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Till geochemistry in Oppdal and Rennebu,
Sør-Trøndelag county, Norway

NORGES GEOLOGISKE UNDERSØKELSE - NGU -

REPORT

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Till geochemistry in Oppdal and Rennebu, Sør-Trøndelag county, Norway

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Summary:
A geochemical till survey was carried out in an area covering great parts of Oppdal and Rennebu municipalities, Sør-Trøndelag county, Norway. Till samples from 877 locations were collected and dry-sieved (< 2 mm), and an Aqua Regia extraction of the material was analysed by ICP-MS for 51 elements.

This report presents the results of the survey with tables and maps, and reviews the quality of the data. Only first impressions of the results are given:

- The material shows a close relation to the mapped bedrock geology
- Several distinct anomalies are discovered in the survey area
  - Multi-element anomaly running W of Brattskarven in the north to Sissihøa in the south
  - Au and Sb anomaly around Brattskarven
  - Ag and Cd anomaly around Soknedal

The overall impression from the data quality control (QC):

- The natural variation in the field contributes with the largest error.
- The chemical analyses are overall very good, unfortunately the Au analyses are of limited quality.
- Several elements suffer from the rounding effect.
- Both in-house standards show good results.

The QC also reveals some problematic elements, where maps should be viewed with caution.

Following this report is an excel table with georeferenced chemical data so that the reader can utilize the data, see http://www.ngu.no/mins-data/Geokjemi/OppdalRennebu/. The QC results should always be kept in mind while using the data.

Keywords: geochemistry	till	mineral soil
Au	exploration	multi-element

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1. INTRODUCTION

As a part of the MINN[1] and MINS[2] programmes at the geological survey of Norway (NGU), the geochemistry team has conducted several regional geochemical surveys in the northern parts of Norway: Nordkinn (Reimann et al., 2012), Nord-Salten (Finne and Eggen, 2013) and Hattfjelldal (Eggen and Finne, 2014). These areas were chosen based on results from new analysis (Reimann et al., 2011) of samples collected from a number of geochemical studies conducted during the 80's. Modern analytical methods provided new insights to this material, and areas that displayed anomalies were looked into in more detail.

The bedrock team at NGU conducted geological reconnaissance mapping in the surroundings of Oppdal in 2014 and 2015. During that time, several large gold nuggets were panned in a river in the Oppdal area in central Norway (Kalseth-Iversen, 2015). A bedrock study in the local area did not localize the source rock for the mineralization (Sandstad et al., 2017), but the findings sparked renewed mineral exploration interest in the area. Figure 1 provides an overview of the area. All locations mentioned in the text are shown here in addition to the known occurrences of mineralization.

1.1 Bedrock geology

Figure 2 shows a simplified geological map of the area. The bedrock geology within the investigated area is dominated by Caledonian nappes belonging to several tectonostratigraphic levels. The area can be divided into three roughly north-south-trending units (Figure 2).

1) To the west of a series of NNW-SSE-trending late- to post-Caledonian faults, several nappes consisting of Proterozoic acidic magmatic rocks, Neoproterozoic quartzitic rocks and Cambro-Ordovician volcanoclastic rocks are metamorphosed in amphibolite facies and folded into recumbent isoclinal folds, resulting in a complex map pattern (Figure 2; Krill, 1980; Robinson et al., 2014). They are interpreted to represent remnants of the continental margin of Baltica telescoped during the Caledonian orogeny (Gee et al., 1985; Stokke, 2016).

2) The central area, east of the prominent faults, is occupied by a higher tectonic level consisting of Cambro-Ordovician metabasalts, felsic volcanites, metacherts and volcanoclastic rocks, which are partly inverted and intruded by a series of Ordovician to Silurian mafic to acidic plutons (Figure 2; Rohr-Torp, 1972; Krill, 1980; Nilsen et al., 2003). These rocks probably developed in marginal oceanic basins and island-arcs during the closure of the Iapetus ocean (Gee et al., 1985).

[1] http://www.ngu.no/en/projects/minn
[2] http://www.ngu.no/en/projects/mins

3) The easternmost area consists of Neoproterozoic to Silurian clastic metasedimentary rocks (in places calcareous), intercalated with ribbon chert, graphitic schist and metabasalts (Nilsen 1978; Nilsen and Wolff, 1989; Gasser and Grenne, 2017). The succession is intruded by Ordovician to Silurian mafic to acidic plutons (Nilsen et al. 2007). These rocks represent a fragment of a mainly continentally-derived Proterozoic to Paleozoic terrane, which contains volcanic products of both a rift-related and an island-arc /back-arc phase and which was accreted to the Baltican margin during the Caledonian orogeny (Gee et al., 1985; McClellan, 1995; Nilsen et al., 2007; Gasser and Grenne, 2017).

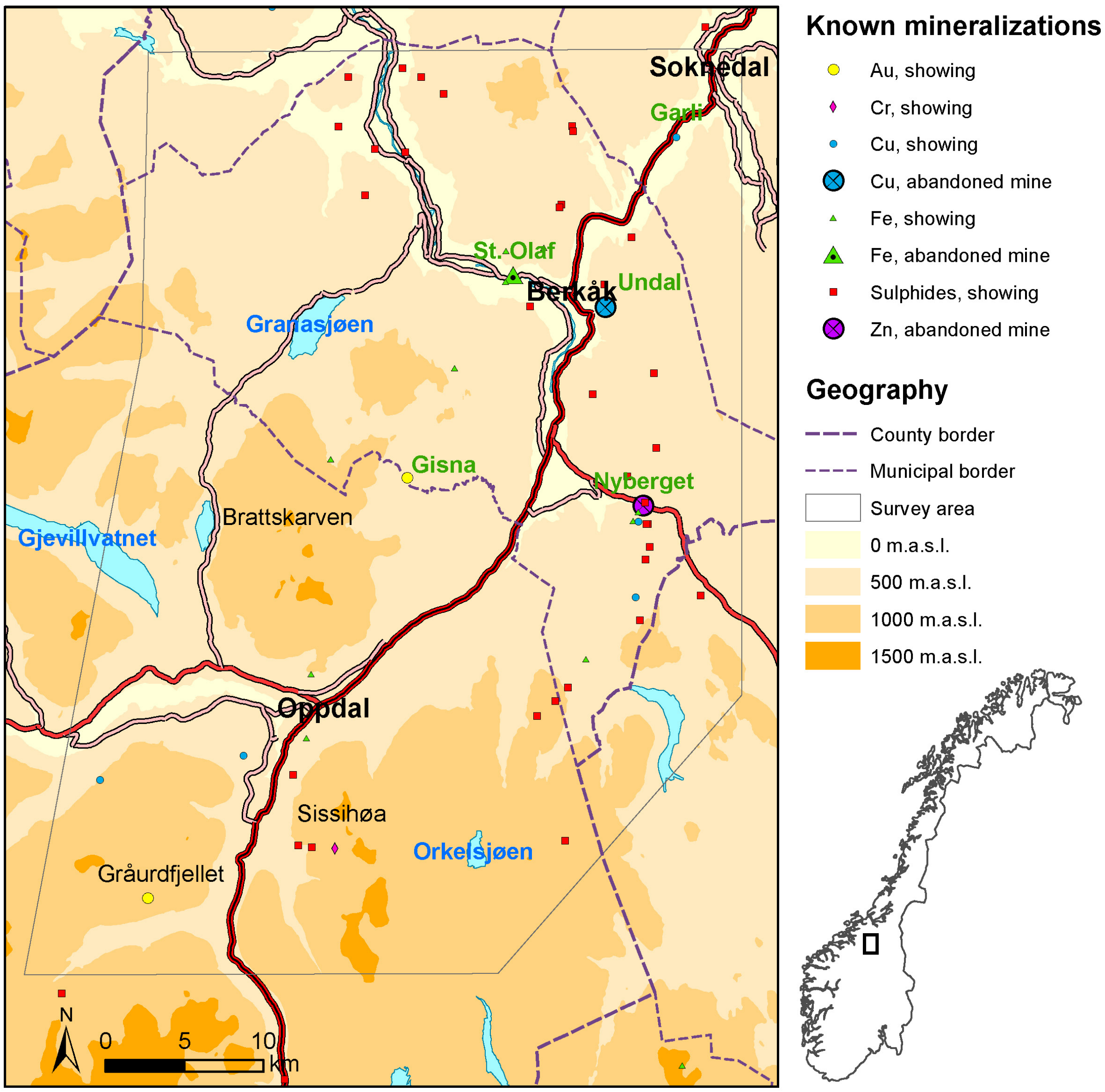

Figure 1: Topographical overview of the survey area with known metal occurrences added from NGU's ore deposit database (www.ngu.no).

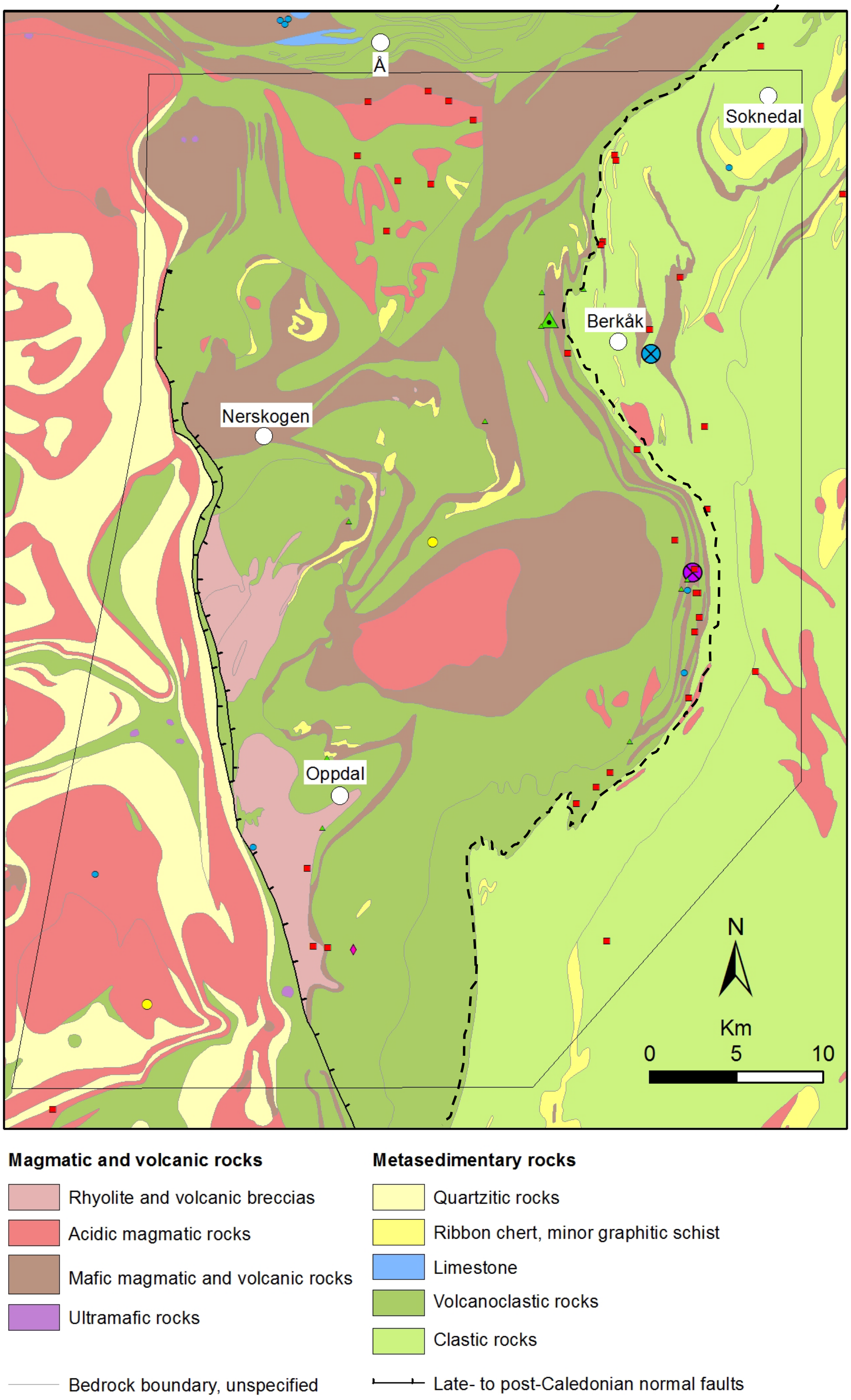

Figure 2: Geological map of the survey area. The western and central units are separated by a number of normal faults, while the stippled line delineates the boundary (thrust plane) between the central and the easternmost geological units.

1.2 Quaternary geology

The Oppdal area mainly consists of areas covered with thin till deposits and numerous bedrock outcrops. Thicker till deposits and peat deposits in the area are mainly located at lower altitudes. In many of the valleys, glaciofluvial and fluvial deposits are present, which constitutes a challenge when sampling, as these types of sediments generally were avoided as a geochemical sample media.

A study of Quaternary deposits in the Gisna valley concludes that the continental ice sheet has moved in several directions, judging by the till material. The oldest movement occurred from south towards the north, later on during the melting phase the ice moved NE/NW/W. In the latest stage the ice moved towards NW/W (Sandstad et al., 2017).

1.3 Mineral deposits in the area

A large number of volcanogenic massive sulfide (VMS) base metal ore deposits, which are documented in NGUs ore deposit database (see www.ngu.no), occur in the area. The mines in the area have played a minor part in the total copper and pyrite production and most deposits do not reach ore grade. Most of the mineral deposits within the sampled area are described by Nilsen (1978) as bound to the central, volcanosedimentary formation, the Elgsjø formation (Figure 1 and 2). Some of these present possess elevated gold values, e.g., the Garli mineralization (with up to 0.6-0.9 mg/kg Au). The tectono-stratigraphic position and age of the bedrock units in the eastern area is not well understood and still under debate.

Three metal occurrences in the region have actually been mined in the past, though on a small scale. These are the Nyberget zinc deposit near Innset, the Undal copper deposit right to the south of Berkåk and the St. Olaf iron deposit right to the west of Berkåk (Figure 1).

Gold prospecting was carried out in the south-westernmost part of the area in the early 1990'ies, and gold mineralization in bedrock and gold anomalies in soil samples were detected in the Gråurdfjellet area (Livgard 1993, 1994a, 1994b) – see Figure 1 for location. The recent discovery of gold nuggets during gold panning in the Gisna river, NE of Oppdal (Kalseth-Iversen 2015 – see Figure 1) has further increased the interest in the area.

2. METHODS

2.1 Planning stage and field work

The 1 x 2.5 km sampling grid was considered a realistic compromise between the available resources for the project and the area of interest, which during the planning stages, was expanded in order to include known mineral deposits. This is also a sampling density that is similar to the three previous MINN surveys (1 x 2 km).

Maps were generated to assist in the planning of field logistics, where the sampling grid was overlain on topographical maps along with polygons delineating glaciofluvial and fluvial deposits, as these deposits were to be excluded from sampling. Within each of the grid squares, field workers were free to find a suitable location, preferably as close as possible to the grid center and with a minimum distance of 10-100 m from roads.

Sample pits were excavated, well into the mineral soil layer, using paint-free steel spades. Sampling was preferably conducted within the C-horizon in podzol soil. Samples were collected into Rilsan® plastic bags using a small steel trowel. Figure 3 shows a typical sample pit and a typical size sample bag.

Figure 3: Sample pit, typical example.

Sample contamination in the field was minimized through different measures: the field crew did not wear any jewellery during sampling and tools were wiped clean between samples. For about every 20th sample a duplicate sample was collected 1-10 m from the original sample site, resulting in a total of 47 duplicate pairs. Samples were collected from a total of 877 locations. All samplers worked individually. On average, a sampler was able to collect 6-7 samples per day.

Helicopter support was used to transport samplers to (in some instances also from) the most remote locations. Prior to the field work, exemptions from regulations on motorized off-road travel were granted from the proper authorities. In addition, landing permissions for the helicopter landing locations were granted from land owners. Field work was mainly carried out in the period 3.8 – 25.08.2015, with the number of samplers fluctuating between 3 and 9 people.

2.2 Sample preparations

Upon arrival at the NGU laboratories, all samples were dried in their opened original sampling bags for three weeks at temperatures below 40 °C. Sample wet weight was 1.5 kg (average), after drying the average weight was 1.2 kg. All samples were subsequently dry-sieved to 2 mm, where the fraction larger than 2 mm were saved for possible later usage. An additional split was generated from all samples, also from the field duplicates. Figure 4 shows the sample preparation sequence.

