plots

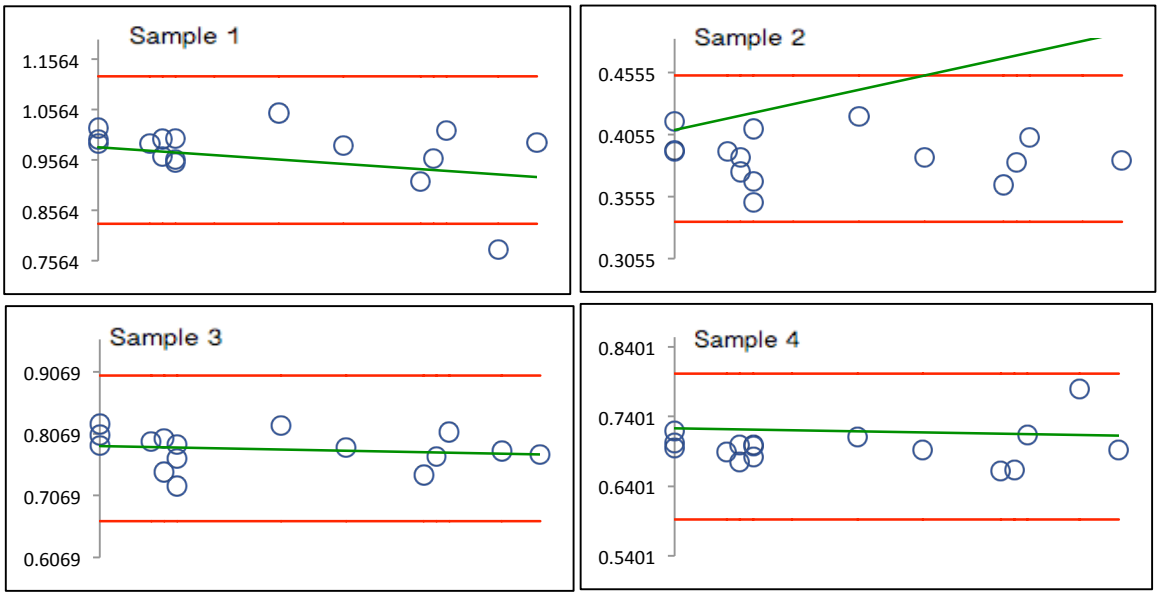


Kernel Density Plots



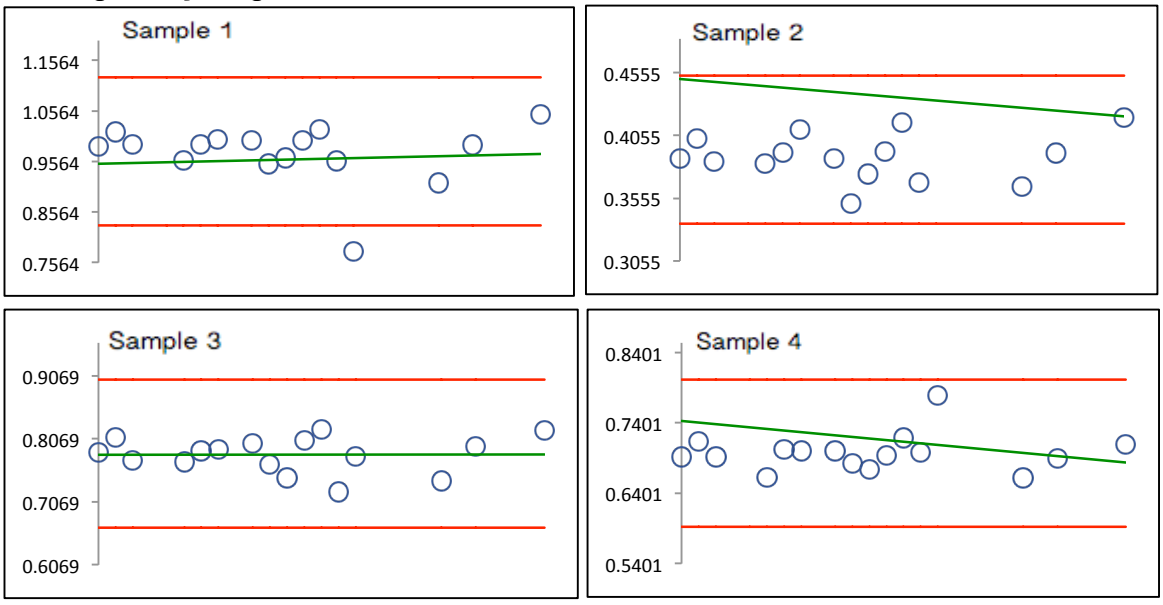
MOLYBDENUM

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

NICKEL

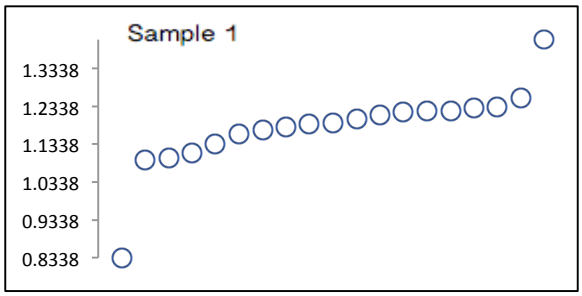
Summary Statistics

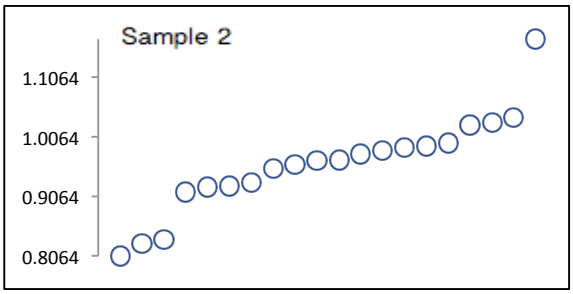
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	19	20	20	19
Median	1.19	0.966	0.762	0.424
Robust Mean	1.18	0.960	0.759	0.423
U	0.0184	0.0184	0.0131	0.0066
Robust Standard Deviation	0.0641	0.0658	0.0467	0.0229
Regression Standard Deviation	0.0887	0.0720	0.0569	0.0318
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0887	0.0720	0.0569	0.0318
Outliers	1	0	0	1
|z|>3.0	1	0	1	1
2<|z|<3	1	2	0	0

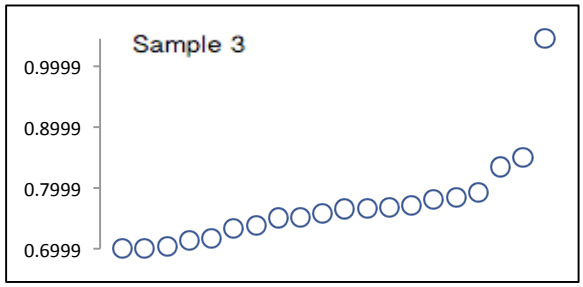
Methods Used

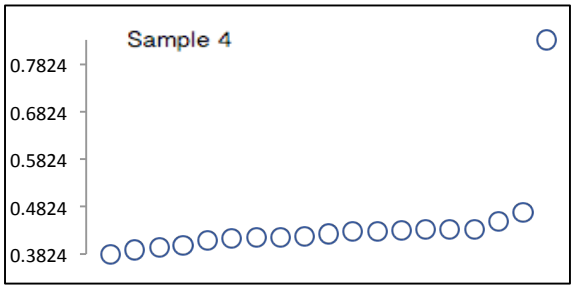
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	19	20	20	19

All summary stats and the plots below are based on the data excluding any flagged outliers