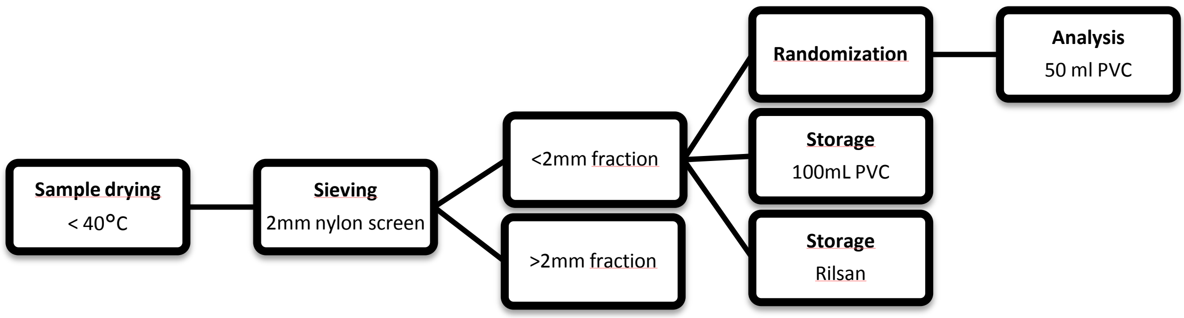

Figure 4: Sample preparation sequence, from left to right.

Nylon sieves were used, no jewellery was worn during preparation work. Cross contamination via sample dust during sieving was controlled by sieving samples one at a time in a vented box. All sieving equipment was cleaned using a vacuum cleaner in between every sample.

Following sample preparation, one single series of all samples were randomized in a structured manner, so that for about every 19th ordinary sample sent to the laboratory, a field duplicate, its split and its ordinary sample as well as a split of the project standards MINN and Sagelva were inserted. The control samples were not always inserted in the exact same positions within the group.

2.3 Chemical analyses

The MINN campaigns of 2011, 2012 and 2013 (Reimann et al., 2012b; Finne and Eggen, 2013; Eggen and Finne, 2014) as well as the reanalysis of the Nordland and Troms samples (Reimann et al., 2011) followed the same procedure with successful quality assessment at the same laboratory. For all these campaigns, a 15 g sample weight was used for extraction. Prior to this study a change in laboratory was considered, therefore reference samples were analyzed at the new laboratory and compared to the previously used laboratory. The results (not presented here) showed very good agreement, therefore the samples could safely be analyzed at a new laboratory.

The randomized series of 90+ g aliquots were shipped to ALS laboratories in Piteå, Sweden. The samples were further shipped and analysed at ALS Vancouver, Canada. The samples were analysed for 51 chemical elements (Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, Zr) according to their Au-ME-TL43 method, where 25 g sample weight was used for Aqua Regia extraction, with ICP-MS finish.

Analytical results were returned from the laboratory within one month after receiving the samples. The remainder of the sample material was stored in the event of mishaps with the first weighing, and for possible upcoming analyses following alternative procedures. Unused sample material was not returned, but incinerated by the laboratory after the holding period, according to local regulations.

2.4 Quality control

Quality control (QC) within a geochemical study gives the opportunity to distinguish between actual natural variability of the sampling media and introduced systematic and random uncertainties and errors caused by the methods used (Johnson, 2011), both in the field and in the lab.

Geochemical data are compositional data, meaning that they do not contain truly independent values but only relative information; the reported concentrations of all elements analyzed depend on one another (Aitchison, 1986; Filzmoser et al., 2009). Such data have some special properties which can lead to wrong results when applying the methods developed for classical statistical data analysis (Reimann et al., 2013). Thus EDA (exploratory data analysis) techniques and simple order statistics as suggested by Reimann et al. (2008) are used here. All statistical calculations are determined by use of the freely available R software (R development core team, 2016) and the additional StatDA package (Filzmoser, 2015).

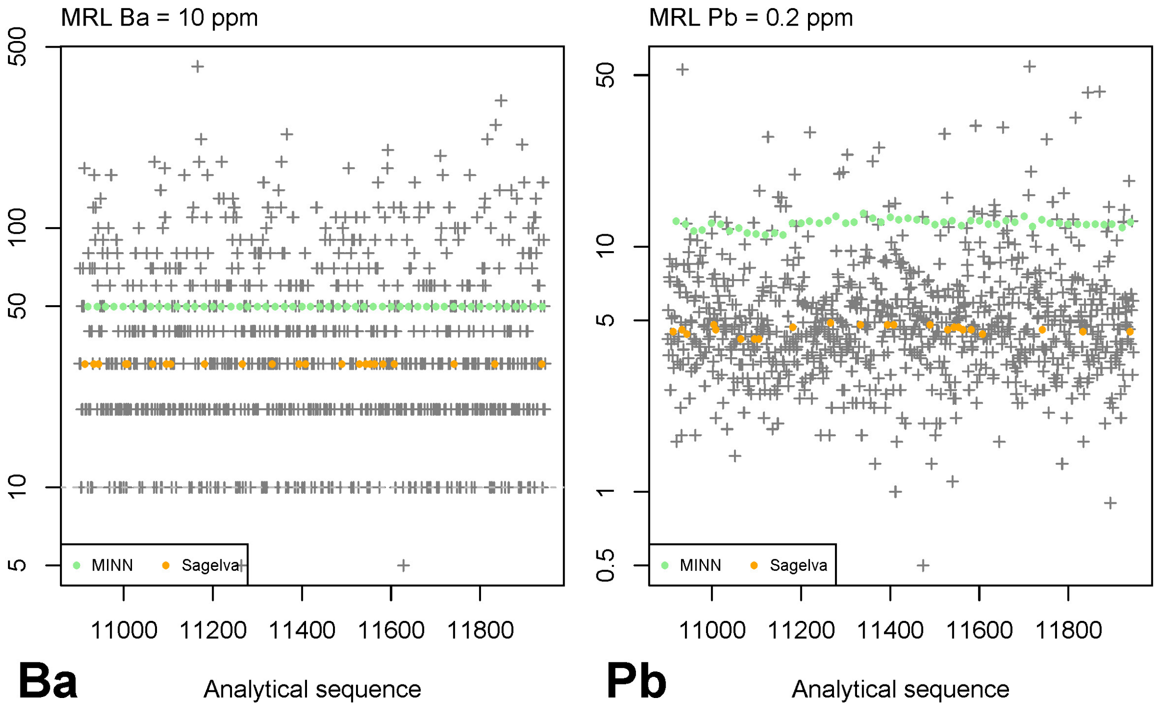

Figure 5: Random plot for Ba and Pb. No instrumental drift is observed for these elements. Note how the rounding of the data is affecting Ba and note how the MINN standard stands out of the point cloud.

As a first step in the quality control of the analytical results, the data is studied in random plots, where the concentration of an element (for duplicates, standards and ordinary samples) is plotted according to the analytical (i.e. randomized) sequence. Figure 5 shows random plots for Ba and Pb. Note that for the samples where the results are reported less than the reporting limit, the results here are set to half of the reporting limit. Random plots will reveal instrumental drift, batch problems, how the in-house standard material blends in and other possible artefacts. In this material no instrumental drift is observed from the random plots. However, what the random plots *are* revealing is generous rounding of all results. The rounding of analytical results is often conducted by the laboratory to produce nice-looking data tables, but this procedure simultaneously degrades the data quality and makes a versatile use of the data almost impossible.

2.4.1 In-house project standards

Two in-house project standard materials were inserted into the randomised sample sequence. The project standards were used to estimate the accuracy of the analysis and to detect possible time trends or breaks in the analysis sequence. The MINN standard material has been used in three previous surveys and therefore gives an excellent opportunity to compare four surveys. The Sagelv standard is a new in-house standard material that has not been extensively analysed. The precision for the standard material is calculated by dividing the median absolute deviation (MAD) by the median and finally multiplied with 100 to report percent values. The lower the number is, the better the precision is determined.

2.4.1.1 MINN standard

The MINN standard displays very similar results for all four studies (Figure 6). The main impression from this comparison is that, for most elements, the four campaigns can be compared without any further levelling between datasets. Appendix III presents these results for all elements.

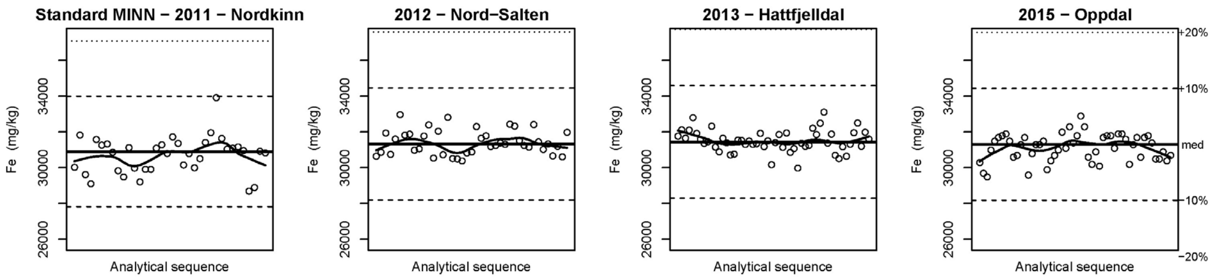

Figure 6: X-chart for Fe in the MINN standard during four geochemical campaigns from 2011 to 2015. In 2011, 2012 and 2013, the analyses were run at a different laboratory than the 2015 Oppdal campaign. Dashed and dotted lines marks ±10% and ±20% deviation, respectively

In the MINN standard, elements like Au, B, Cd, Re and Ta are present at very low concentrations which brings along very poor precision. Table 1 gives summarized statistics for the MINN standard. The analyses for a few elements are proving problematic when looking at the results for this particular standard: Ge, S and Se. A whole range of elements, where a significant part of the samples are below the reporting limit, show dubious results for precision (Precision = 0 in Table 1). X-charts for all elements for the MINN standard are given in Appendix II.

2.4.1.2 Sagelva standard

The Sagelva standard (Figure 7) is proving stable throughout the analytical sequence for most elements where the concentrations are markedly above the reporting limit. A range of elements are present at very low concentrations which brings along very poor precision. Table 2 gives summary statistics for the Sagelva standard. X-charts for all elements for the Sagelva standard are given in Appendix II..

2.4.2 Laboratory QC

The laboratory inserted three splits of its own mid-range geological QC sample MRGeo08 for overall QC as well as aliquots of each of the certified reference materials OREAS-503b (n=9), OREAS-45b (n=10) and OREAS-904 (n=10). In addition the laboratory inserted 19 blank samples. The laboratory also did replicate weighing, extraction and analyses of 16 replicate pairs throughout the analytical sequence. An evaluation of these results are not presented here.

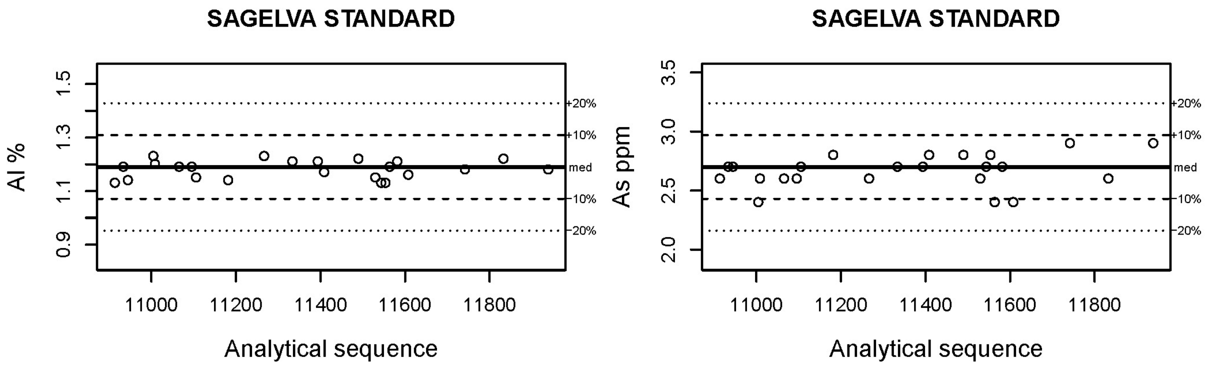

Figure 7: X-charts of Al and As for the new in-house standard Sagelva. Dashed and dotted lines marks ±10% and ±20% deviation, respectively.

2.4.3 Precision

Table 3 shows the estimate of precision based on the field duplicates and the analytical duplicates. A total of 47 duplicate pairs were collected and analysed. Low duplicate precision is principally due to natural variability, which is presented by the difference between the ordinary field sample and the field duplicate sample. For the elements, where problems with precision were observed (for example Au, B, Ge, Pd, Pt, Re, Se, Ta and Te), the problem was due to very low concentrations. However, the field duplicate results reveal that some elements are plagued with poor reproducibility, and maps should be viewed with care (see notes in maps).

Field duplicate samples were split into 47 pairs of analytical duplicates. XY-plots show that the analytical duplicates behave much better than the field duplicates. This can be seen in Figure 8 (examplified by Ba and Pb), Table 3 and Appendix IV for all elements. However, Au, Na, S, Se and W show relatively poor precision in the analytical duplicates.

2.4.4 Quality control summary

Overall impression:

- The natural variation in the field contributes with the largest error.
- The chemical analyses are overall very good, unfortunately the Au analyses are of limited quality.
- Several elements suffer from the rounding effect.
- Both standards show good results.

The QC reveals some problematic elements. The following elements show very poor analytical quality and are not provided maps for: B, Na, Re and Ta. The following elements show poor data quality and maps for these elements should be studied with care: Au, Ag, Hf, S, Se, Te and W.

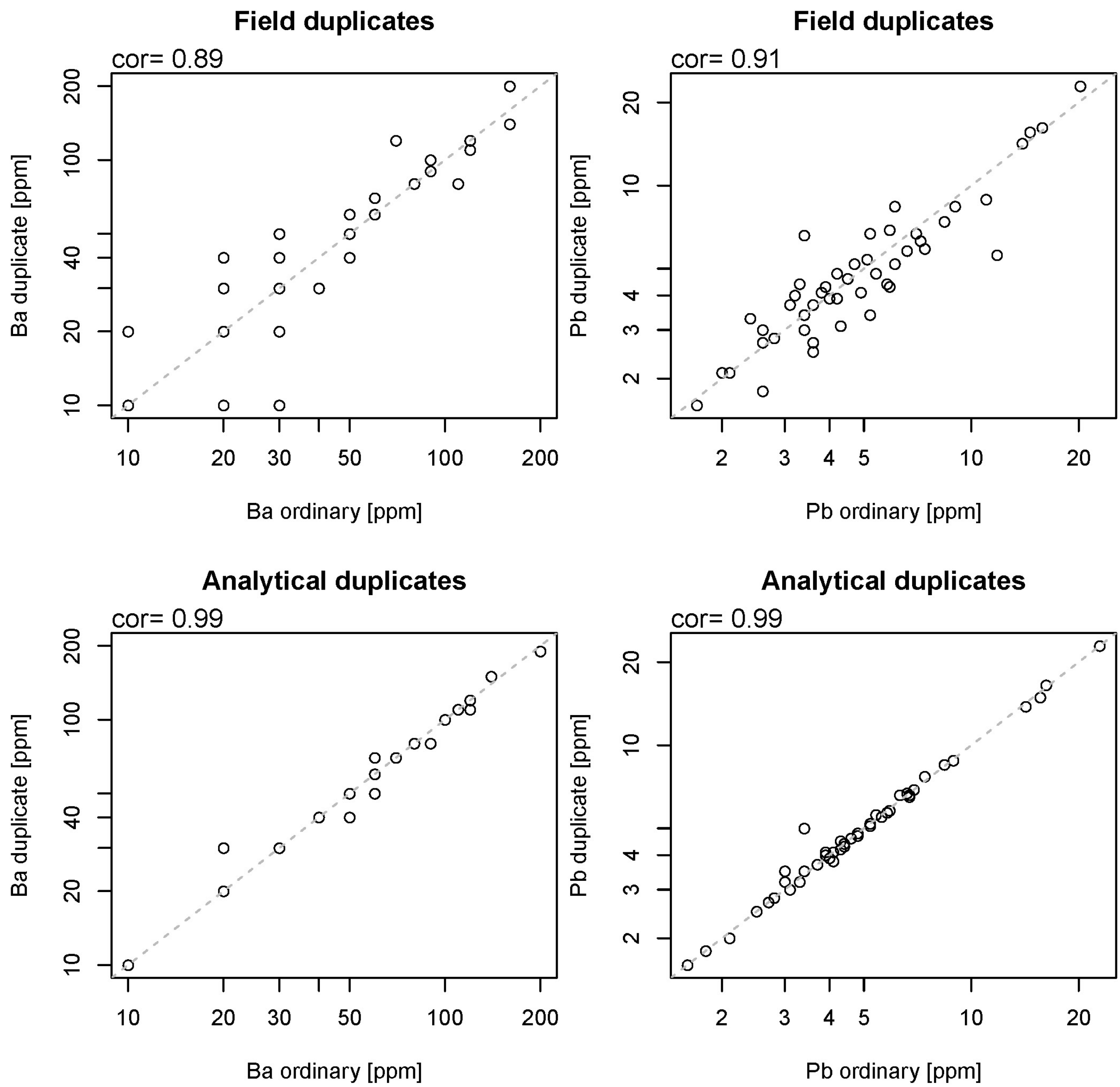

Figure 8: XY plots for field and analytical duplicate samples. Ba is presented as a example with poorer quality, while Pb represents a good example. Note the logarithmic scale on both axis.