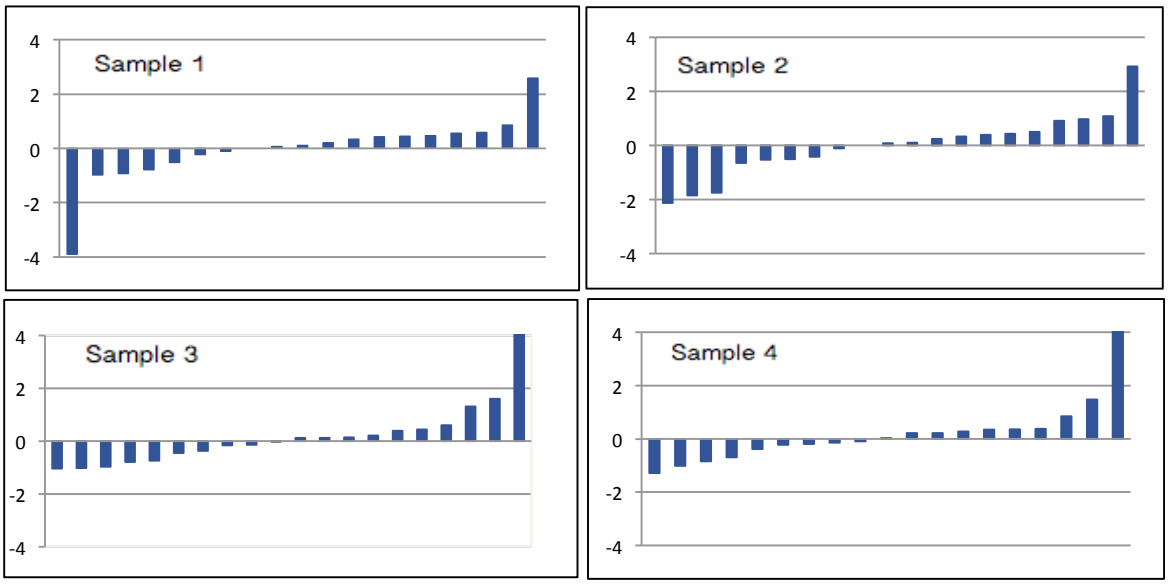




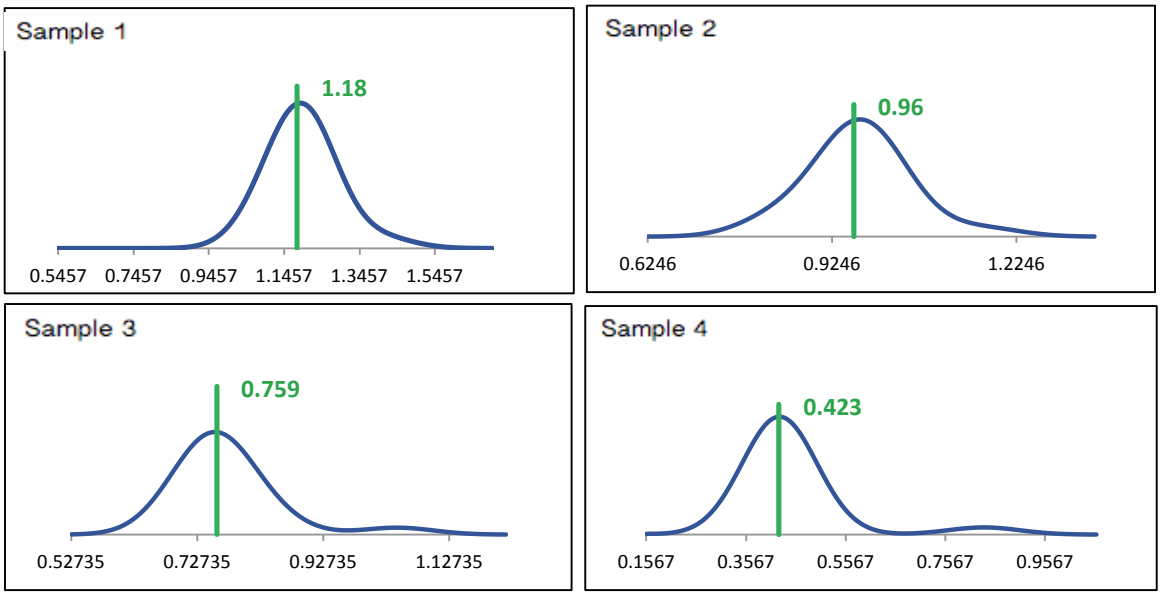


NICKEL

z-Score Plots

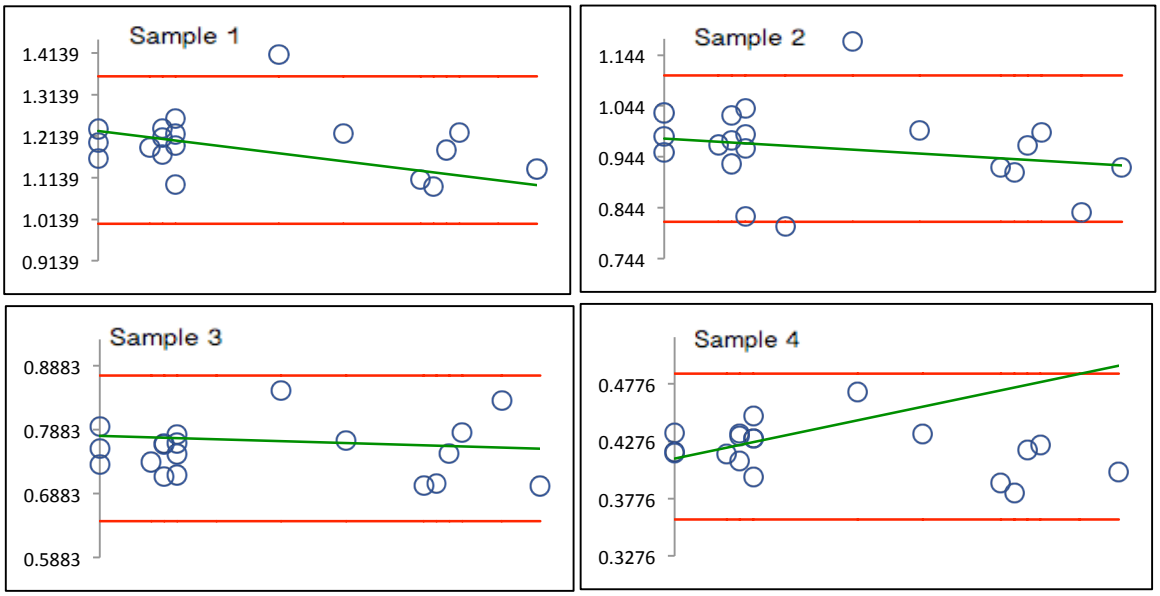


Kernel Density Plots



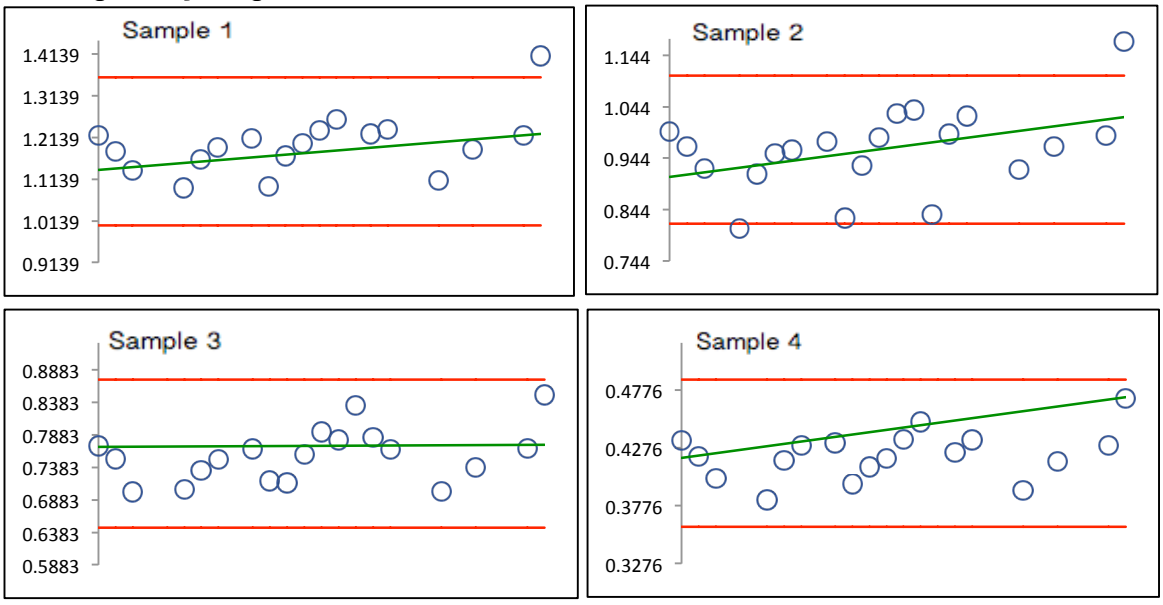
NICKEL

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

STRONTIUM

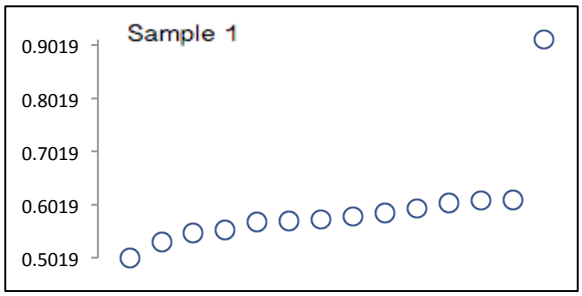
Summary Statistics

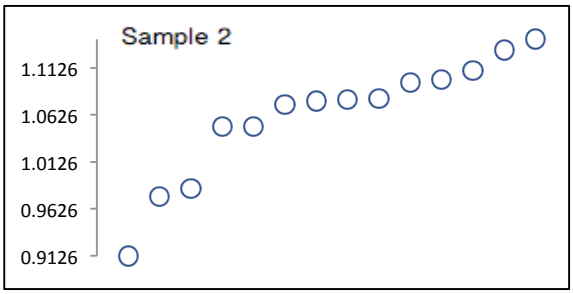
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	14	14	14	14
Median	0.577	1.08	0.861	0.431
Robust Mean	0.578	1.07	0.868	0.433
U	0.0118	0.0207	0.0128	0.0070
Robust Standard Deviation	0.0353	0.0619	0.0383	0.0210
Regression Standard Deviation	0.0433	0.0799	0.0651	0.0325
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0433	0.0799	0.0651	0.0325
Outliers	1	1	1	1
|z|>3.0	1	0	1	2
2<|z|<3	0	0	0	0

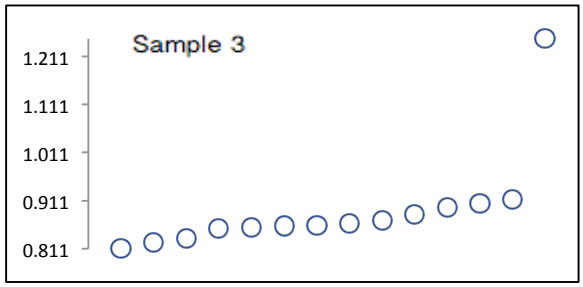
Methods Used

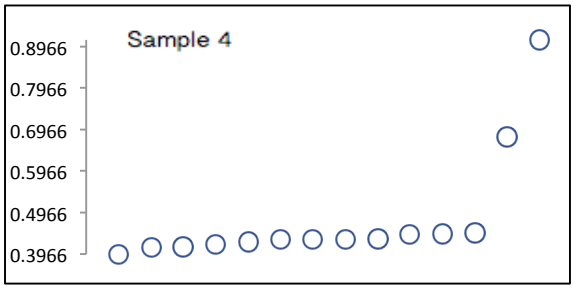
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	14	14	14	14