3. PRESENTATION OF RESULTS

Following this report is an excel table with georeferenced chemical data that can be downloaded from http://www.ngu.no/mins-data/Geokjemi/OppdalRennebu/. The QC results should always be kept in mind while using the data.

3.1 Data tables

A statistical overview for the dataset is provided in Table 3. The table is built around the minimum, maximum and median value, and also provides the values for a number of additional quantiles (percentiles) for the analyzed elements. As an additional measure of variation the number of powers are provided. These provide a direct impression of the orders of magnitude variation for each variable. When using classical statistical methods for calculation of the mean and standard deviation, to derive at “thresholds” for anomalies, 2.6% of all data is often identified as anomalies at both ends of the distribution. This is provided that the dataset has a normal distribution. The data at hand are far from normally distributed and therefore unsuited for classical statistics – thus the quantiles Q2 and Q98 (or Q5 and Q95) can be taken as lower and upper thresholds for the data. However, quite often Cumulative Probability (CP) plots (see below) provide a better means of identifying anomalies in the data by inspection of shape of the curve than reading a table.

Table 5 displays the analytical results with a more common approach, showing median, 98th percentile value and maximum concentration for the Oppdal dataset and data for directly comparable Hattfjelldal (Eggen and Finne, 2014), Nord-Salten (Finne and Eggen, 2013) and Nordkinn datasets (Reimann et. al, 2012). They are comparable in terms of grain size, laboratory procedures, and number of samples. For median, Q98 and maximum, the highest value for each element between the three datasets is underlined/bold.

3.2 Combination plot

A combination plot (see Appendix I) , which combines the quantile probability plot, histogram, density and scatterplot, helps to better understand the data distribution. In addition, it may reveal possible analytical artefacts. In this plot only ordinary samples are included. The combination plots also show the effect of rounding the results for many elements. The rounding of results eliminates the possibility to conduct confident statistics like multivariable analyses, but does not affect mapping purposes too much.

3.3 Cumulative probability (CP) plots

Plots of the cumulative distribution function are one of the most informative displays of geochemical distributions (Reimann et al., 2008). In the plots the concentration is plotted along the X-axis and the cumulative probability is plotted along the Y-axis, and it allows the direct visual recognition of breaks in the curve which may be indicative of different geochemical processes. Breaks in the uppermost few percentiles of the distribution are often used as thresholds for anomaly identification. Readings below the method reporting limit (MRL) are here set to half the MRL value for that element, respectively. Appendix Iprovides the CP-plots for all 51 variables.

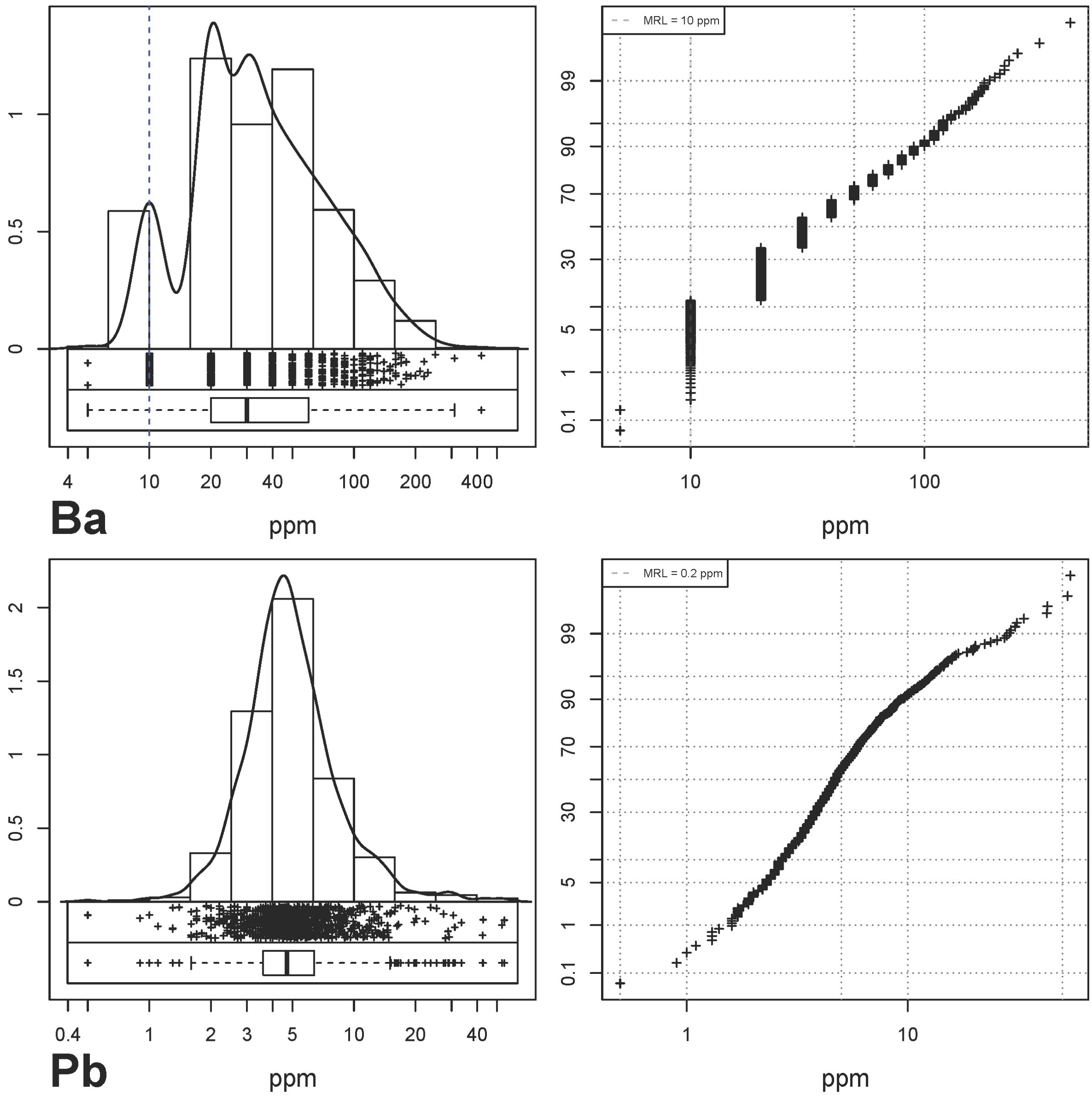

Figure 9: Combination (left) and CP plots (right) for Ba and Pb. Note how the rounding effect is shown for Ba, while Pb shows no rounding effect. Note logarithmic scale on x-axis.

3.4 Maps

Many different methods for producing geochemical maps exist (see discussion in Reimann, 2005 or in Chapter 5 of Reimann et al., 2008). In mineral exploration, the so called “growing dot maps” as introduced by Bjørklund and Gustavsson (1987) are probably most often used. However, they focus the attention almost exclusively on the high values, the “anomalies” and are less well suited to study the data in more detail, e.g., in relation to geology. It may also be argued that the "growing dot map" has limitations in detecting local anomalies as they often do not display especially high values in relation to the whole dataset, but rather high values in relation to their local surroundings. Some of these shortcomings can be helped by giving special attention to the growth increment of the symbols, and the overall size of the symbols in the map image.

	EDA symbol set	EDA symbol set used in this report extremes are accentuated	Precentiles used in this report
Highest values	+	■	98−100%
Higher values	+	+	75−98%
Inner values	·	·	25−75%
Lower values	○	○	2−25%
Lowest values	◯	◯	0−2%

Figure 10: The EDA symbol set.

The EDA (exploratory data analysis) symbol set aims to provide an optical weight for each symbol in the map (Reimann et. al, 2008). Lower values are shown by circles, the inner (most common and in many cases the "least interesting") values are shown as dots, while the higher values are shown by crosses in the original EDA symbol set. Figure 10 shows the original EDA symbols to the left, and the symbols used in this report in the middle. The percentiles used for the classes are 2 – 25 – 75 – 98% for all maps in this report.

All maps are presented in Appendix V and examples are given in Figure 11. Please note that elements where a large portion of the data (> 30%) is reported below the reporting limit, the maps are presented as growing dot maps. This is because an EDA map is build around divisions of the percentiles, and becomes meaningless to elements where a large portion of the data is reported below the reporting limit and thus "fixes" a large portion of the data to one single value (i.e. half the reporting limit). Elements presented by growing dot maps are: Au, Hf, Se, Sb and W.

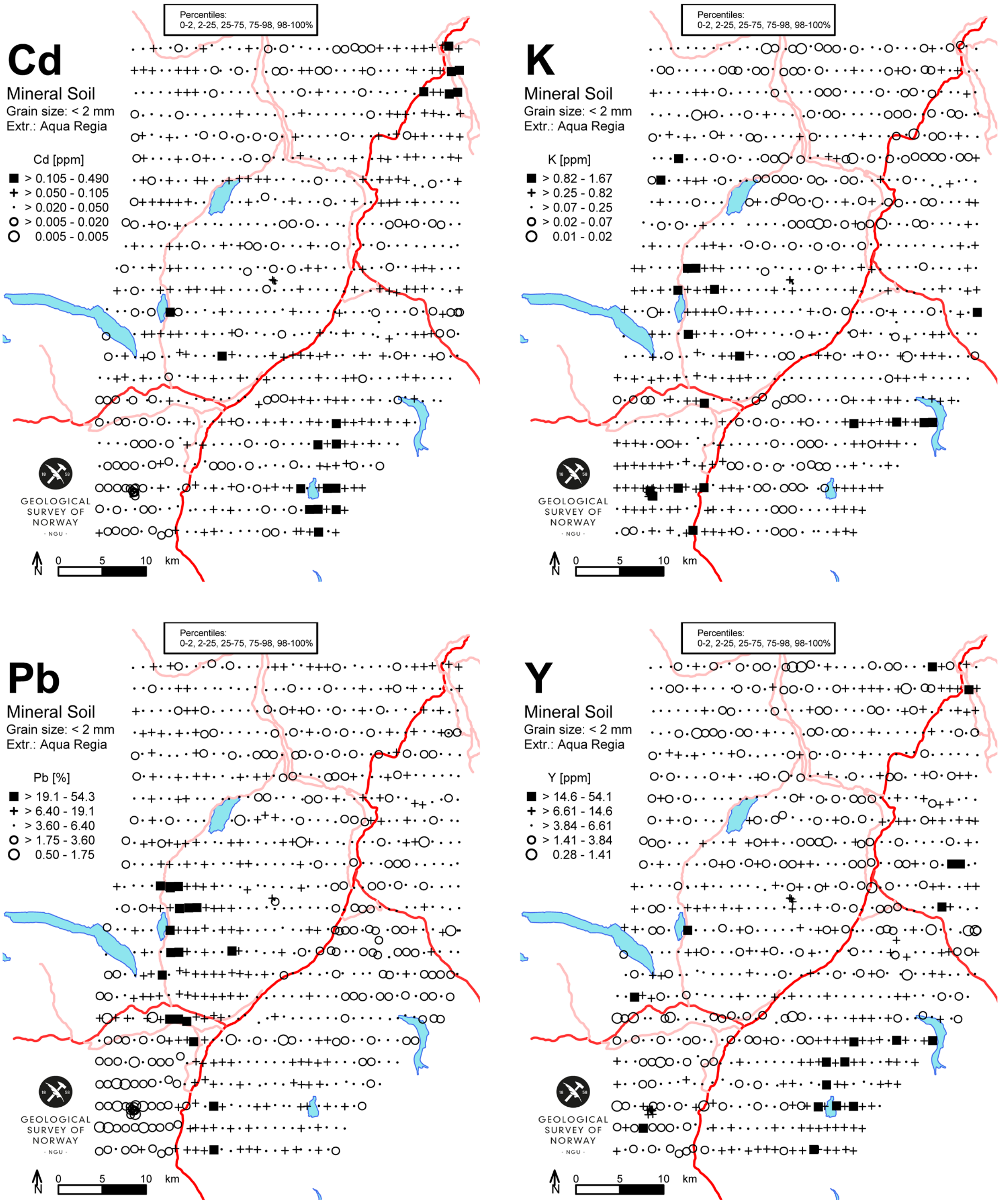

Figure 11: Geochemical maps for Cd, K, Pb and Y, showing some of the different geographic patterns elements can have. Interval breaks in the following percentiles: 0,2,25,75,98,100.

The dataset for this report is provided in the NGU geochemical database (available via: http://www.ngu.no/mins-data/Geokjemi/OppdalRennebu/), and therefore gives the reader the possibility to download and use different mapping techniques. Note, however, that in the provided data file all values below method reporting limit (MRL) are marked as “<n”, n being the MRL.

4. IMPRESSIONS OF RESULTS

A comprehensive discussion of the results is not the aim of this report, however, a few notes are necessary. First of all, all samples were taken from material that is considered to be of fairly local origin, as all fluvial and glaciofluvial deposits were avoided, based on existing quaternary deposit maps and observations in the field. The till material, at least in the central area around Gisna, shows a dominance of material that has been transported small distances, a few hundred meters or even shorter (Sandstad et al., 2017). The geochemistry also shows a close relation to the mapped bedrock geology, again indicating that material, also outside the areas where the soil consists of in situ weathered rock, has been transported only short distances.

There are several distinct anomalies in the sampled area, the most prominent features in the maps being the multi-element anomaly running W of Brattskarven in the north to Sissihøa in the south. The anomaly running south from Brattskarven carries a number of elements: Ba, Be, Bi, Ca, Ce, Cr, Cs, Ge, La, Mg, P, Pb, Rb, Sn, Sr, Th, Tl, U and W. The second largest anomaly lies in the area around Orkelsjøen The Orkelsjøen anomaly carries a somewhat different element suite: As, Cd, Ce, Ge, La, Li, Mo, Te and Y. These differences in elements might indicate that these two anomalies have different sources. The large anomaly, running east of the fault that separates the two bedrock units to the west, is possibly related to the rhyolitic volcanic, subvolcanic and volcanoplastic rocks in that area. That the anomaly carries Be (beryl), P (apatite) and Th is especially indicative of this.

An anomaly of gold and antimony is centered around Brattskarven. In addition, an anomaly is located in the north-eastern fringe of the sampled area, around Soknedal, that carries Ag and Cd.

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Table 1: Summary statistics for the MINN standard material. Median (Q50) from the Nordkinn campaign are given for comparison. All concentration units in mg/kg.

MINN standard (n=52) alphabetical												Sorted by precision			
Element	Min	Q50	Max	Precision	Nordkinn Q50	Element	Min	Q50	Max	Precision	Nordkinn Q50	Element	Precision	Element	Precision
Ag	<0.01	0.01	0.01	-	0.005	Mo	1.77	1.89	2.13	2.35	1.8	S	74	Al	2.6
Al	16300	17400	18100	25600	17085	Na	<100	100	100	-	35	Se	25	Mg	2.6
As	1.7	2.1	2.4	7.06	2.2	Nb	1.37	1.63	1.82	6.37	1.8	Ge	21	Zn	2.6
Au	<0.001	<0.001	0.001	0.0000	<0.0002	Ni	17.4	18.9	20.6	3.14	19	As	7.1	Fe	2.4
B	5	10	10	-	0.5	P	340	360	380	4.12	368	Li	6.5	Cs	2.4
Ba	50	50	50	-	49	Pb	11.2	12.5	13.7	2.97	13	Nb	6.4	Mo	2.4
Be	0.32	0.37	0.42	6.09	0.33	Rb	65.7	72.2	77.5	2.77	67	Zr	6.2	V	2.3
Bi	0.07	0.08	0.12	-	0.09	Re	<0.001	<0.001	<0.001	-	<0.001	Be	6.1	Mn	2.1
Ca	700	800	800	-	744	S	<100	100	200	74.1	100	Sc	4.9	Au	-
Cd	<0.01	0.01	0.01	-	0.01	Sb	0.03	0.03	0.05	-	0.03	In	4.6	Ag	-
Ce	24.5	27.9	30.1	3.72	26	Sc	2.8	3.0	3.3	4.94	2.1	Cu	4.2	B	-
Co	10.5	12.0	12.7	3.71	12	Se	2.8	0.3	3.3	24.7	0.3	P	4.1	Ba	-
Cr	20	21	22	-	23	Sn	0.6	0.6	1.2	-	0.6	Tl	4.1	Bi	-
Cs	4.08	4.42	4.91	2.35	4.2	Sr	3.4	3.7	4.0	4.01	3.6	Y	4.0	Ca	-
Cu	9.60	10.6	12.0	4.20	11	Ta	<0.01	<0.01	<0.01	-	<0.05	Sr	4.0	Cd	-
Fe	29500	31300	32900	23700	30902	Te	<0.01	0.01	0.01	-	0.01	Ce	3.7	Cr	-
Ga	5.60	6.04	6.47	3.56	5.5	Th	3.6	4.0	4.3	3.71	3.8	Co	3.7	Hf	-
Ge	0.05	0.07	0.09	21.2	0.08	Ti	1890	2060	2170	2.88	2163	Th	3.7	Hg	-
Hf	0.04	0.04	0.11	-	0.09	Tl	0.49	0.55	0.61	4.08	0.53	Ga	3.6	Na	-
Hg	<0.01	<0.01	0.01	-	<0.005	U	2.28	2.51	2.75	3.24	2.5	La	3.6	Re	-
In	0.014	0.016	0.019	4.63	<0.02	V	31	33	34	2.25	33	U	3.2	Sb	-
K	5100	5600	5900	26500	5544	W	<0.05	<0.05	<0.05	-	<0,1	Ni	3.1	Sn	-
La	15.7	16.7	17.7	3.55	16	Y	7.95	8.66	9.40	4.02	8.4	Pb	3.0	Ta	-
Li	15.3	17.1	19.0	6.52	16	Zn	55	58	61	2.56	59	Ti	2.9	Te	-
Mg	5500	5800	6100	25600	5946	Zr	2.2	2.4	2.6	6.18	4.1	Rb	2.8	W	-
Mn	203	217	227	2.05	235							K	2.7		

Table 2: Summary statistics for the Sagelva standard material. All concentration units are given in mg/kg. Precision calculated by dividing the median absolute deviation by the median, multiplied with 100%.

MINN standard (n=23) alphabetical										Sorted by precision			
Element				Precision	Element				Precision	Element		Element	
	Min	Q50	Max			Min	Q50	Max			Precision		Precision
Ag	<0.01	<0.01	<0.01	-	**Mo**	0.27	0.29	0.35	5.1	**Ge**	25	**Ni**	3.2
Al	11300	11900	12300	3.7	**Na**	50	100	100	-	**In**	14	**P**	2.8
As	2.4	2.7	2.9	5.5	**Nb**	0.20	0.26	0.30	5.7	**Ca**	10	**U**	2.7
Au	<0.001	<0.001	0.001	-	**Ni**	35.6	37.7	40.0	3.2	**Ti**	7.7	**Mn**	2.4
B	<10	<10	10	-	**P**	500	530	550	2.8	**Sr**	7.6	**Mg**	2.1
Ba	30	30	30	-	**Pb**	4.2	4.6	4.9	3.2	**V**	6.5	**Co**	1.7
Be	0.2	0.2	0.3	6.2	**Rb**	7.3	7.9	8.5	3.8	**Be**	6.2	**Au**	-
Bi	0.06	0.07	0.07	-	**Re**	<0.001	<0.001	<0.001	-	**Nb**	5.7	**Ag**	-
Ca	1300	1500	1600	9.9	**S**	<100	<100	100	-	**Zn**	5.7	**B**	-
Cd	0.01	0.03	0.03	-	**Sb**	0.06	0.07	0.08	-	**As**	5.5	**Ba**	-
Ce	31.2	33.0	36.3	4.0	**Sc**	2.8	3.0	3.4	4.9	**Li**	5.1	**Bi**	-
Co	8.2	8.6	9.3	1.7	**Se**	0.1	0.1	0.2	-	**Mo**	5.1	**Cd**	-
Cr	40	42	43	3.5	**Sn**	0.2	0.2	0.2	-	**Sc**	4.9	**Hf**	-
Cs	0.68	0.72	0.80	4.1	**Sr**	7.0	7.8	8.7	7.6	**Y**	4.6	**Hg**	-
Cu	21.9	24.8	26.7	3.6	**Ta**	<0.01	<0.01	<0.01	-	**Cs**	4.1	**K**	-
Fe	15000	15800	16500	3.8	**Te**	<0.01	0.02	0.03	-	**Ce**	4.0	**Na**	-
Ga	3.06	3.20	3.44	3.2	**Th**	4.1	4.5	4.8	3.3	**La**	4.0	**Re**	-
Ge	0.05	0.06	0.08	24.7	**Ti**	530	580	640	7.7	**Fe**	3.8	**S**	-
Hf	0.06	0.07	0.07	-	**Tl**	0.08	0.09	0.09	-	**Rb**	3.8	**Sb**	-
Hg	<0.01	<0.01	0.01	-	**U**	0.51	0.55	0.59	2.7	**Al**	3.7	**Se**	-
In	0.010	0.011	0.012	13.5	**V**	22	23	24	6.5	**Zr**	3.7	**Sn**	-
K	900	1000	1000	-	**W**	0.05	0.05	0.06	-	**Cu**	3.6	**Ta**	-
La	14.1	14.9	15.9	4.0	**Y**	6.70	7.13	7.66	4.6	**Cr**	3.5	**Te**	-
Li	10.2	11.6	12.8	5.1	**Zn**	25	26	27	5.7	**Th**	3.3	**Tl**	-
Mg	6600	7000	7300	2.1	**Zr**	3.9	4.0	4.4	3.7	**Ga**	3.2	**W**	-
Mn	230	243	251	2.4						**Pb**	3.2		

Table 3: Precision estimates of field and analytical duplicate samples

Field duplicates (47 pairs)				Analytical duplicates (47 pairs)			
Alphabetical		Sorted		Alphabetical		Sorted	
Element	Precision	Element	Precision	Element	Precision	Element	Precision
Ag	64	Te	98	Ag	13.7	Au	41.5
Al	18	Ag	64	Al	4.8	Na	30.6
As	64	As	64	As	7.7	S	29.3
Au	34	U	61	Au	41.5	Se	27.6
B	15	Se	48	B	9.3	W	23.6
Ba	20	W	43	Ba	6.0	Hg	20.7
Be	19	Na	41	Be	4.5	Cd	14.6
Bi	18	S	37	Bi	14.3	Bi	14.3
Ca	17	Nb	36	Ca	5.0	Ag	13.7
Cd	26	Mo	35	Cd	14.6	Hf	13.7
Ce	23	Au	34	Ce	3.1	Te	12.7
Co	25	Hf	33	Co	6.3	Sb	11.8
Cr	17	Hg	32	Cr	4.6	B	9.3
Cs	17	Y	32	Cs	4.0	Zr	9.3
Cu	20	La	30	Cu	6.4	Ge	8.7
Fe	25	Tl	28	Fe	5.2	As	7.7
Ga	21	K	28	Ga	3.7	Cu	6.4
Ge	19	Mn	26	Ge	8.7	Co	6.3
Hf	33	Zr	26	Hf	13.7	In	6.2
Hg	32	Cd	26	Hg	20.7	Li	6.1
In	16	Co	25	In	6.2	Ba	6.0
K	28	Fe	25	K	3.6	Mo	6.0
La	30	Sn	24	La	3.2	Sn	5.6
Li	22	V	23	Li	6.1	Sr	5.4
Mg	17	Ce	23	Mg	4.6	Fe	5.2
Mn	26	Li	22	Mn	5.1	Mn	5.1
Mo	35	Sb	22	Mo	6.0	Nb	5.1
Na	41	Ga	21	Na	30.6	Zn	5.1
Nb	36	Th	21	Nb	5.1	Ca	5.0
Ni	16	Ba	20	Ni	4.9	Ni	4.9
P	19	Cu	20	P	3.7	Tl	4.9
Pb	18	Be	19	Pb	3.7	Al	4.8
Rb	19	Rb	19	Rb	3.5	Cr	4.6
Re	-	Ge	19	Re	-	Mg	4.6
S	37	P	19	S	29.3	Be	4.5
Sb	22	Al	18	Sb	11.8	V	4.5
Sc	15	Bi	18	Sc	4.4	Sc	4.4
Se	48	Pb	18	Se	27.6	Ti	4.4
Sn	24	Ti	17	Sn	5.6	Cs	4.0
Sr	13	Cs	17	Sr	5.4	Y	3.8
Ta	14	Cr	17	Ta	-	Ga	3.7
Te	98	Zn	17	Te	12.7	P	3.7
Th	21	Ca	17	Th	3.5	Pb	3.7
Ti	17	Mg	17	Ti	4.4	K	3.6
Tl	28	In	16	Tl	4.9	Rb	3.5
U	61	Ni	16	U	3.4	Th	3.5
V	23	Sc	15	V	4.5	U	3.4
W	43	B	15	W	23.6	La	3.2
Y	32	Ta	14	Y	3.8	Ce	3.1
Zn	17	Sr	13	Zn	5.1	Re	-
Zr	26	Re	-	Zr	9.3	Ta	-

Table 4: Statistics for mapped data (n=877). All concentration units in mg/kg.

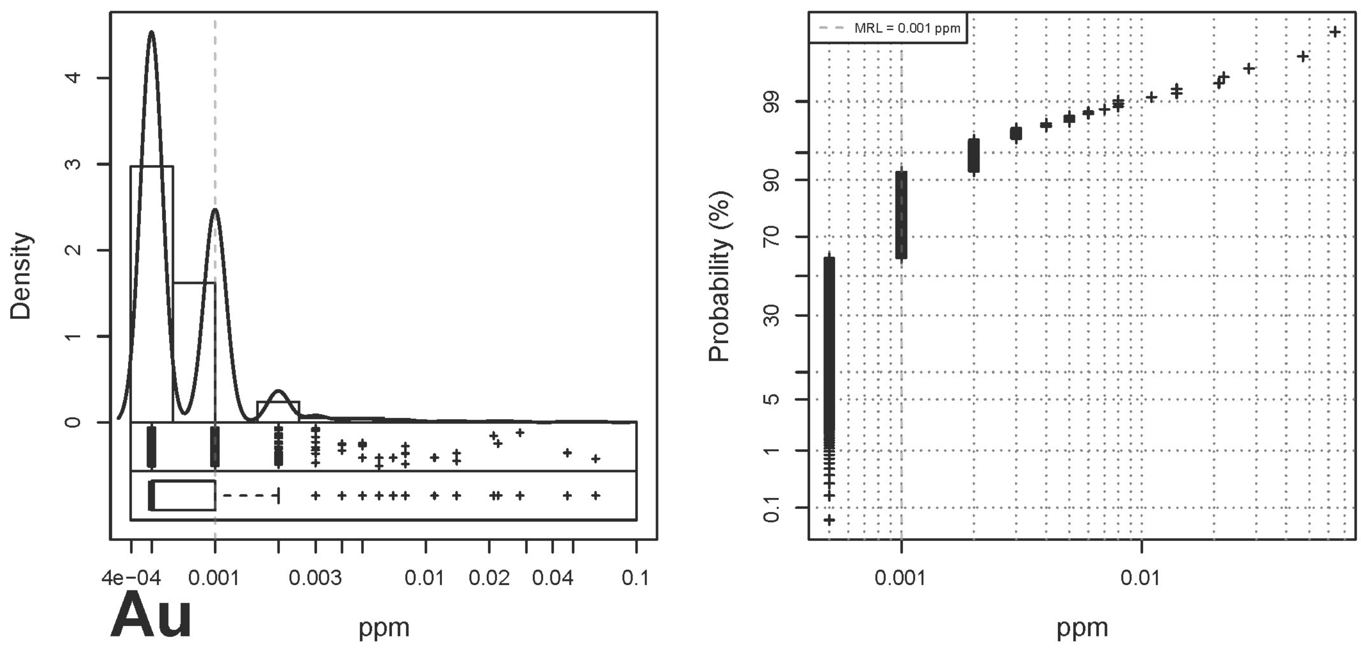
Element	n<MRL	MRL	Min	Q2	Q5	Q10	Q25	Q50	Q75	Q90	Q95	Q98	Max	Powers
Ag	94	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.03	0.05	0.08	0.11	0.43	1.9
Al	0	100	1100	4750	8100	9700	12700	16100	19900	23100	25800	29100	42800	1.6
As	0	0.1	<0.1	<0.1	0.1	0.2	0.6	1.4	2.6	5.3	8.5	13.3	240	3.7
Au	521	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.002	0.004	0.064	2.1
B	348	10	<10	<10	<10	<10	<10	10	10	10	10	10	10	0.3
Ba	2	10	<10	10	10	10	20	30	60	94	120	160	420	1.9
Be	9	0.05	<0.05	0.10	0.14	0.17	0.23	0.30	0.42	0.64	0.92	1.49	3.27	2.1
Bi	0	0.01	0.01	0.03	0.04	0.04	0.06	0.07	0.09	0.13	0.16	0.30	0.88	1.9
Ca	0	100	100	300	500	700	1100	1600	2200	3000	3800	5000	13700	2.1
Cd	24	0.01	<0.01	<0.01	0.01	0.01	0.02	0.03	0.05	0.07	0.08	0.11	0.49	2.0
Ce	0	0.02	1.55	7.99	9.81	12.9	18.2	27.8	38.7	55.2	67.3	82.4	136	1.9
Co	0	0.1	0.2	2.0	3.6	4.8	7.1	10.1	14.2	17.6	20.4	23.9	43.0	2.3
Cr	0	1.0	2	10	15	23	40	56	73	99	131	169	415	2.3
Cs	0	0.05	0.33	0.56	0.69	0.83	1.12	1.55	2.25	3.12	4.40	6.71	11.6	1.5
Cu	0	0.2	0.2	1.9	4.4	7.0	12.1	18.7	28.5	41.8	52.4	67.8	644	3.5
Fe	0	100	1600	7300	9900	12400	16600	21800	27400	33000	36600	43900	71700	1.7
Ga	0	0.05	0.97	2.14	2.61	3.07	3.95	4.86	5.79	6.83	7.88	9.59	17.8	1.3
Ge	186	0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.06	0.08	0.09	0.10	0.12	0.26	1.0
Hf	235	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	0.05	0.08	0.11	0.15	0.34	1.5
Hg	102	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.04	0.05	0.06	0.24	1.7
In	15	0.005	<0.005	0.005	0.007	0.008	0.011	0.014	0.018	0.022	0.025	0.031	0.057	1.4
K	0	100	100	200	300	400	700	1400	2500	4540	6020	8200	16700	2.2
La	0	0.2	0.7	3.3	4.5	5.7	8.0	11.4	16.3	22.4	27.0	32.7	146	2.3
Li	0	0.1	0.4	2.4	5.3	8.1	12.1	16.7	22.9	27.6	31.2	36.6	70.5	2.2
Mg	0	100	200.00	1650	2900	4000	5900	8200	11600	14700	17100	20500	30300	2.2
Mn	0	5.0	6.0	46	73	100	149	229	327	435	541	703	2280	2.6
Mo	12	0.05	<0.05	0.06	0.08	0.11	0.18	0.33	0.57	0.95	1.41	2.37	11.9	2.7
Na	272	100	<100	<100	<100	<100	<100	100	100	200	200	300	1100	1.3
Nb	3	0.05	<0.05	0.14	0.22	0.30	0.47	0.69	1.12	1.63	2.13	2.88	7.09	2.5
Ni	0	0.2	0.7	3.7	8.7	13.2	21.6	33.5	46.7	61.9	74.7	92.4	180	2.4
P	0	10	40	85	130	200	320	510	660	830	1036	1445	2580	1.8
Pb	0	0.2	0.5	1.8	2.3	2.7	3.6	4.7	6.4	9.3	12.6	19.1	54.3	2.0
Rb	0	0.1	1.2	3.0	4.2	5.4	8.5	13.7	22.0	36.5	48.2	68.2	116	2.0
Re	869	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.3
S	160	100	<100	<100	<100	<100	100.00	100	200	300	400	600	3100	1.8
Sb	656	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.08	0.11	0.18	0.64	1.4
Sc	0	0.1	0.3	0.8	1.3	1.6	2.1	2.9	3.7	4.5	5.3	6.3	10	1.5
Se	310	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.20	0.3	0.5	0.6	0.8	3.1	1.5
Sn	32	0.2	<0.2	<0.2	0.2	0.2	0.3	0.3	0.5	0.8	1.2	1.7	5.6	1.7
Sr	0	0.2	1.6	3.5	4.3	5.0	6.7	9.3	15.1	21.7	28.9	40.6	71.9	1.7
Ta	823	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.04	0.9
Te	48	0.01	<0.01	<0.01	<0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.07	0.77	2.2
Th	1	0.2	<0.2	0.7	1.0	1.3	1.9	3.0	4.7	7.0	10.1	14.0	31.7	2.5
Ti	0	50	140	360	448	536	670	870	1120	1470	1750	2100	4110	1.5
Tl	0	0.02	0.02	0.04	0.05	0.06	0.08	0.13	0.20	0.31	0.45	0.71	1.58	1.9
U	0	0.05	0.08	0.26	0.33	0.39	0.51	0.68	1.09	1.76	2.58	3.69	211	3.4
V	0	1.0	6.0	14	19	22	30	38	47	60	72	87	142	1.4
W	221	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.10	0.18	0.28	0.44	2.4	2.0
Y	0	0.05	0.3	1.42	2.17	2.86	3.84	5.07	6.60	8.93	11.3	14.5	54.1	2.3
Zn	1	2.0	<2	8.52	14	18	24	33	43	53	59	67	117	2.1
Zr	115	0.5	<0.5	<0.5	<0.5	<0.5	0.7	1.2	2.3	3.7	5.0	7.5	17.9	1.9