All summary stats and the plots below are based on the data excluding any flagged outliers



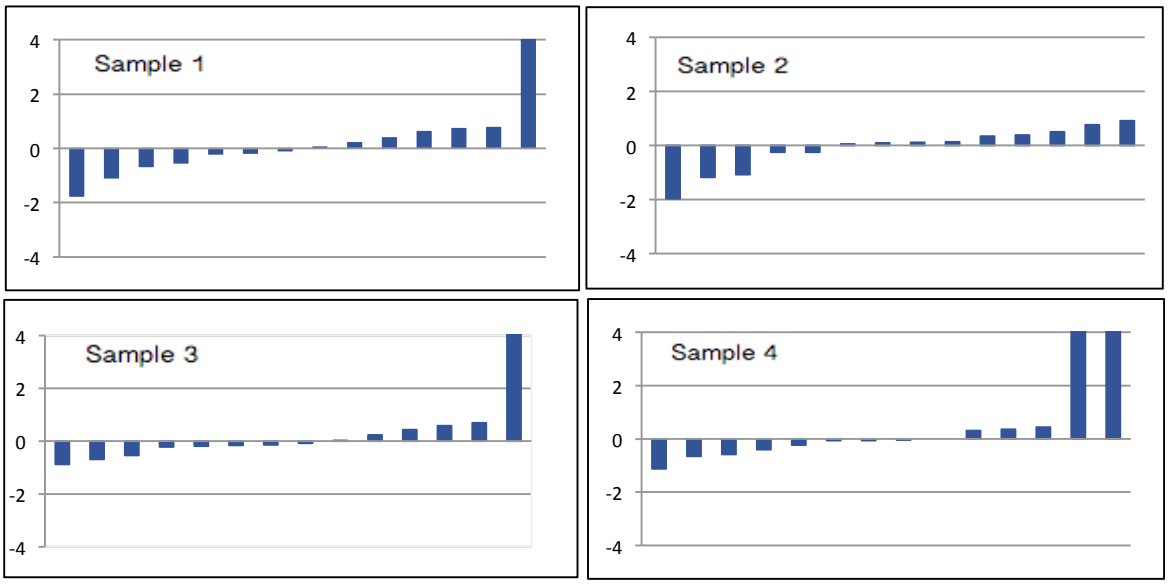




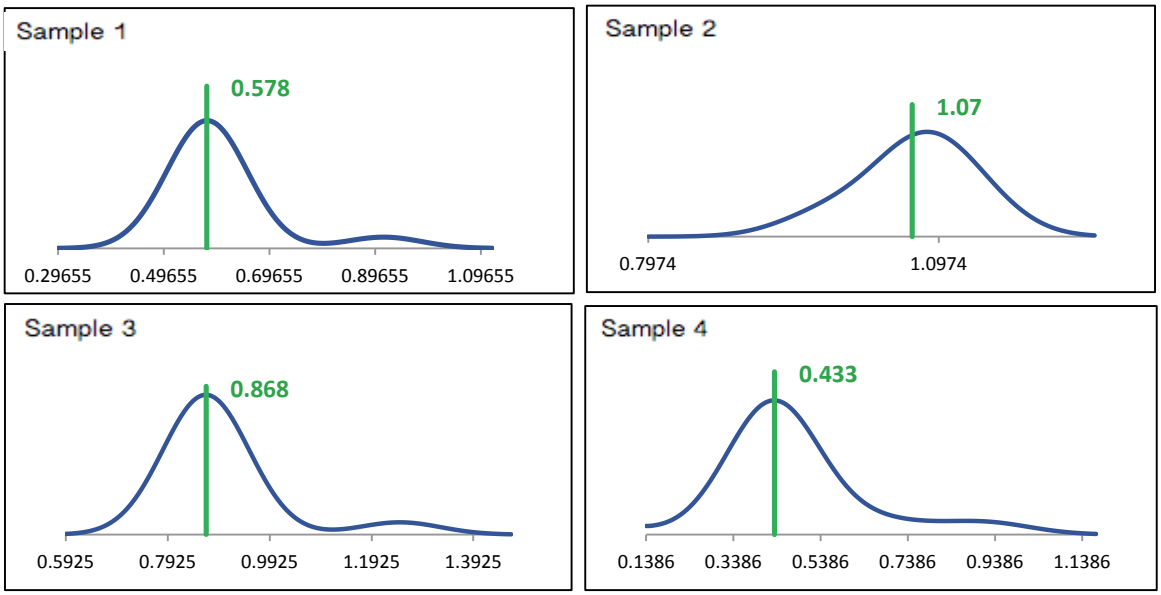


STRONTIUM

z-Score Plots

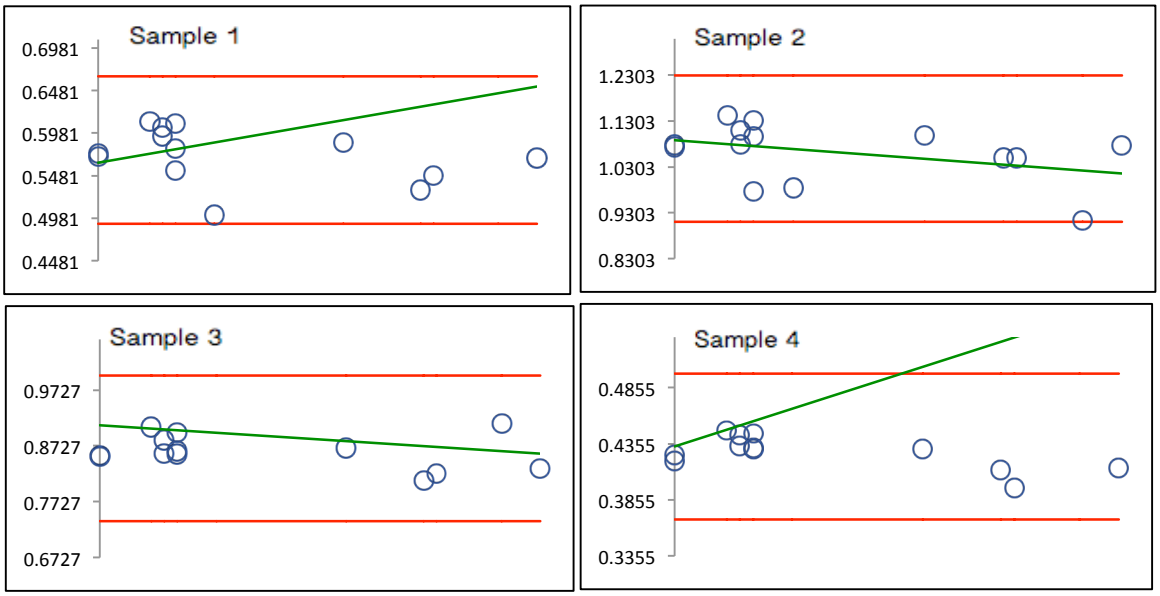


Kernel Density Plots



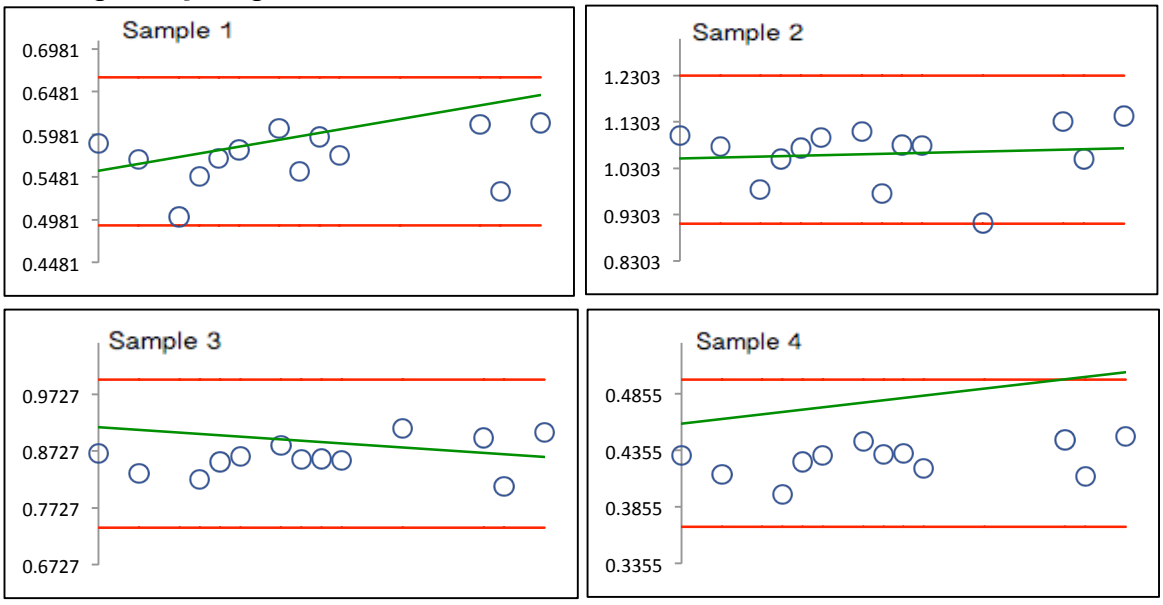
STRONTIUM

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

THALLIUM

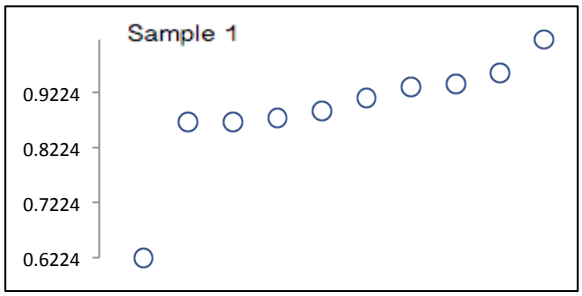
Summary Statistics

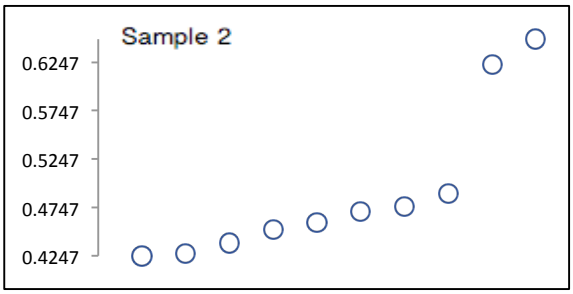
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	10	10	10	10
Median	0.900	0.465	0.608	0.902
Robust Mean	0.905	0.474	0.611	0.904
U	0.0225	0.0208	0.0168	0.0197
Robust Standard Deviation	0.0570	0.0527	0.0425	0.0499
Regression Standard Deviation	0.0905	0.0474	0.0611	0.0904
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0905	0.0527	0.0611	0.0904
Outliers	0	0	0	0
|z|>3.0	1	1	1	1
2<|z|<3	0	1	0	0