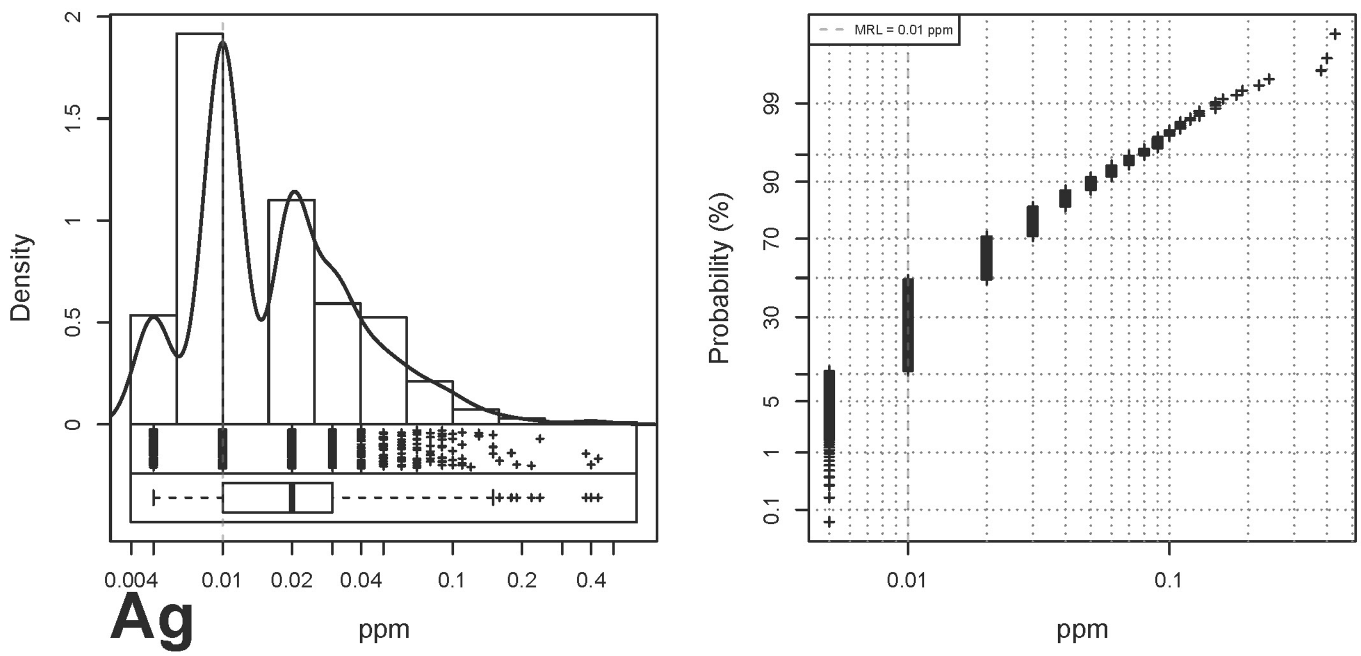
Table 5: Comparable geochemical statistics for four similar surveys. Units in mg/kg.

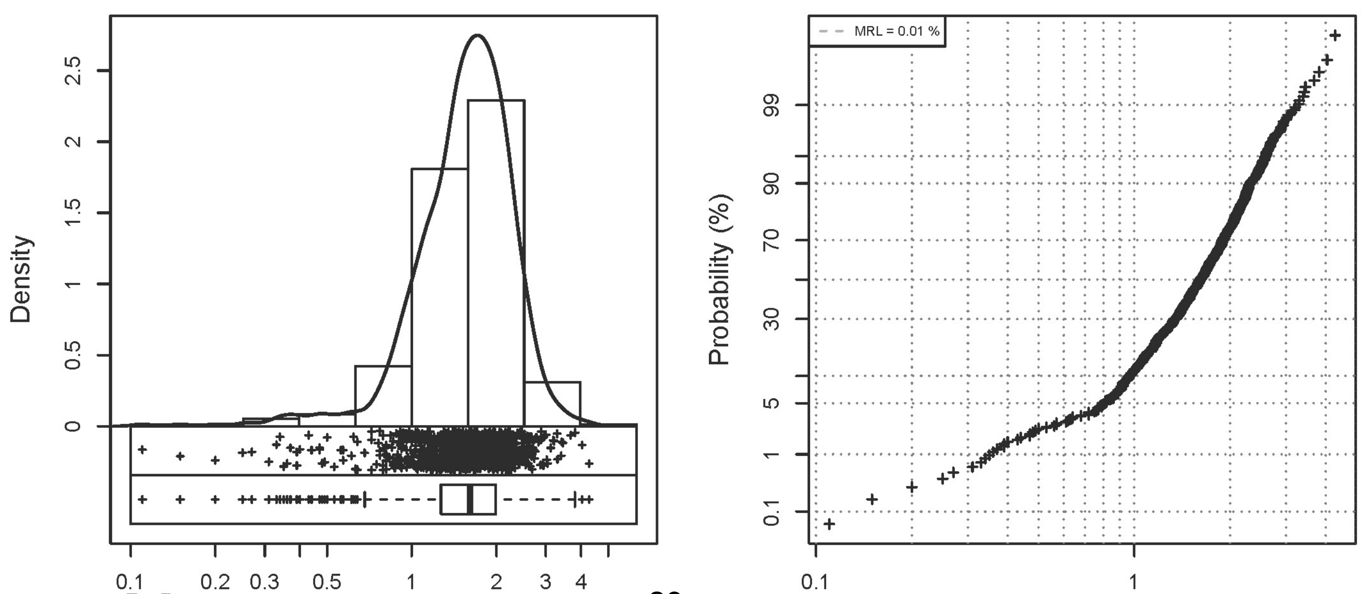
ELEMENT		Oppdal N=877			Hattfjelldal N=954			Tysfjord N=877			Nordkinn N=808		
	MRL	Q50	Q98	MAX	Q50	Q98	MAX	Q50	Q98	MAX	Q50	Q98	MAX
Ag	0.01	0.02	0.11	0.43	**0.025**	**0.194**	0.65	0.0119	0.101	**3.08**	0.011	0.077	0.22
Al	100	**16100**	29100	42800	13935	29423	38640	7010	**32600**	**86100**	15105	25453	32809
As	0.1	1.4	13.3	240	**7.52**	**47**	**498**	0.615	7.8	81.4	2.3	18	67
Au	0.001	<0.001	0.004	**0.064**	<0.002	**0.008**	0.054	0.00026	0.0037	0.035	**0.001**	0.005	0.034
B	10	10	10	10	<7.0	<7.0	7.3	<1	1.82	13.6	<1	2.2	3.8
Ba	10	30	160	420	17	78	262	17.7	**213**	**596**	**45**	127	190
Be	0.05	0.30	**1.49**	**3.3**	0.23	0.76	1.7	0.195	0.789	2.39	0.3	0.9	1.9
Bi	0.01	0.07	0.30	0.88	**0.13**	0.35	2.2	0.09	0.39	**3.25**	0.1	**0.4**	1
Ca	100	**1600**	5000	13700	1504	**6689**	**313558**	720	6460	274000	619	2357	11714
Cd	0.01	0.03	0.11	0.49	<0.05	**0.22**	**0.74**	0.0188	0.127	0.655	0.02	0.13	0.71
Ce	0.02	27.8	82.4	136	37.1	110	225	38	**190**	593	**54**	174	**799**
Co	0.1	10.1	23.9	43.0	**11**	**35**	69	2.37	22.9	65.2	10	20	**179**
Cr	1.0	**56**	**169**	415	34	101	**885**	7.71	104	343	21	43	187
Cs	0.05	1.55	**6.71**	**11.6**	1.1	3.8	9.8	1.05	5.6	9.78	**2.8**	5.9	11
Cu	0.2	18.7	67.8	**644**	**23.4**	**81.3**	210	4.33	65.6	390	16	42	660
Fe	100	21800	43900	71700	27476	62888	95312	17300	**46400**	70300	**28010**	45063	**158298**
Ga	0.05	4.86	9.59	17.8	4	11.6	26.4	**5.43**	**14.9**	**27.3**	5	9	12
Ge	0.05	**0.06**	0.12	0.26	<0.10	0.18	0.31	<0.1	**0.30**	0.43	<0.1	0.23	**0.46**
Hf	0.02	0.03	0.15	0.34	0.053	0.18	0.37	0.0271	0.13	0.39	**0.09**	**0.25**	**0.57**
Hg	0.01	0.01	0.06	**0.24**	0.018	0.06	0.23	0.0107	0.05	0.18	0.011	0.04	0.17
In	0.005	0.014	0.031	0.057	<0.020	0.05	**0.26**	**0.0226**	**0.09**	0.23	<0.02	0.04	0.07
K	100	1400	8200	16700	663	3596	10871	1210	**10700**	**18900**	**3712**	8298	12902
La	0.2	11.4	32.7	146	14	53	128	18.2	**90.7**	**438**	**20**	82	408
Li	0.1	**16.7**	36.6	70.5	12	27	73	7.92	**46.3**	**83**	12	29	59
Mg	100	**8200**	20500	30300	7204	19812	**85382**	2090	**21500**	60800	4933	9280	21057
Mn	5.0	229	703	2280	**335**	**1344**	5042	129	812	2410	229	791	**18372**
Mo	0.05	0.33	2.37	11.9	0.54	3.6	18	**0.909**	**28.1**	**136**	0	4	23
Na	100	**100**	300	1100	32	142	626	56.2	**376**	**2530**	38	122	373
Nb	0.05	0.69	2.88	7.09	0.72	3.7	16	**2.43**	**10.7**	**17.9**	1.6	4.1	6.5
Ni	0.2	**33.5**	**92.4**	180	25	80	**364**	3.53	59.8	133	18	32	81
P	10	510	1445	2580	**516**	1481	**5187**	285	**1580**	2970	357	890	2126
Pb	0.2	4.7	19.1	54.3	**10.6**	**28.5**	367	6.59	26.4	**454**	8.9	28	134
Rb	0.1	13.7	68.2	116	8.5	32	68	**19.8**	**90.3**	**195**	42	83	135
Re	0.001	<0.001	<0.001	0.001	<0.010	<0.010	<0.010	<0.001	0.00112	0.00226	<0.001	0.0019	0.0031
S	100	100	600	3100	116	575	4353	**126**	**733**	**4520**	110	440	1746
Sb	0.05	<0.05	0.18	0.64	0.067	**0.45**	**13**	0.04	0.21	1.69	**0.11**	0.38	1.2
Sc	0.1	**2.9**	6.3	10	2.4	6.2	17	1.9	**8.97**	**21.2**	1.9	3.6	5.7
Se	0.2	0.20	0.8	3.1	<0.5	1.1	**6**	**0.22**	**1.77**	5.98	0.4	1.2	4.1
Sn	0.2	0.3	1.7	5.6	0.24	1.1	6.9	**0.86**	**3.16**	**81.3**	0.6	1.1	1.7
Sr	0.2	**9.3**	**40.6**	71.9	8.3	31	252	2.47	24.6	**1260**	5.6	23	52
Ta	0.01	<0.01	0.01	0.04	<0.05	<0.05	<0.05	<0.05	<0.05	**0.086**	<0.05	<0.05	<0.05
Te	0.01	**0.02**	0.07	**0.77**	<0.07	**0.14**	0.49	<0.02	0.1	0.34	<0.02	0.05	0.08
Th	0.2	3.0	14.0	31.7	4.3	12	15	**5.05**	**27.7**	**50.6**	5	11	20
Ti	50	870	2100	4110	755	2587	**7213**	1280	**3710**	5540	**1527**	3060	4303
Tl	0.02	0.13	**0.71**	1.58	0.09	0.28	0.4	**0.16**	0.69	1.54	0.3	0.6	**1.9**
U	0.05	0.68	3.69	**211**	0.82	4.3	20	**1.17**	**18.3**	120	1	4	34
V	1.0	**38**	87	142	29	100	**281**	18.5	**105**	191	29	56	89
W	0.05	0.07	0.44	2.4	<0.05	0.25	2	**0.10**	**0.78**	**2.3**	<0.1	<0.1	0.22
Y	0.05	5.07	14.5	54.1	5.8	22	92	**6.36**	28.8	80.5	10	**42**	**163**
Zn	2.0	33	67	117	45.9	110	**1335**	27.8	**113**	317	**49**	94	254
Zr	0.5	1.2	7.5	17.9	2.8	9.1	23	0.876	5.03	15.8	**4**	**12**	**29**

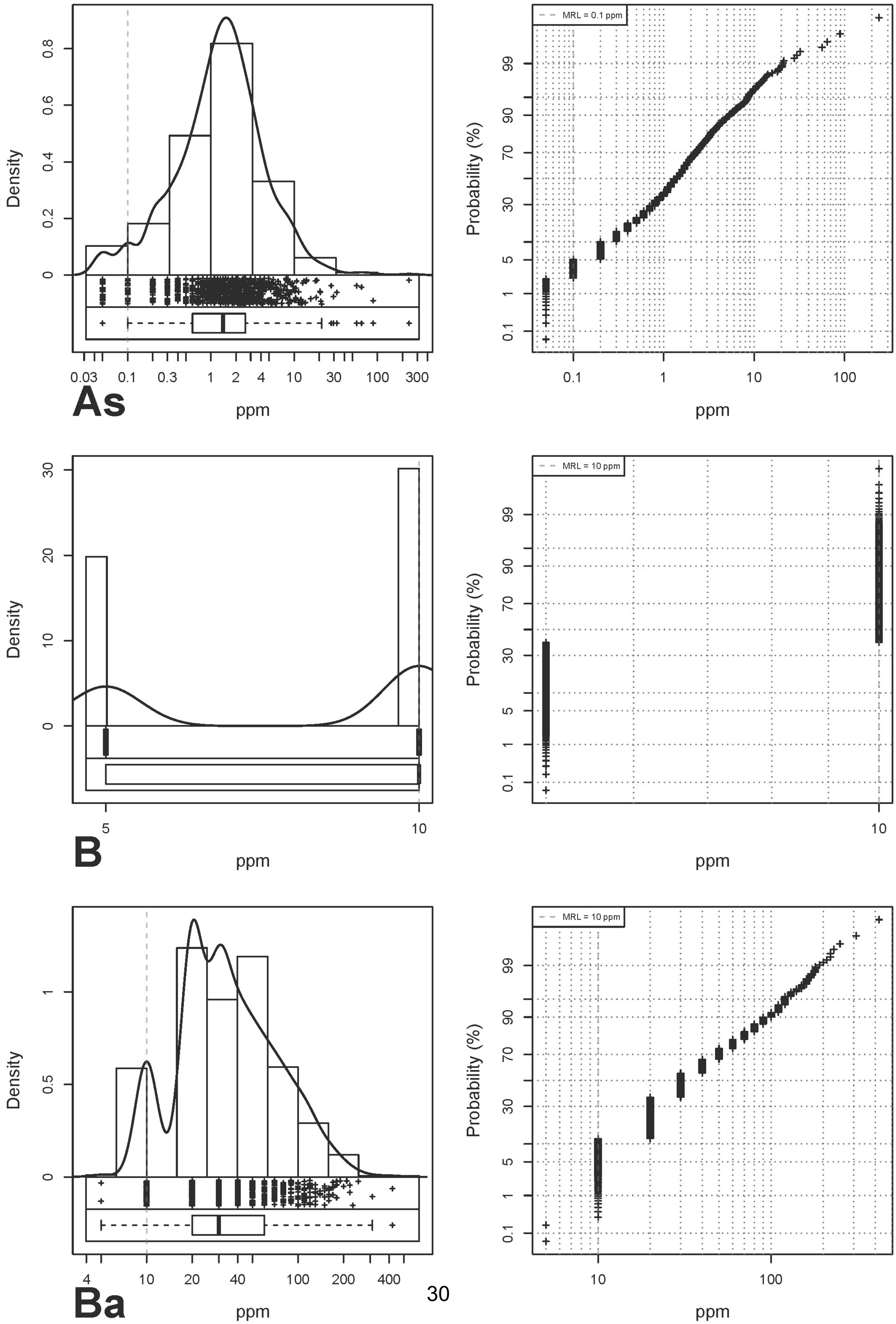
Appendix I Cumulative probability plots (CP plots) and combination plots of all analyzed elements.

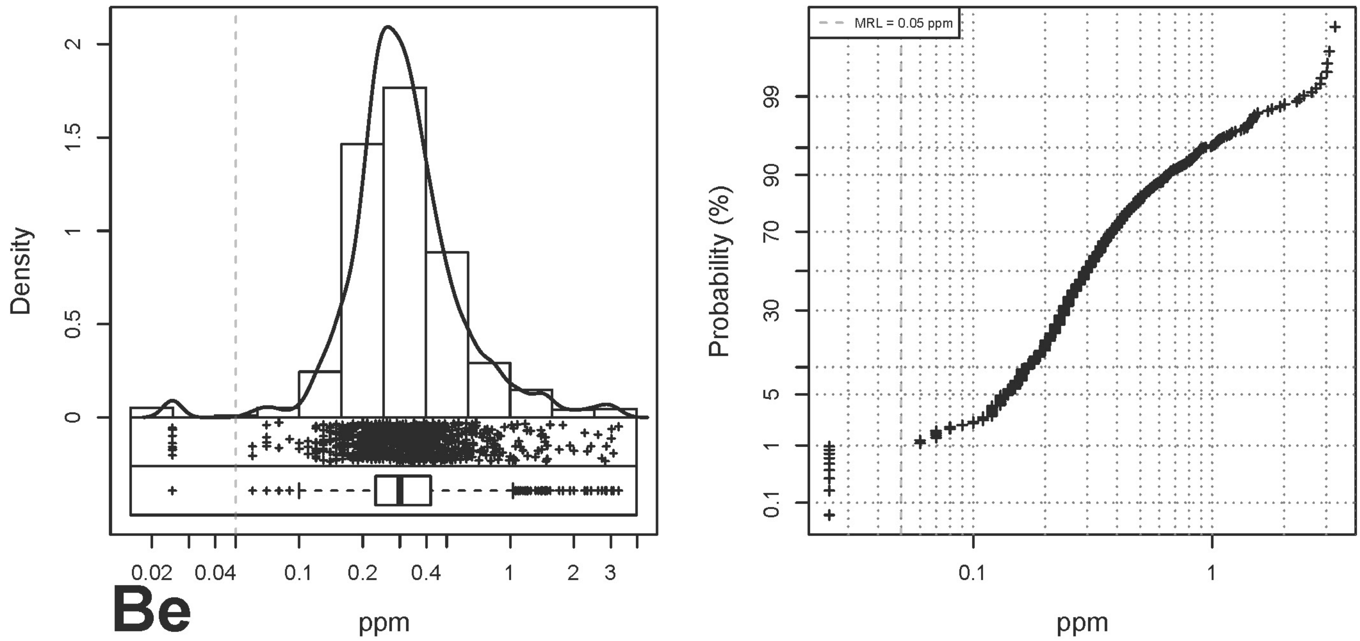
Ordinary field samples only (no standards or duplicates included).
Please note that readings below the reporting limit are set to half of the reporting limit value.
Also note the different concentration units.

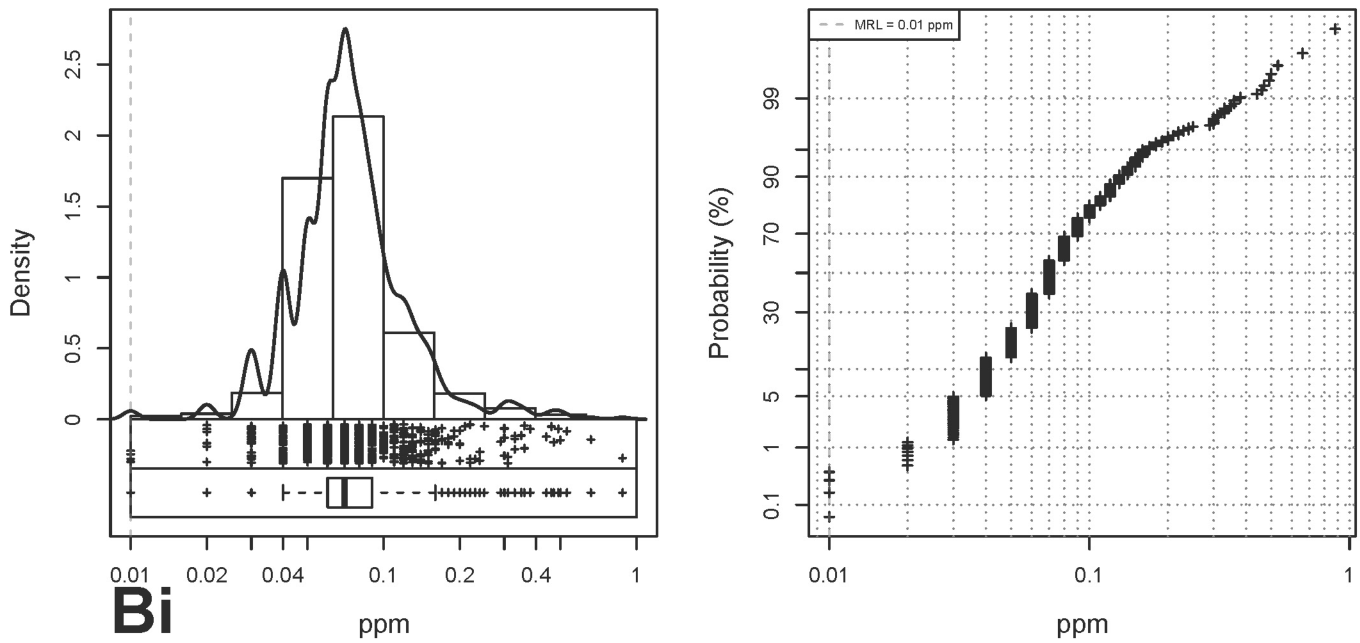

Density
ppm
Au
MRL = 0.001 ppm
Probability (%)
4e−04
0.001
0.003
0.01
0.02
0.04
0.1

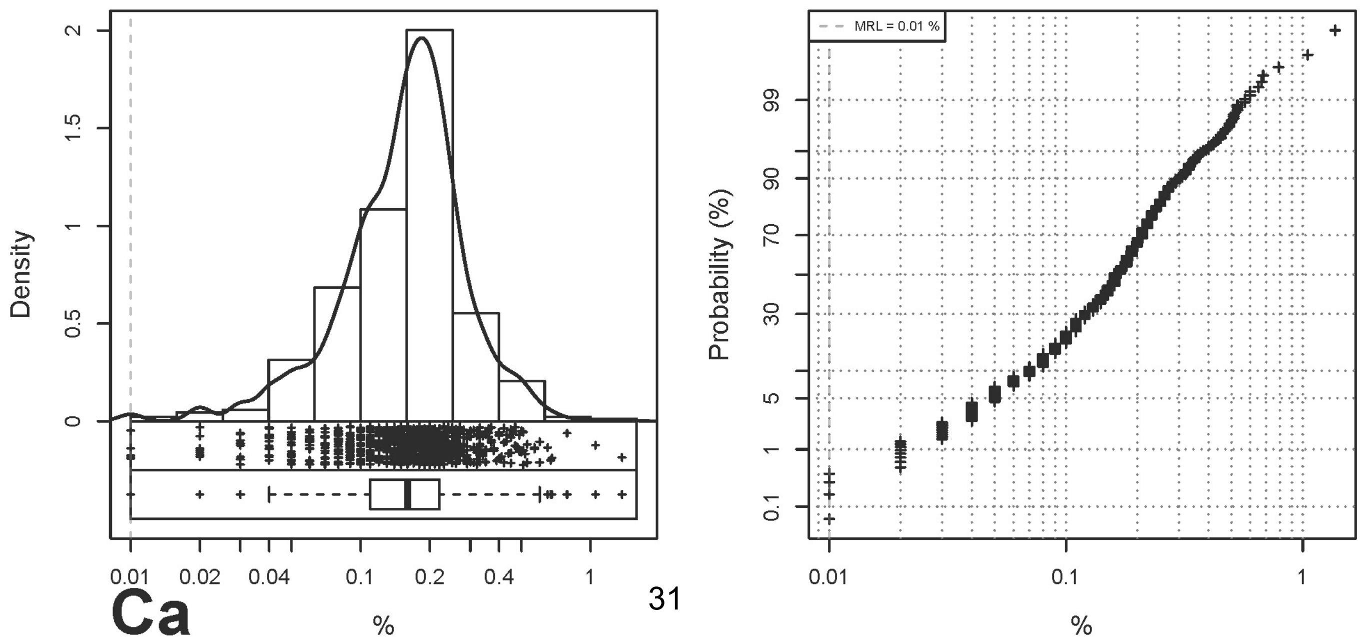

Density
ppm
Ag
MRL = 0.01 ppm
Probability (%)
0.004
0.01
0.02
0.04
0.1
0.2
0.4

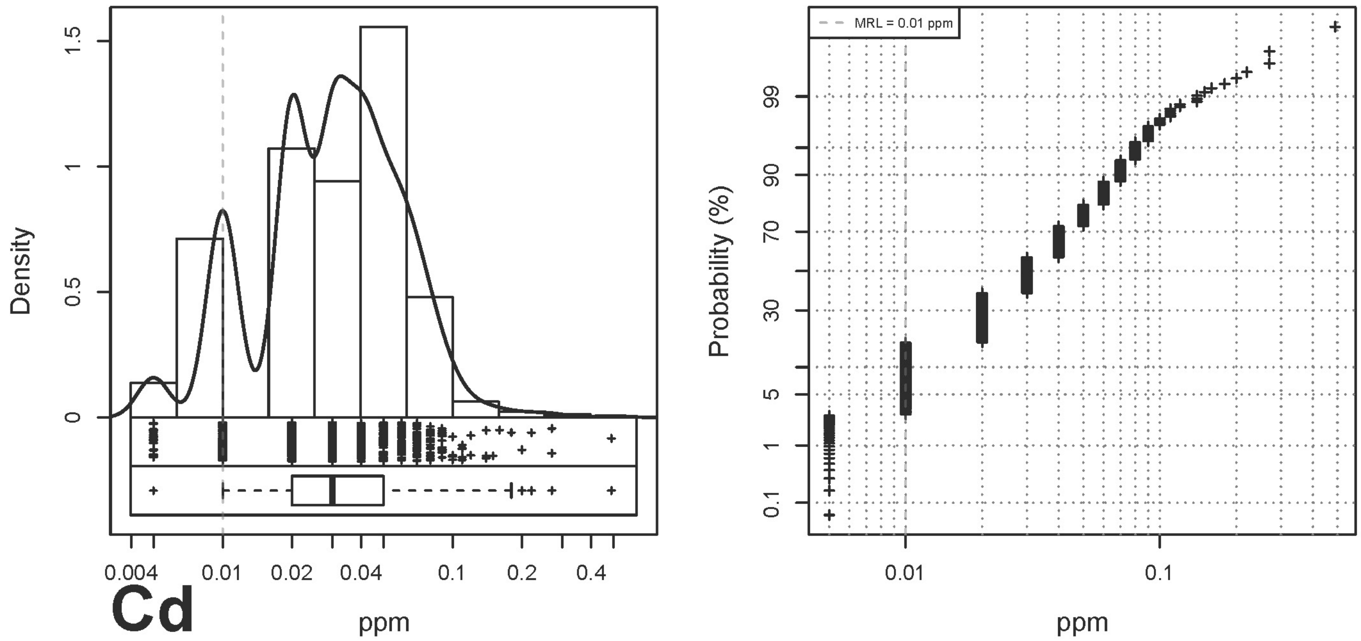

Density
%
Al
MRL = 0.01 %
Probability (%)
0.1
0.2
0.3
0.5
1
2
3
4

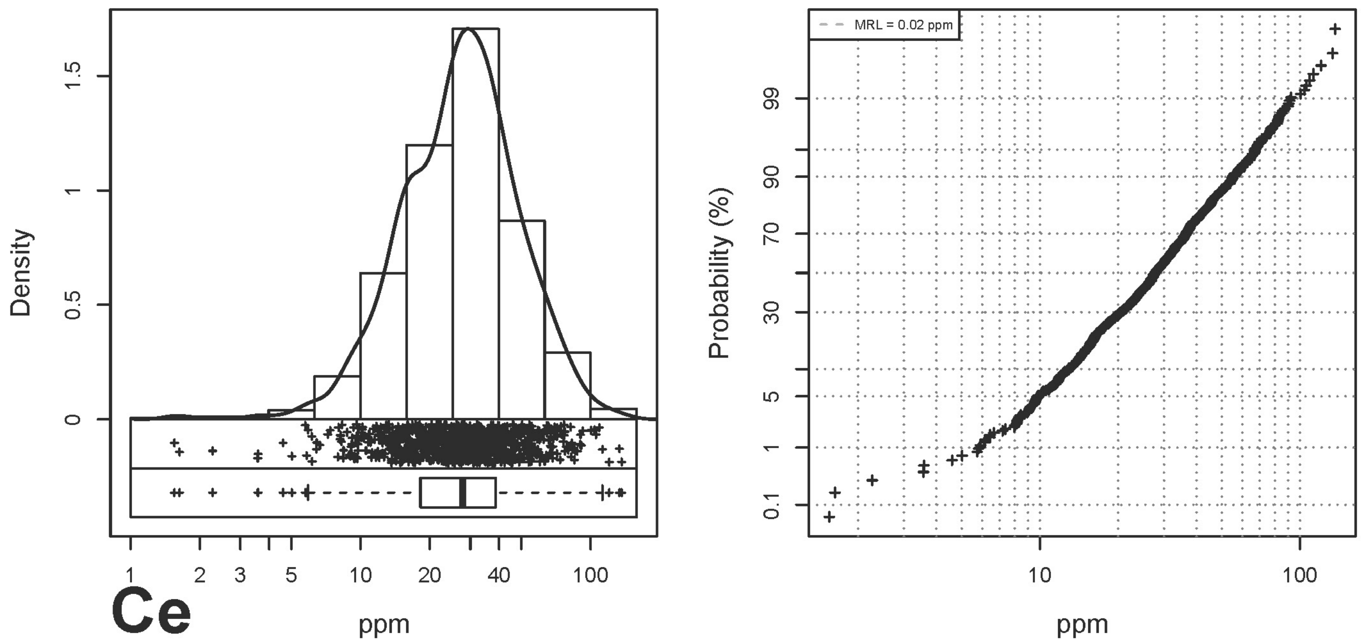

Density
0
0.2
0.4
0.6
0.8
0.03
0.1
0.3
1
2
4
10
30
100
300
As
ppm
MRL = 0.1 ppm
Probability (%)
0.1
1
5
30
70
90
99
0.1
1
10
100
ppm
Density
0
10
20
30
5
10
B
ppm
MRL = 10 ppm
Probability (%)
0.1
1
5
30
70
90
99
10
ppm
Density
0
0.5
1
4
10
20
40
100
200
400
Ba
ppm
MRL = 10 ppm
Probability (%)
0.1
1
5
30
70
90
99
10
100
ppm

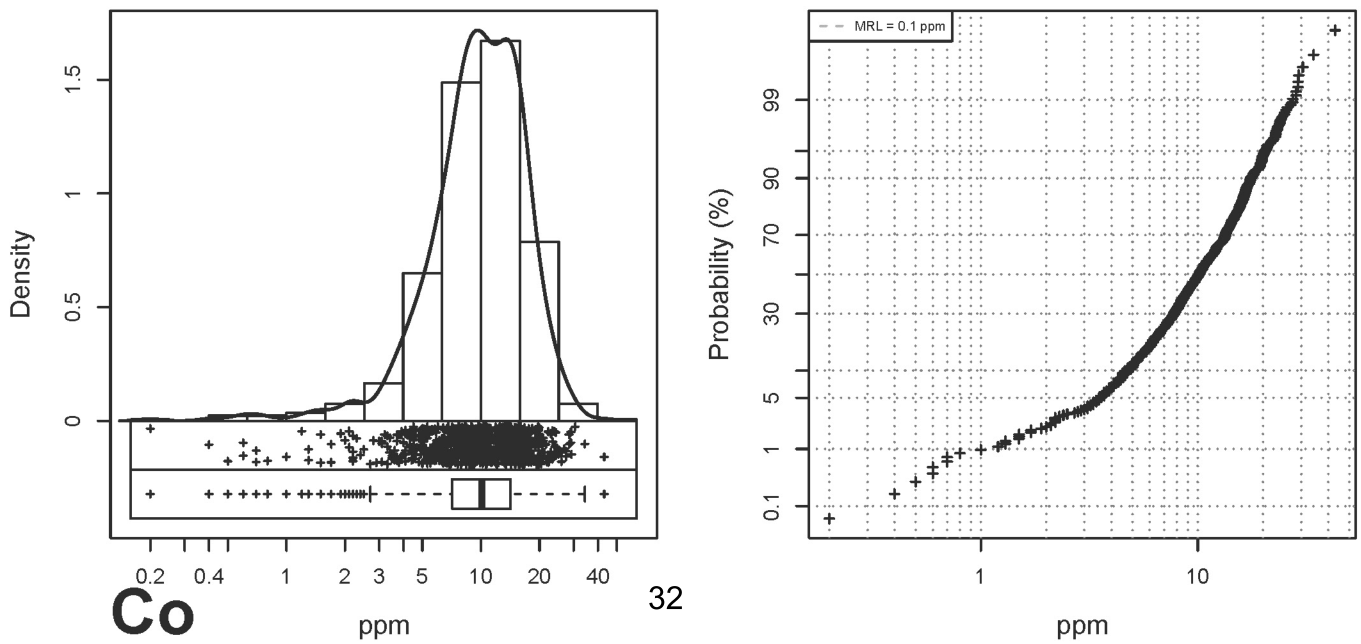

Density
0 0.5 1 1.5 2
0.02 0.04 0.1 0.2 0.4 1 2 3
Be
ppm
MRL = 0.05 ppm
Probability (%)
0.1 1 5 30 70 90 99
0.1 1
ppm