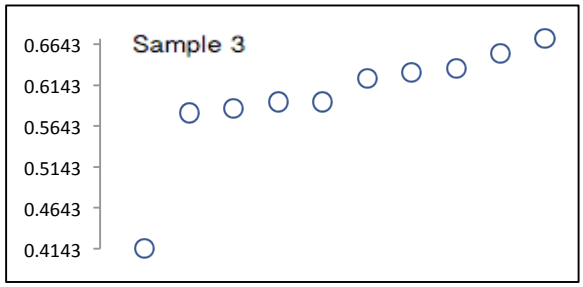
Methods Used

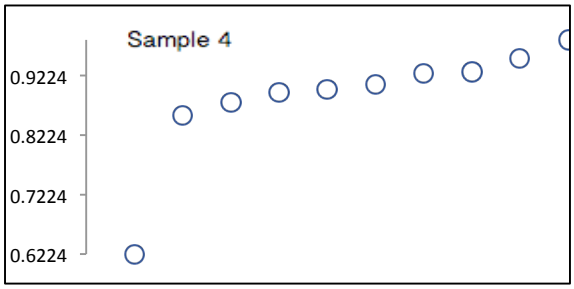
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	9	9	9	9
ICP/MS	1	1	1	1

All summary stats and the plots below are based on the data excluding any flagged outliers