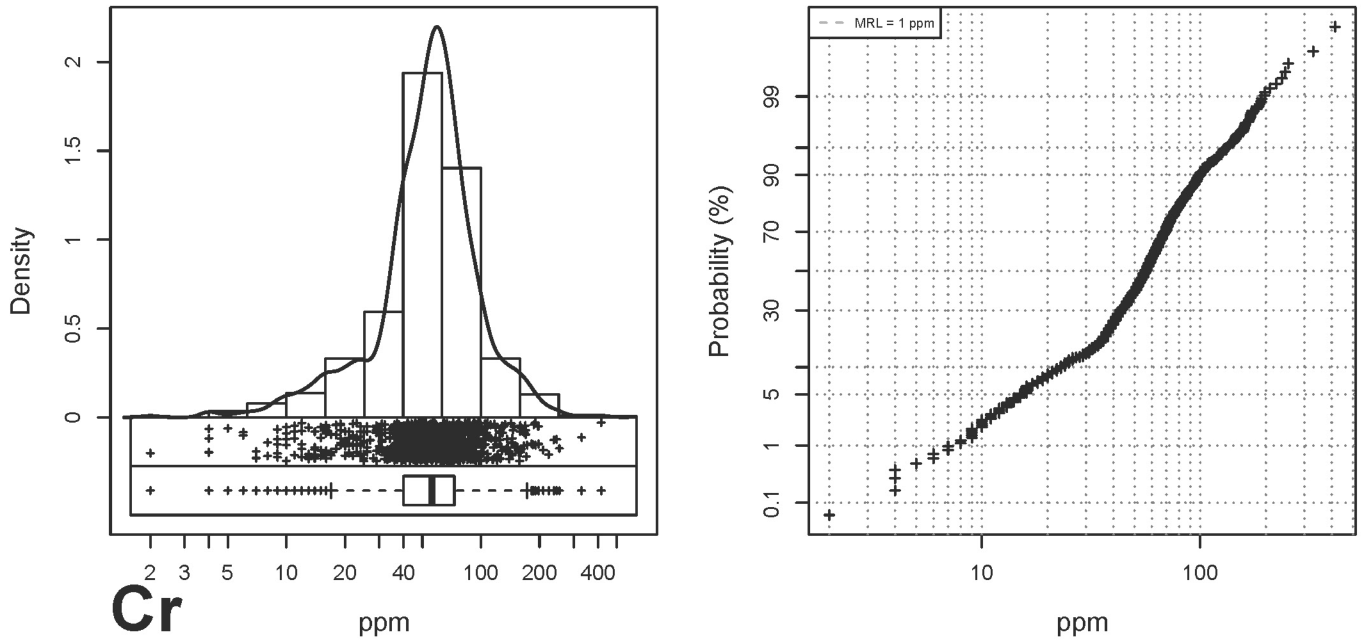

Density
0 0.5 1 1.5 2 2.5
0.01 0.02 0.04 0.1 0.2 0.4 1
Bi
ppm
MRL = 0.01 ppm
Probability (%)
0.1 1 5 30 70 90 99
0.01 0.1 1
ppm


Density
0 0.5 1 1.5 2
0.01 0.02 0.04 0.1 0.2 0.4 1
Ca
%
MRL = 0.01 %
Probability (%)
0.1 1 5 30 70 90 99
0.01 0.1 1
%

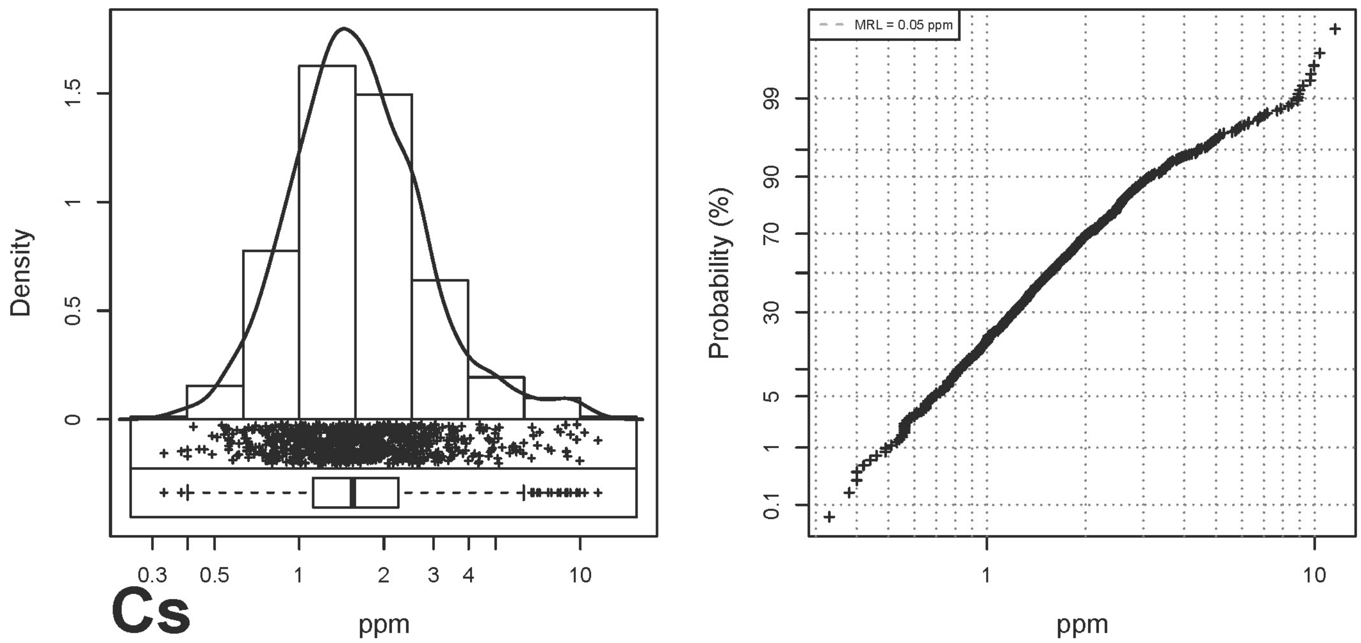

Density
0
0.5
1
1.5
0.004
0.01
0.02
0.04
0.1
0.2
0.4
ppm
MRL = 0.01 ppm
Probability (%)
0.1
1
5
30
70
90
99
0.01
0.1
ppm
Cd


Density
0
0.5
1
1.5
1
2
3
5
10
20
40
100
ppm
MRL = 0.02 ppm
Probability (%)
0.1
1
5
30
70
90
99
10
100
ppm
Ce

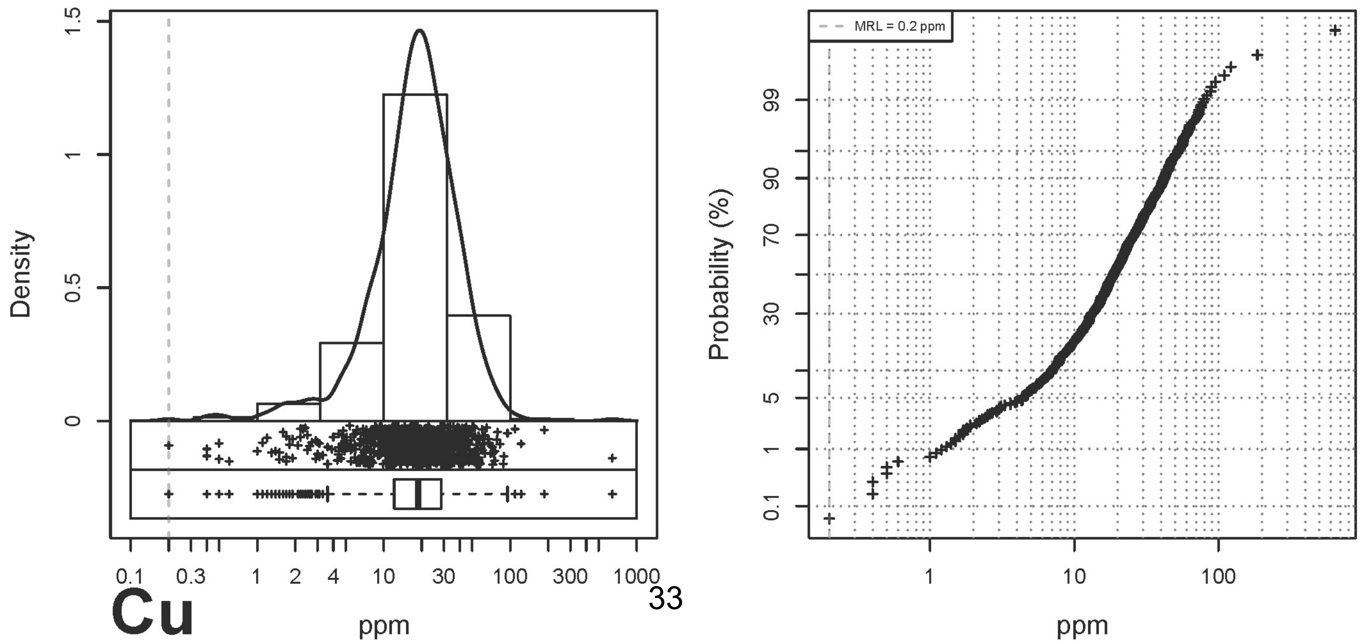

Density
0
0.5
1
1.5
0.2
0.4
1
2
3
5
10
20
40
ppm
MRL = 0.1 ppm
Probability (%)
0.1
1
5
30
70
90
99
1
10
ppm
Co