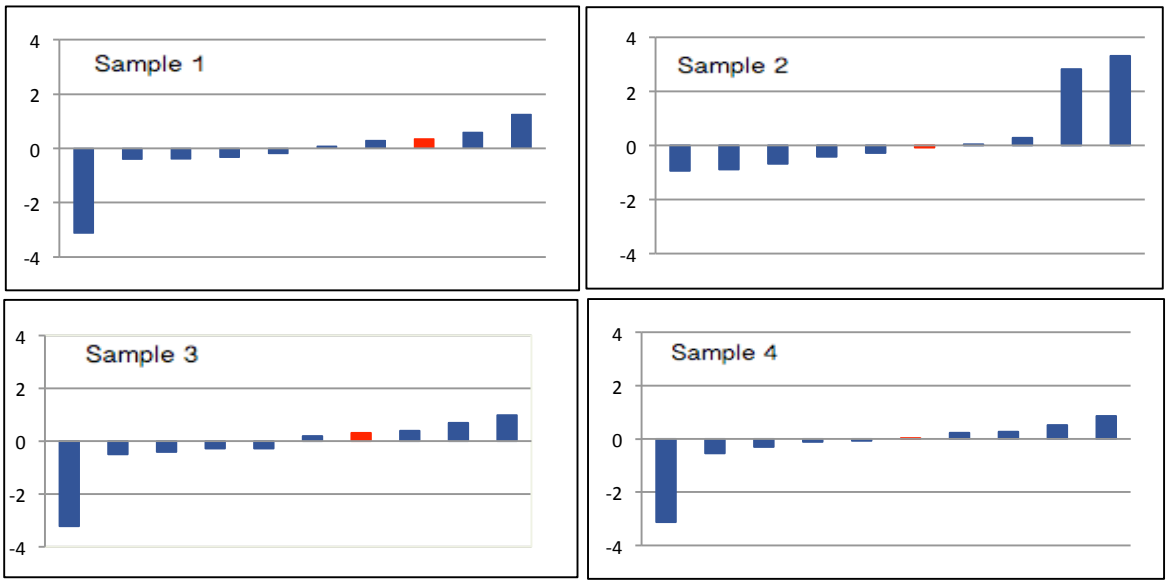




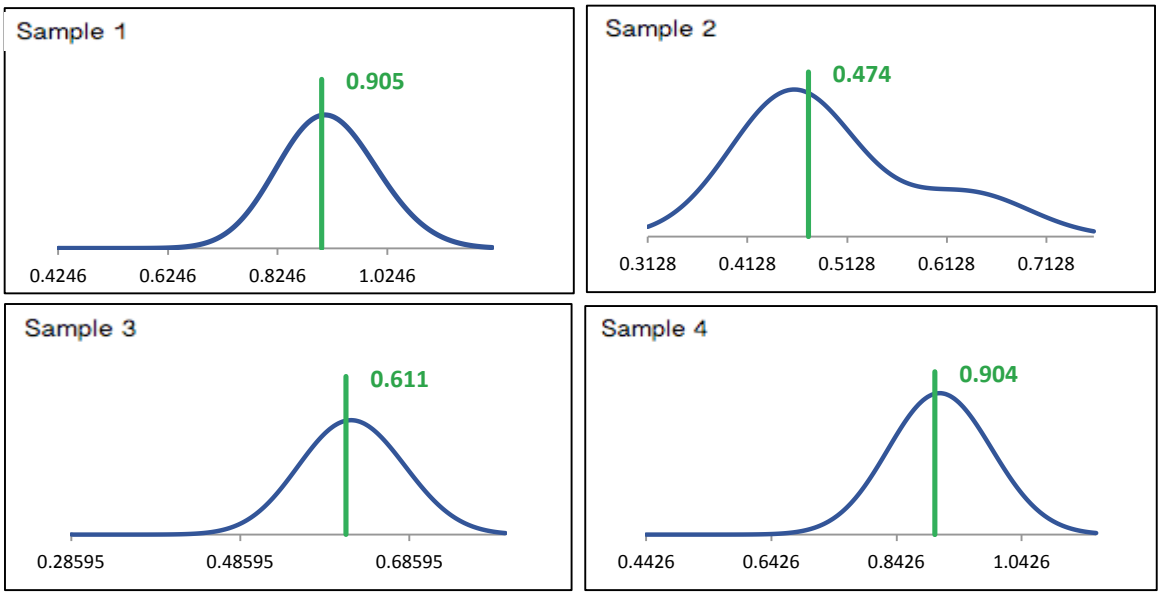


THALLIUM

z-Score Plots

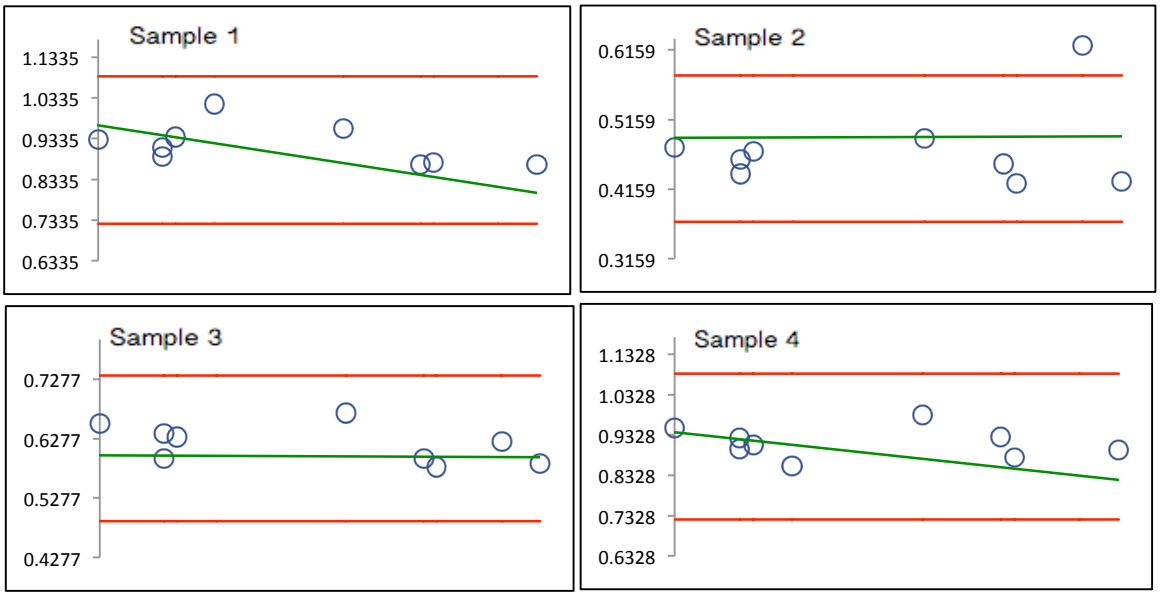


Kernel Density Plots



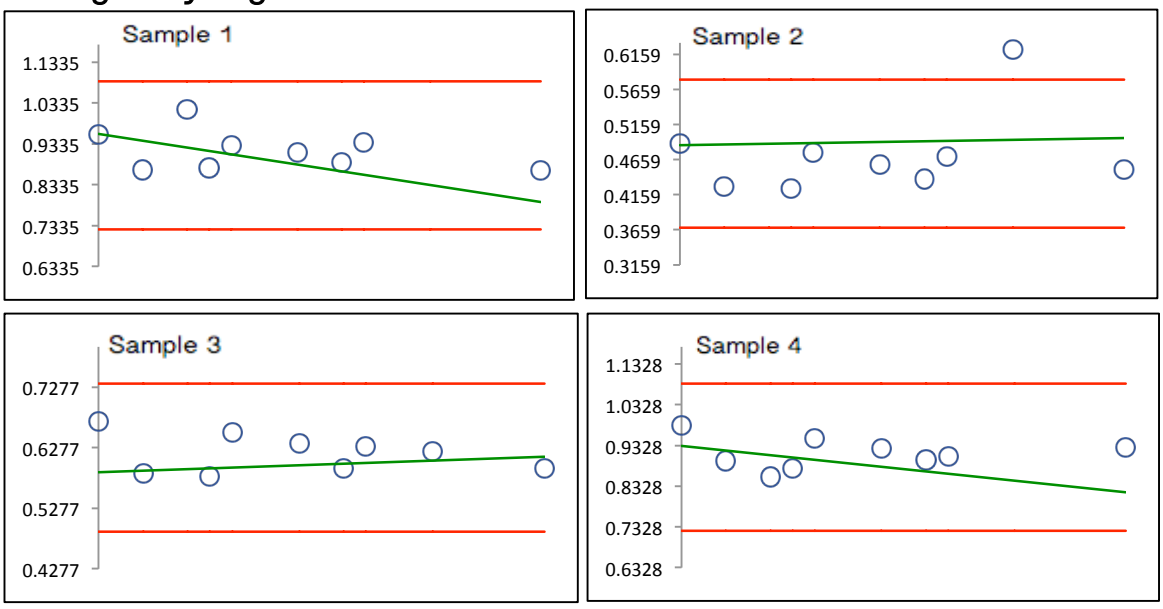
THALLIUM

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

TITANIUM

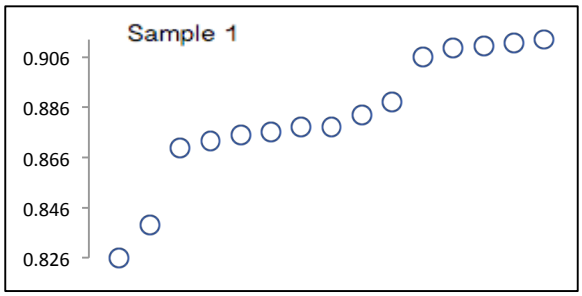
Summary Statistics

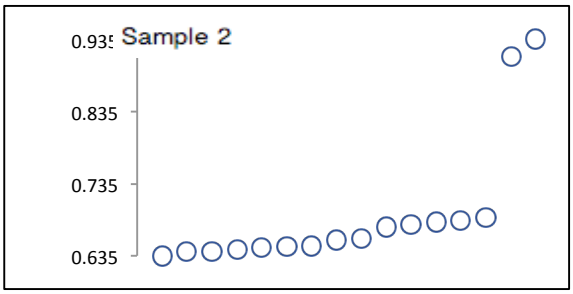
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	15	16	16	16
Median	0.878	0.658	0.898	0.436
Robust Mean	0.884	0.665	0.895	0.440
U	0.0080	0.0083	0.0094	0.0061
Robust Standard Deviation	0.0249	0.0264	0.0300	0.0196
Regression Standard Deviation	0.0663	0.0498	0.0671	0.0330
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0663	0.0498	0.0671	0.0330
Outliers	1	0	0	0
|z|>3.0	0	2	1	2
2<|z|<3	0	0	0	0

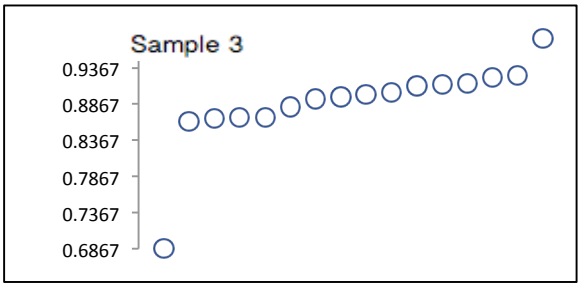
Methods Used

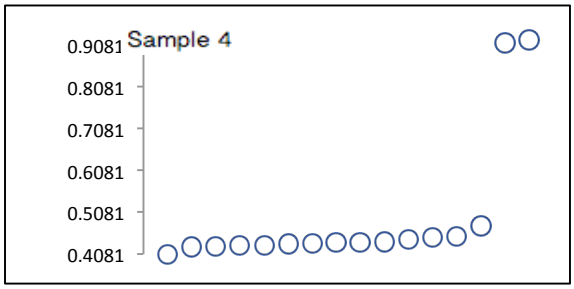
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	15	16	16	16

All summary stats and the plots below are based on the data excluding any flagged outliers



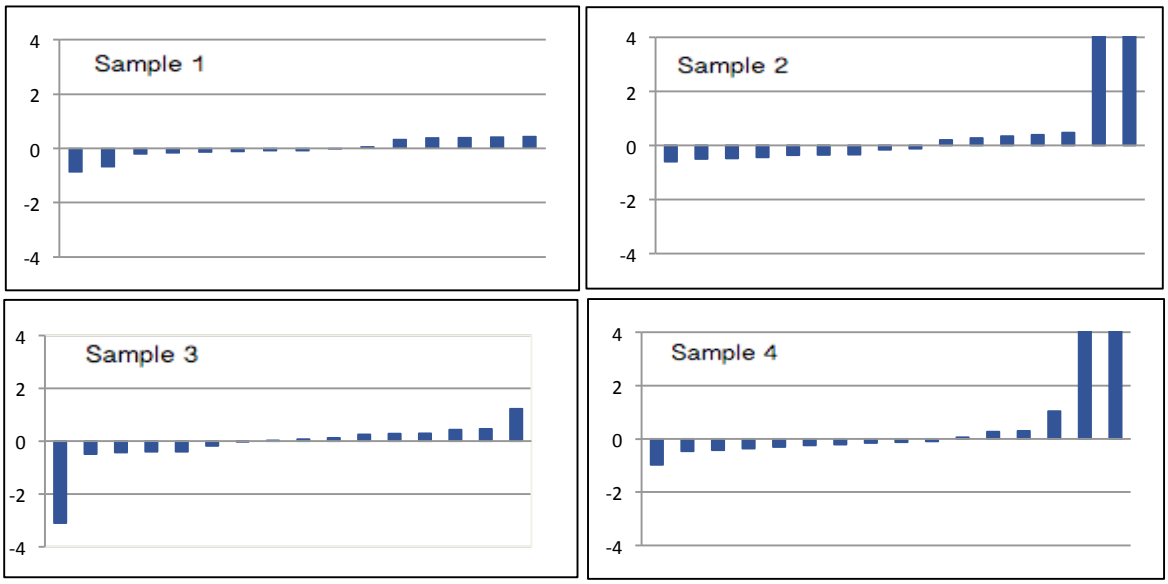




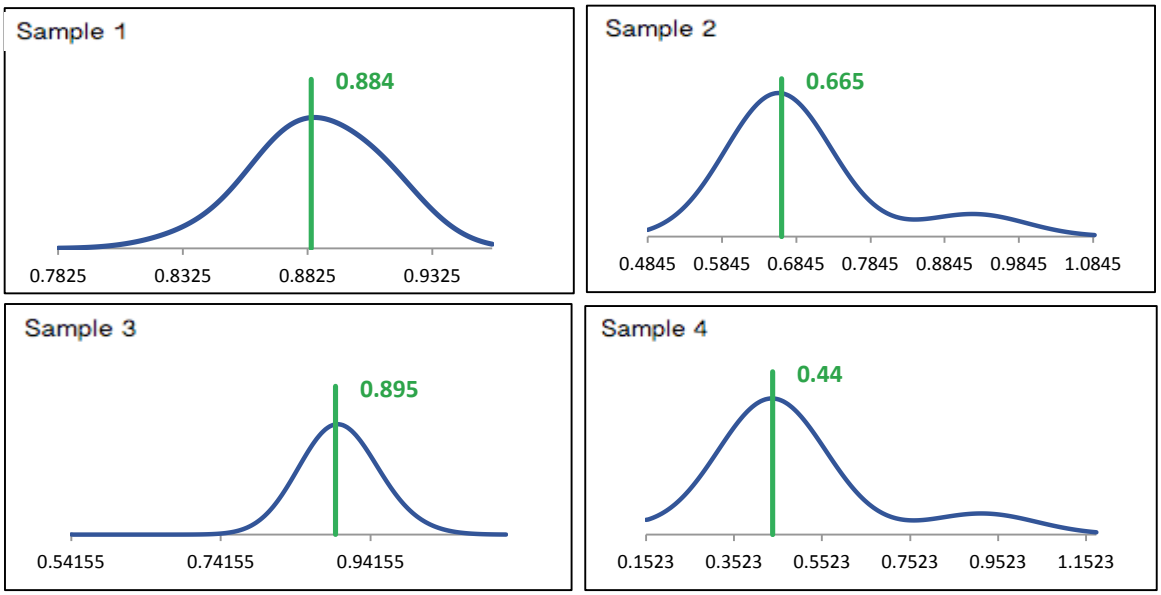


TITANIUM

z-Score Plots

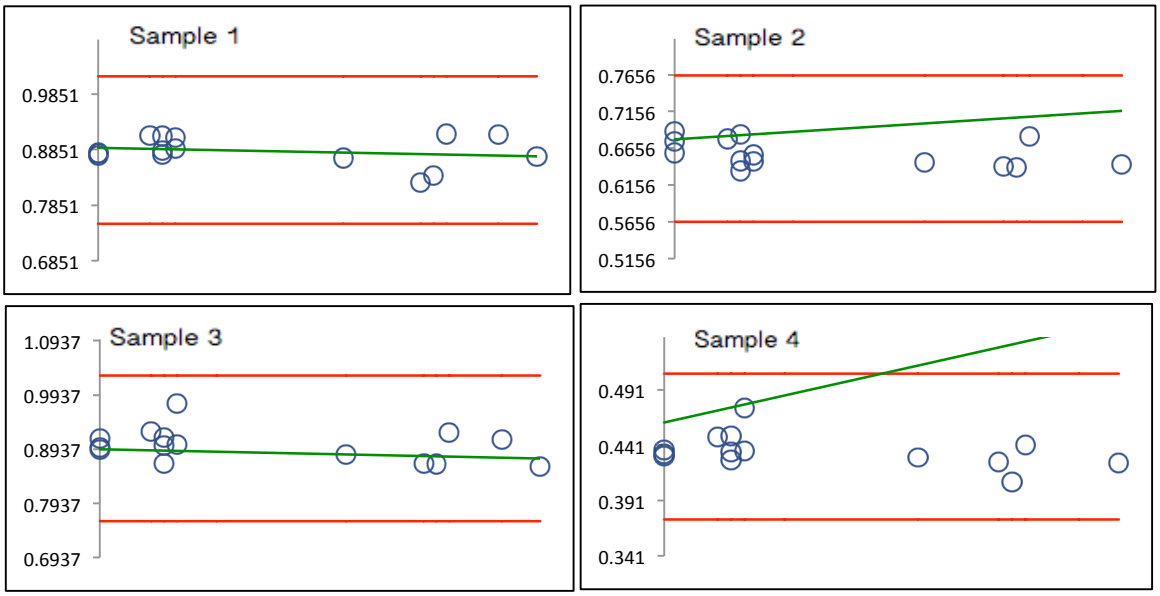


Kernel Density Plots



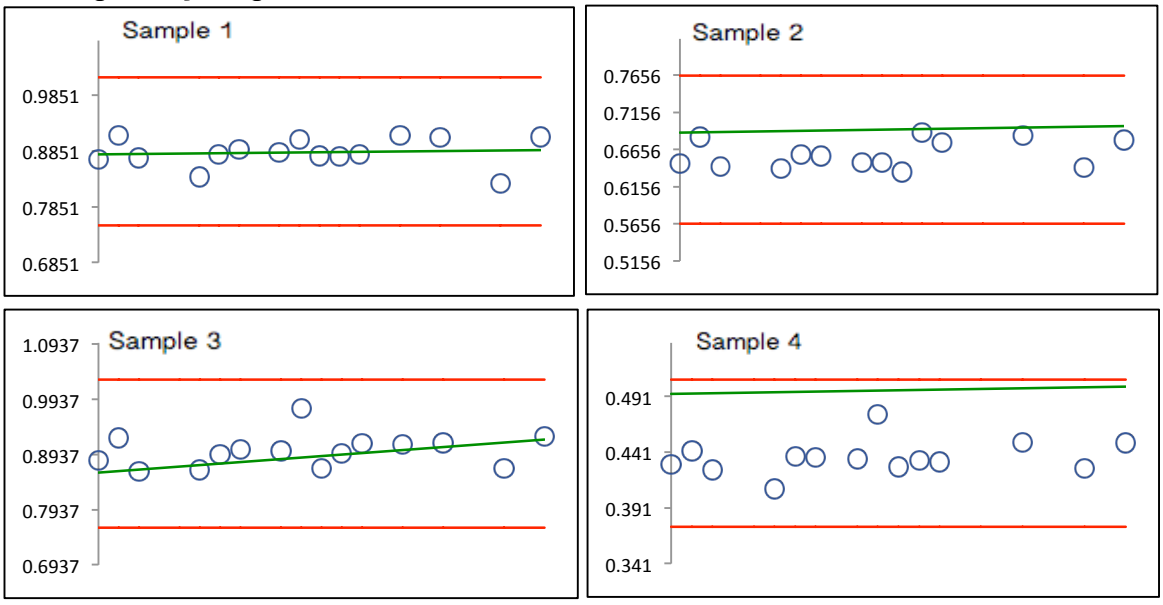
TITANIUM

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

VANADIUM

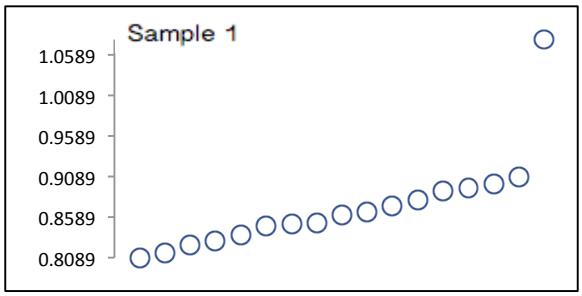
Summary Statistics

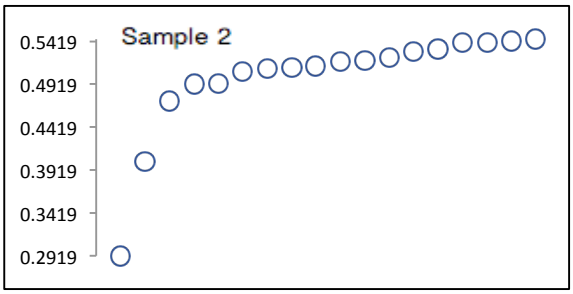
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	17	18	18	17
Median	0.861	0.516	0.282	1.02
Robust Mean	0.862	0.513	0.284	1.03
U	0.0115	0.0082	0.0047	0.0131
Robust Standard Deviation	0.0378	0.0278	0.0158	0.0432
Regression Standard Deviation	0.0647	0.0385	0.0213	0.0771
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0647	0.0385	0.0213	0.0771
Outliers	1	0	0	1
|z|>3.0	1	1	2	0
2<|z|<3	0	1	0	0

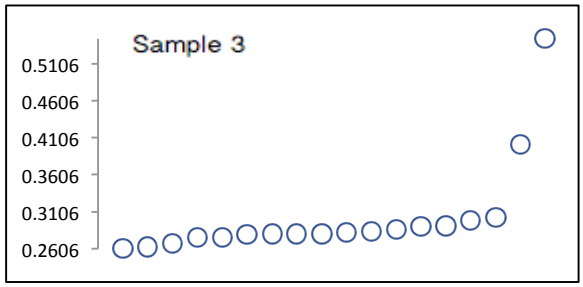
Methods Used

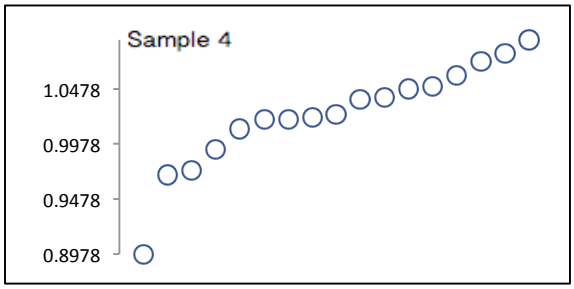
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	17	18	18	17

All summary stats and the plots below are based on the data excluding any flagged outliers



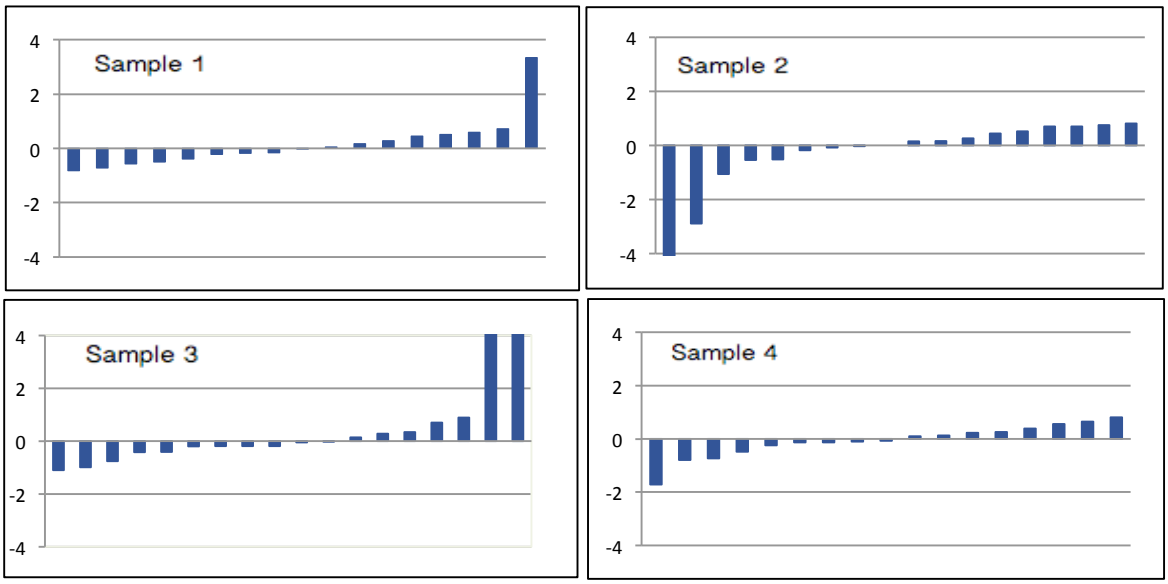




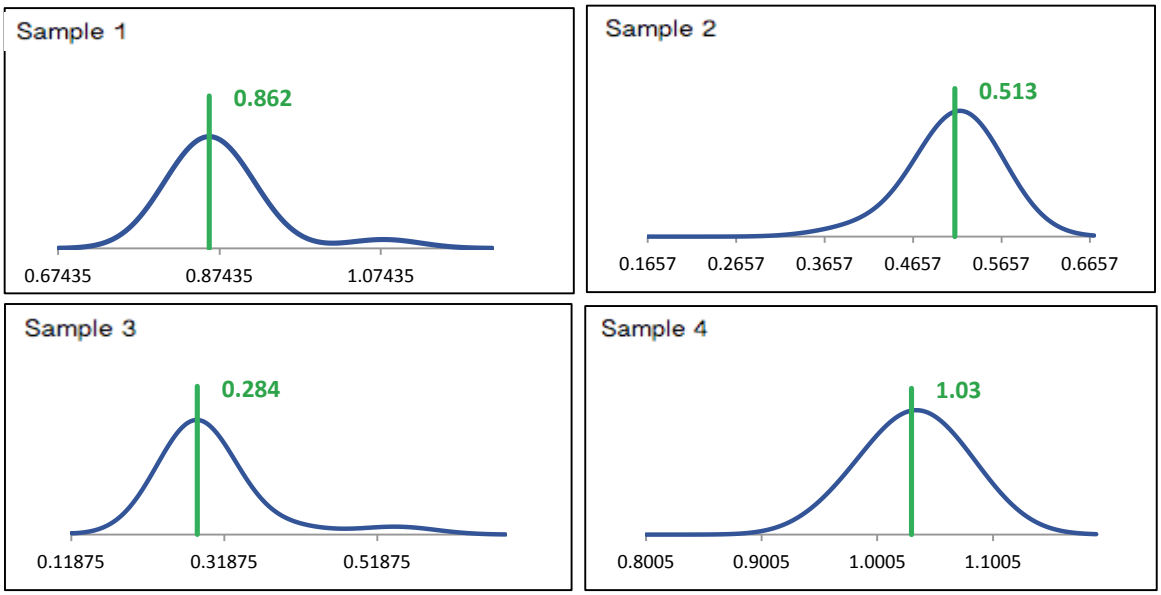


VANADIUM

z-Score Plots

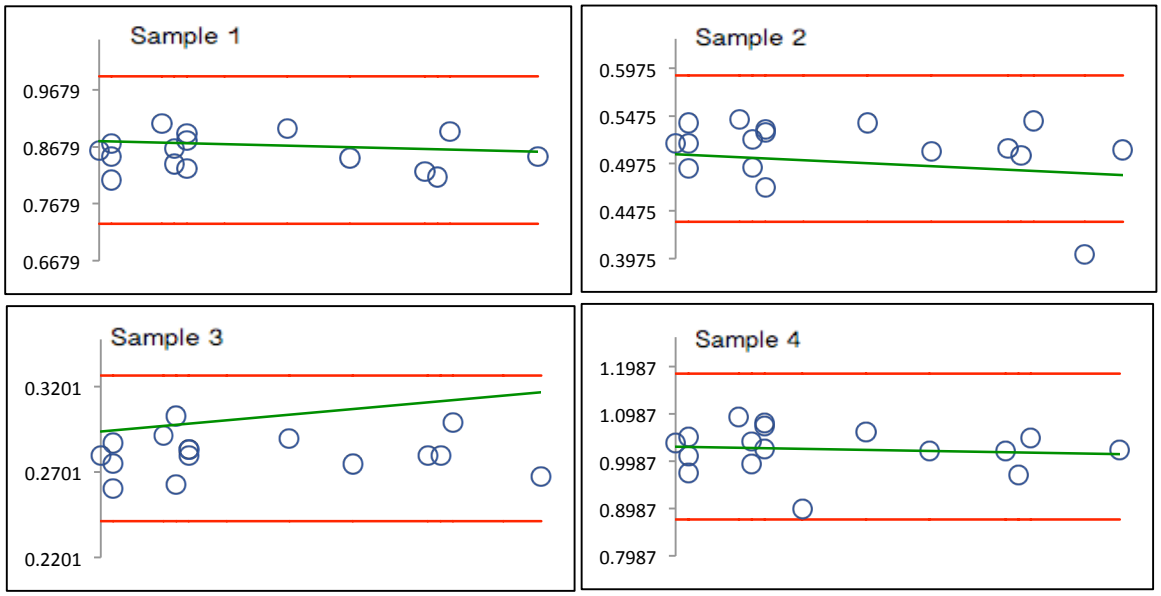


Kernel Density Plots



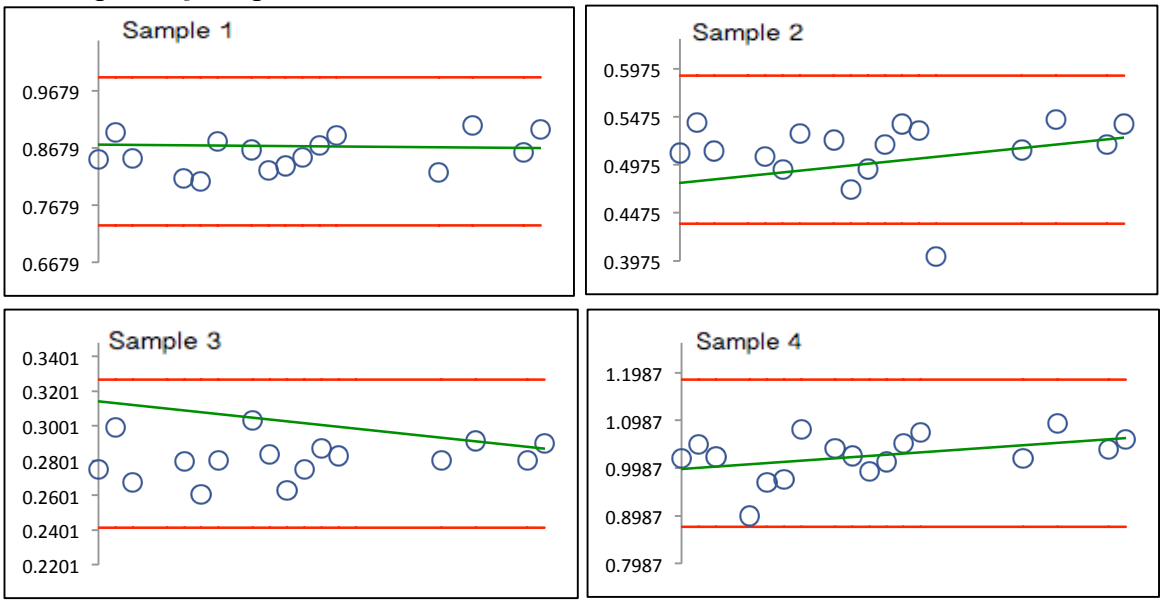
VANADIUM

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).

ZINC

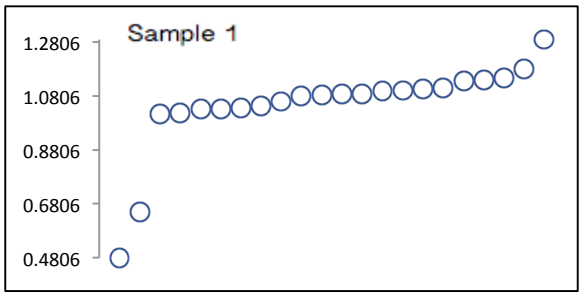
Summary Statistics

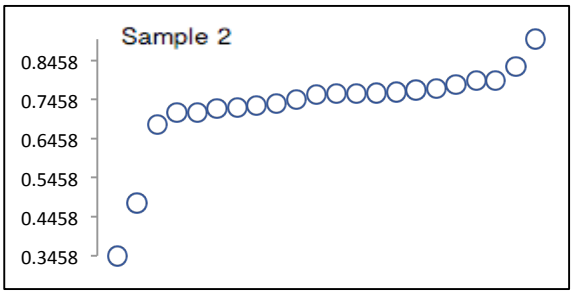
Statistic	C02B-1	C02B-2	C02B-3	C02B-4
N	22	22	22	22
Median	1.09	0.759	0.313	0.590
Robust Mean	1.08	0.749	0.313	0.588
U	0.0171	0.0125	0.0056	0.0097
Robust Standard Deviation	0.0640	0.0468	0.0209	0.0365
Regression Standard Deviation	0.0810	0.0562	0.0235	0.0441
Stability Flag				
Homogeneity Flag				
Standard Deviation Used (SDPA)	0.0810	0.0562	0.0235	0.0441
Outliers	0	0	0	0
|z|>3.0	2	2	2	1
2<|z|<3	1	1	0	1

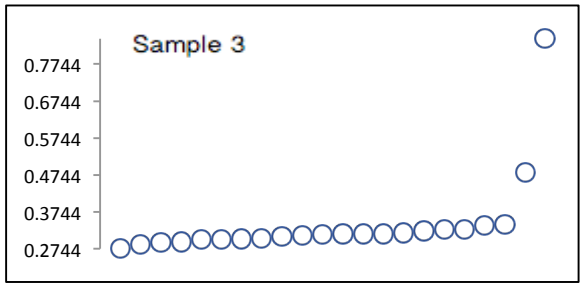
Methods Used

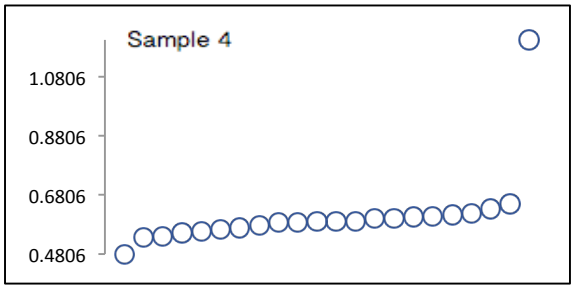
Method	C02B-1	C02B-2	C02B-3	C02B-4
ICP/OES	22	22	22	22

All summary stats and the plots below are based on the data excluding any flagged outliers



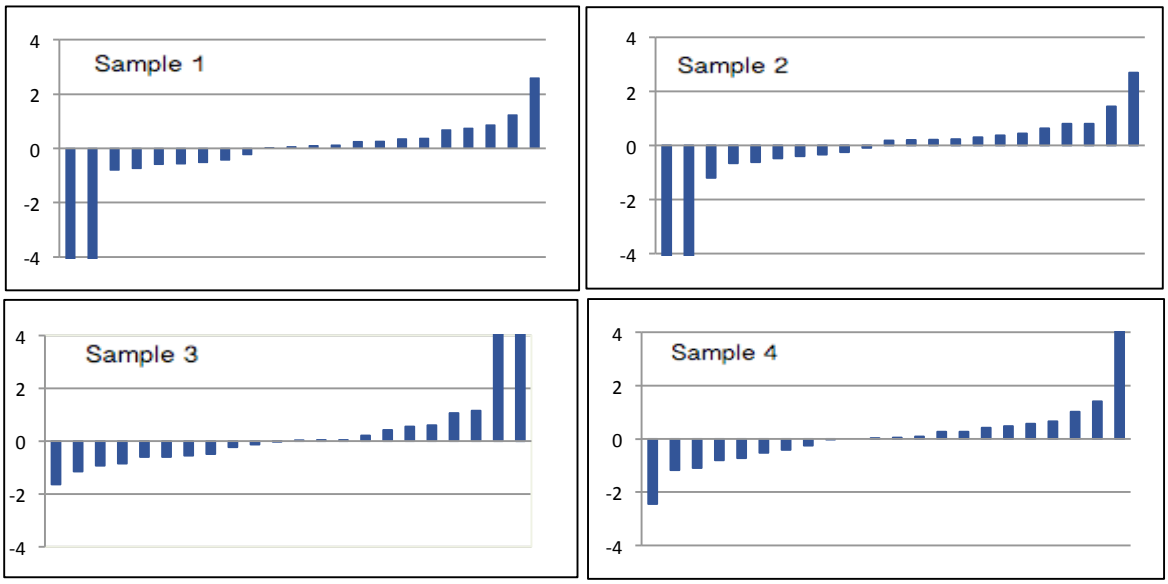




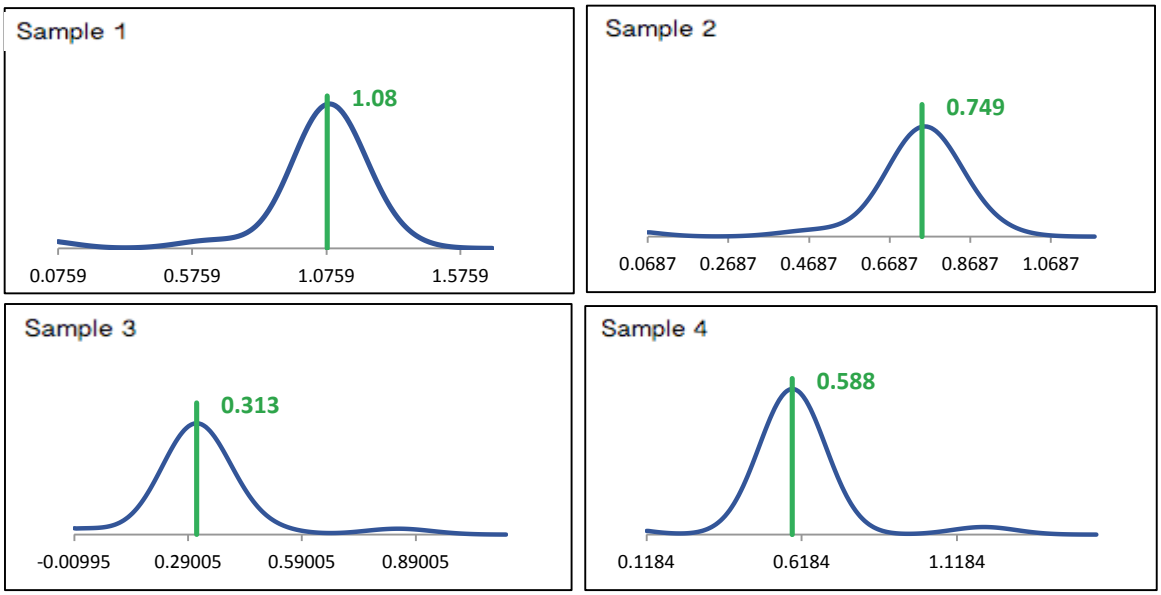


ZINC

z-Score Plots

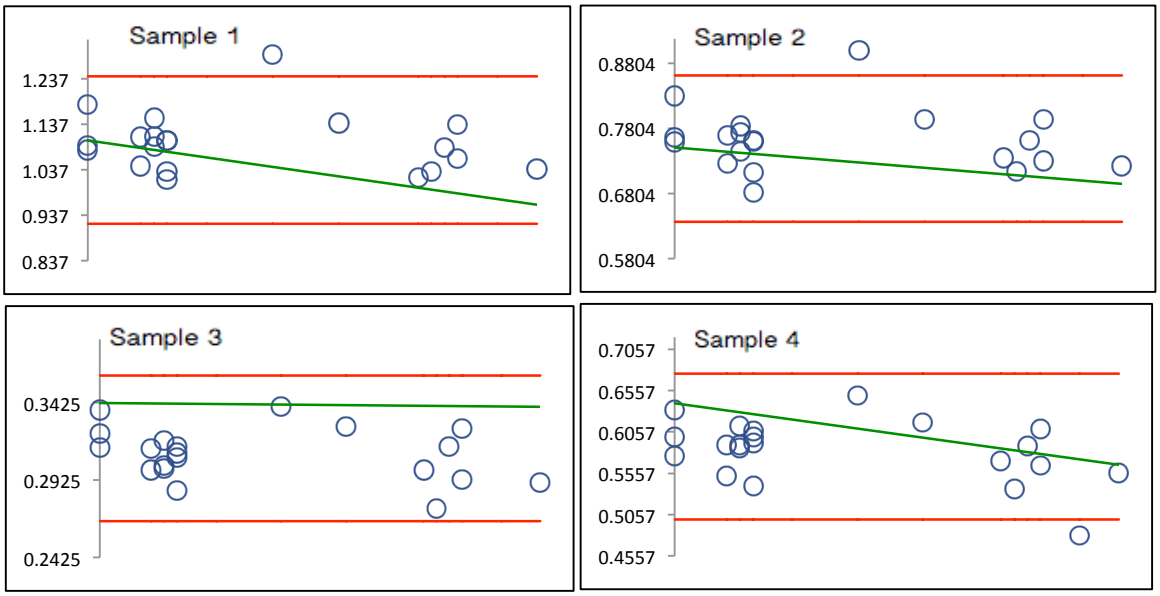


Kernel Density Plots



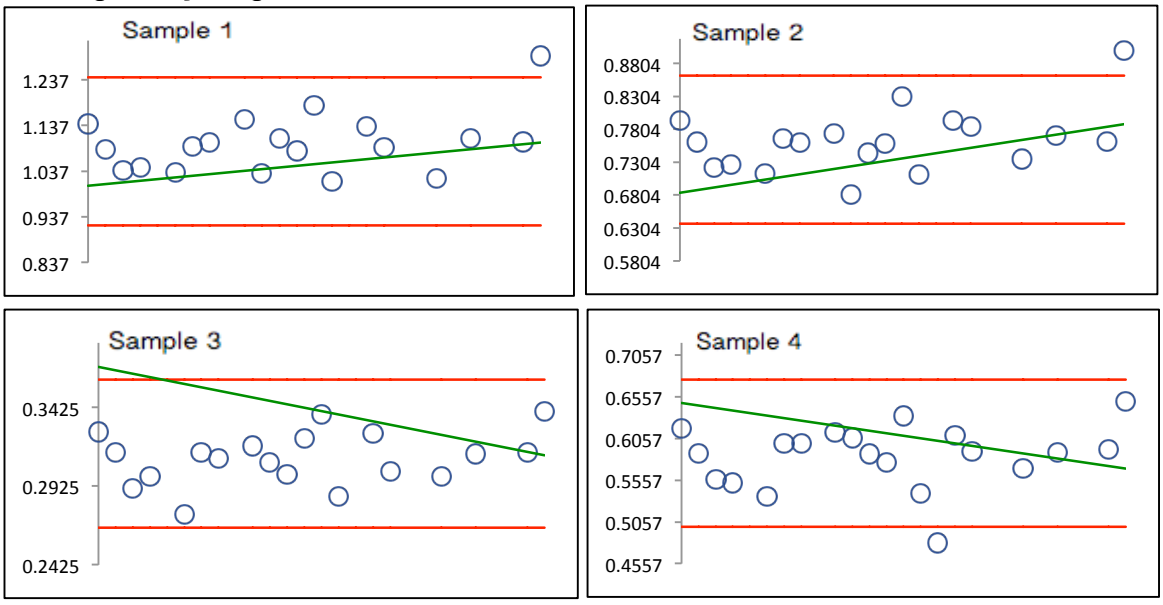
ZINC

Stability Regression



Reported results (Y-axis) plotted against reported analysis date (X-axis)

Homogeneity Regression



Reported results (Y-axis) plotted against bottling order (X-axis).