Density
ppm
MRL = 1 ppm
Probability (%)
ppm

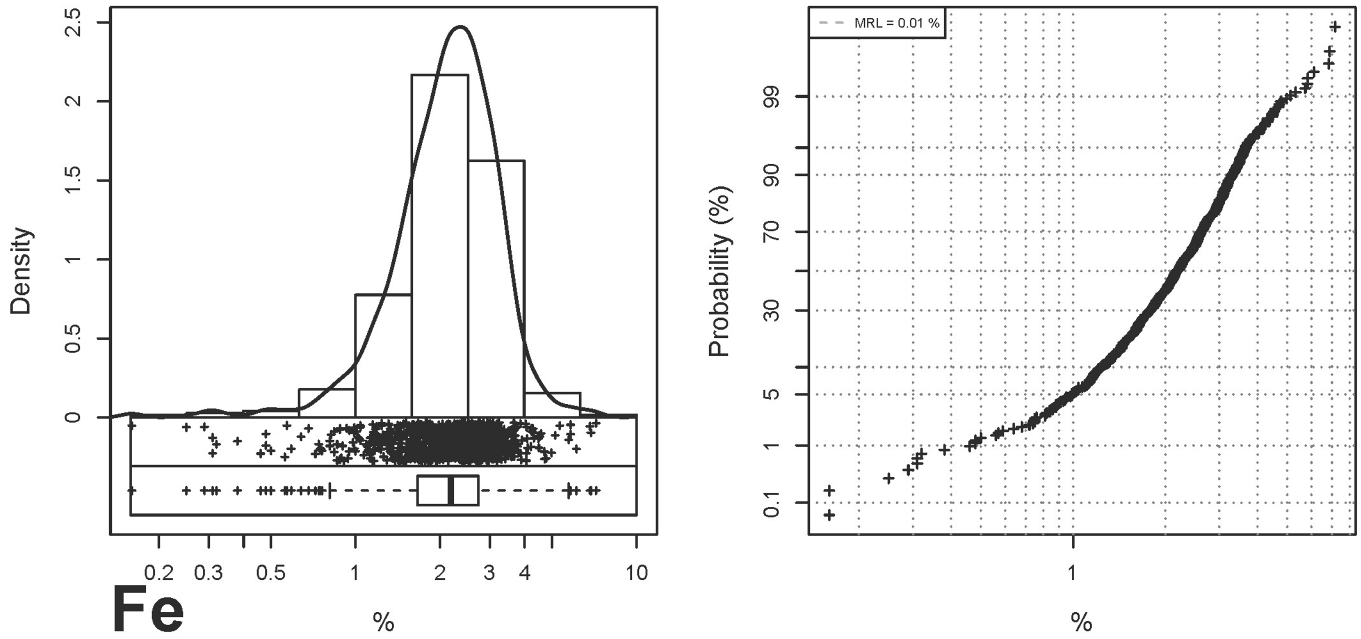
Cr

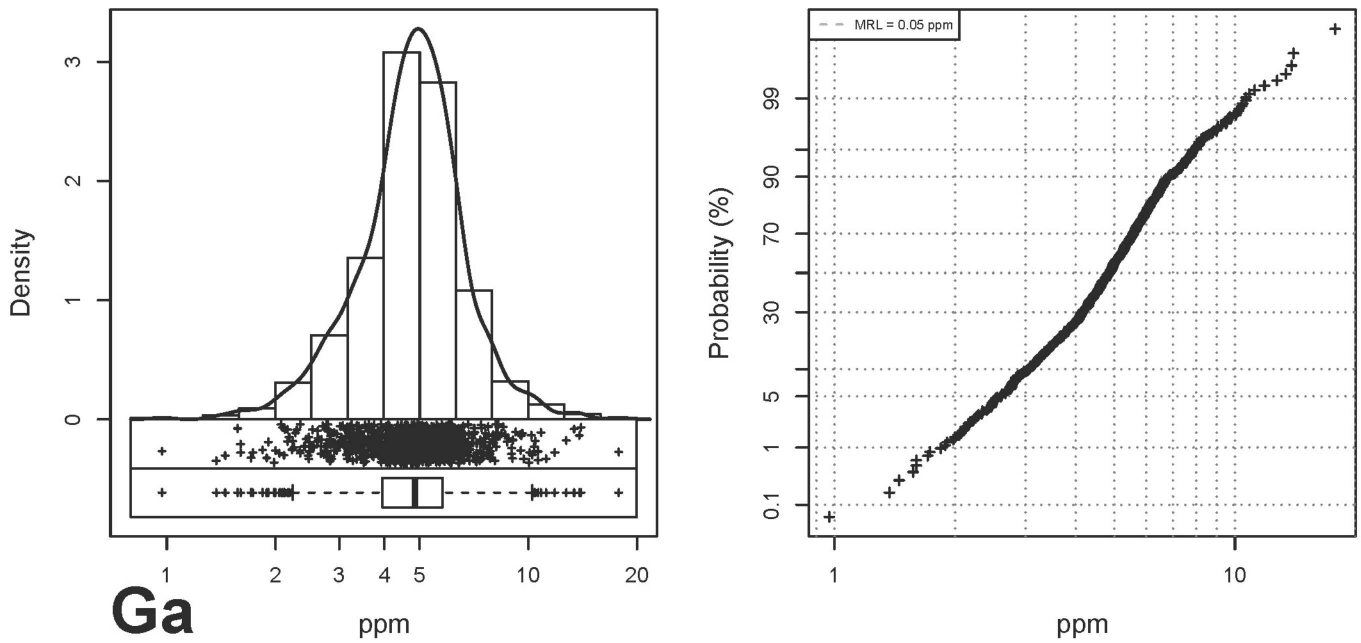

Density
ppm
MRL = 0.05 ppm
Probability (%)
ppm

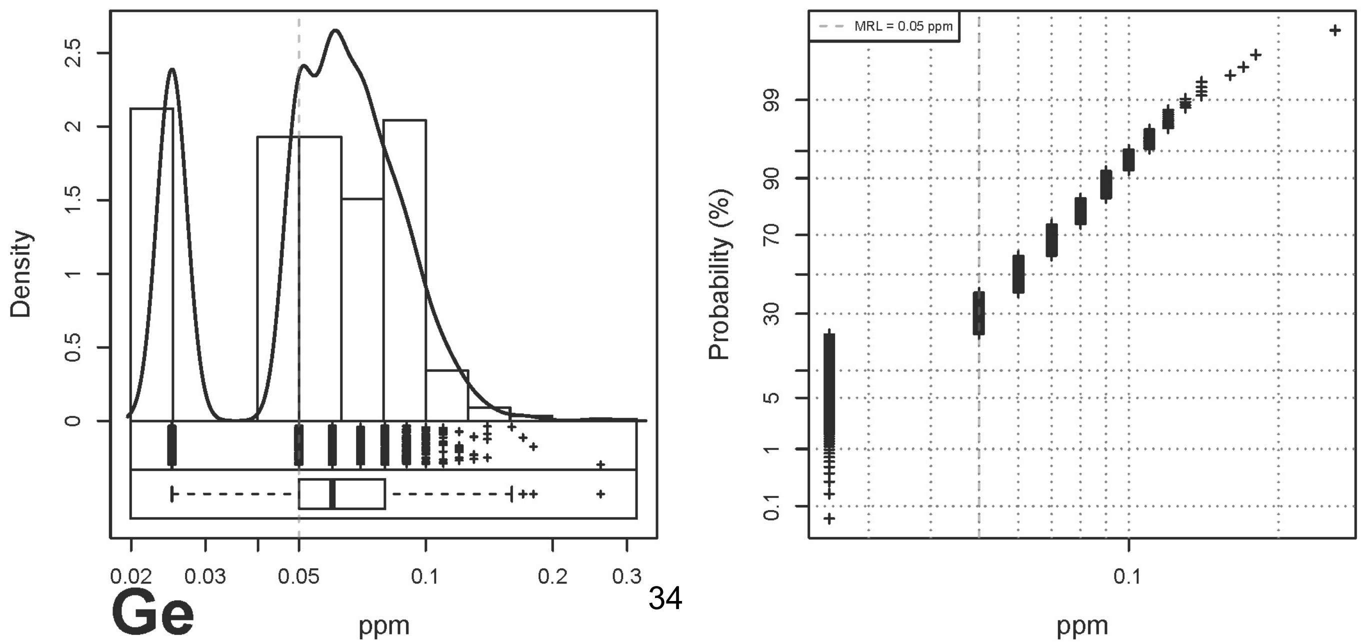
Cs

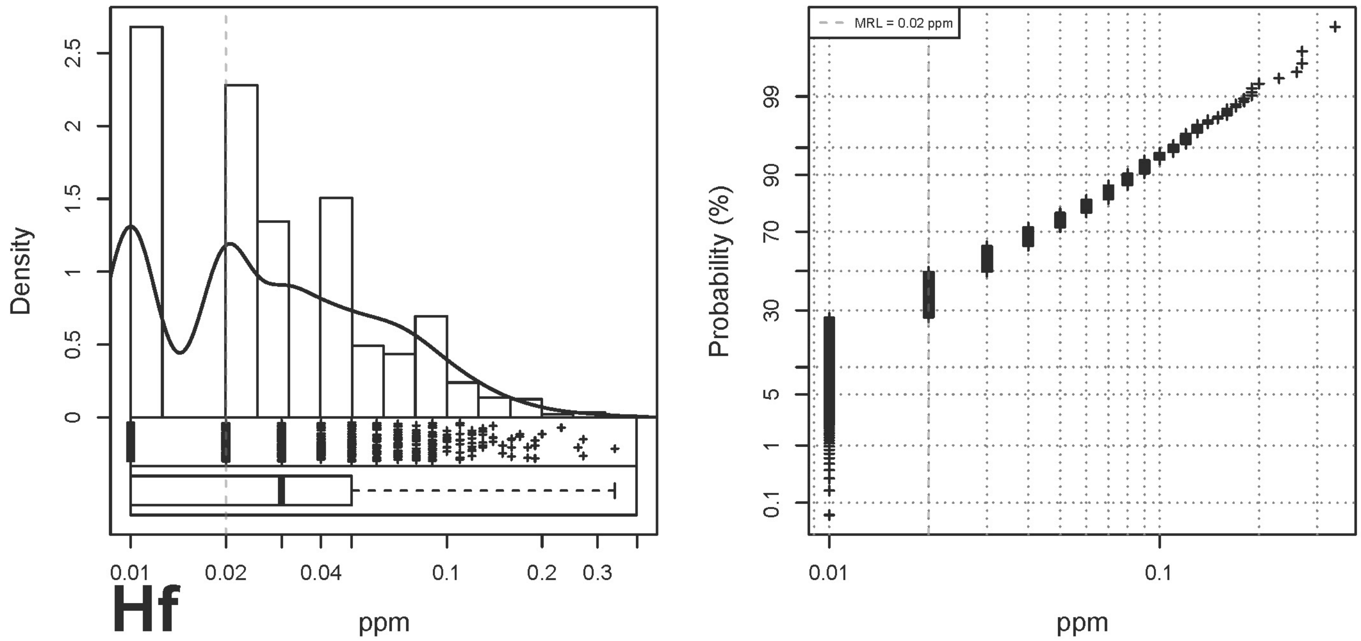

Density
ppm
MRL = 0.2 ppm
Probability (%)
ppm

Cu


Density
%
Fe
Probability (%)
MRL = 0.01 %
%

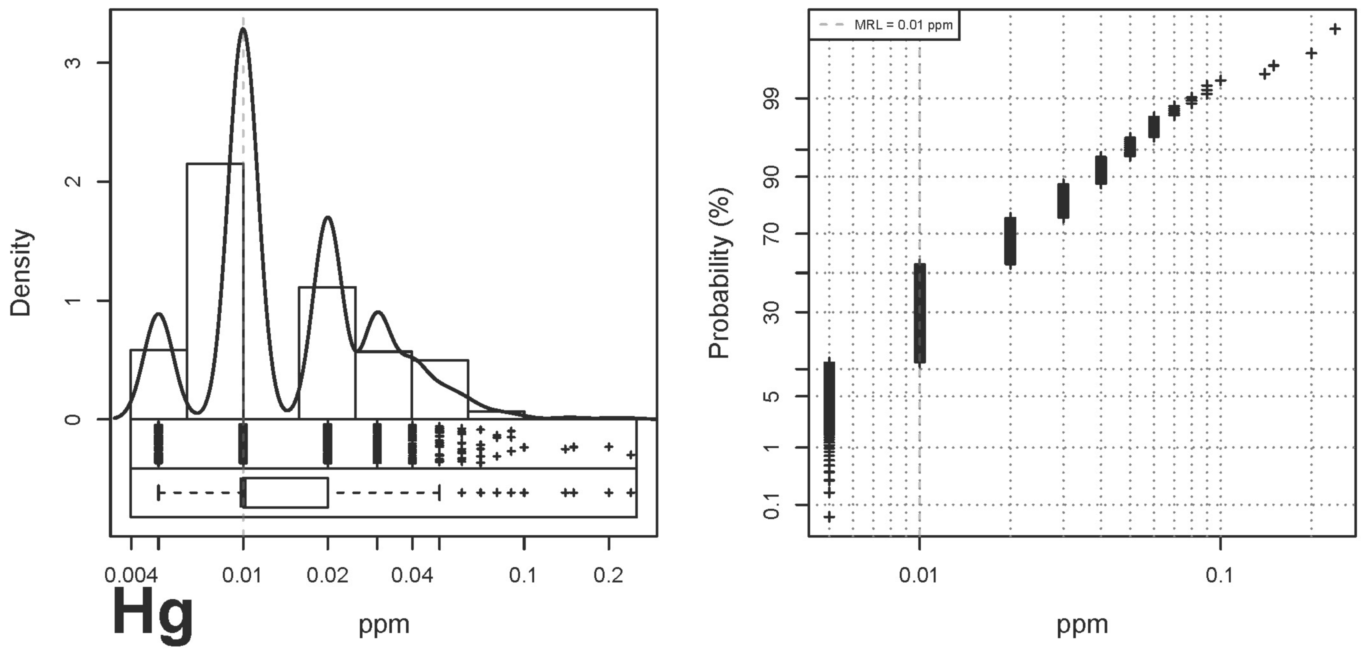

Density
ppm
Ga
Probability (%)
MRL = 0.05 ppm
ppm


Density
ppm
Ge
Probability (%)
MRL = 0.05 ppm
ppm



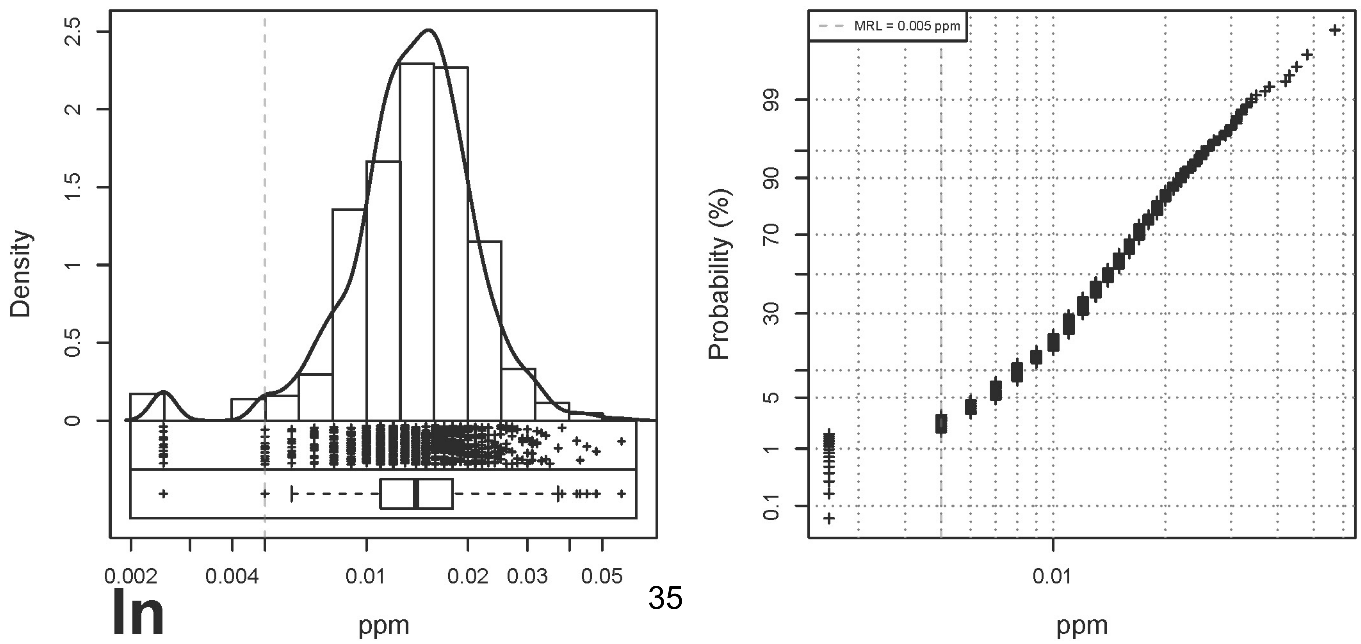
Density
ppm
MRL = 0.02 ppm
Probability (%)
ppm

Hf



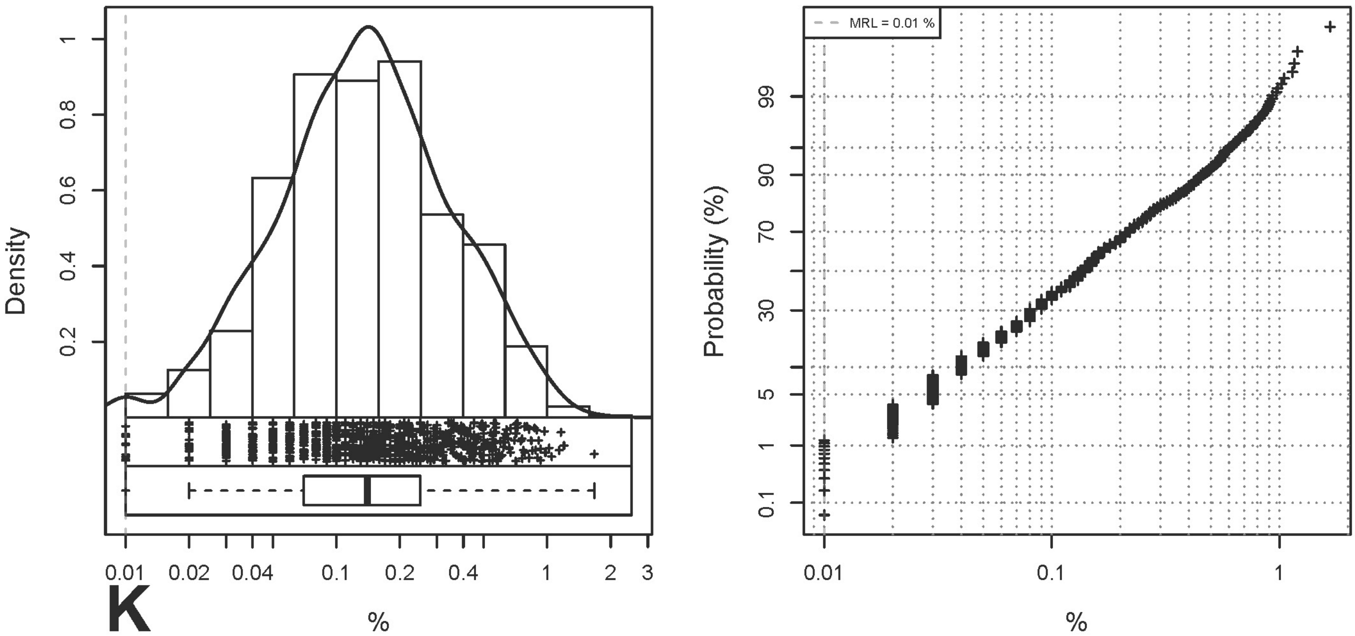
Density
ppm
MRL = 0.01 ppm
Probability (%)
ppm

Hg

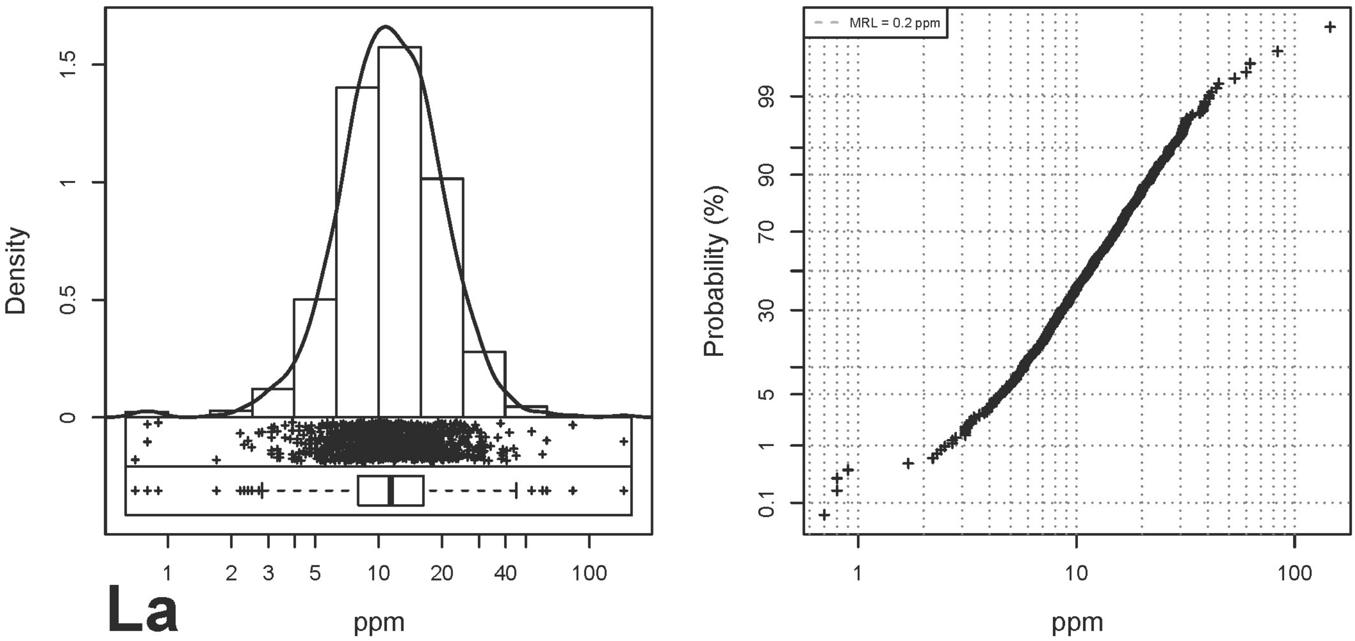


Density
ppm
MRL = 0.005 ppm
Probability (%)
ppm

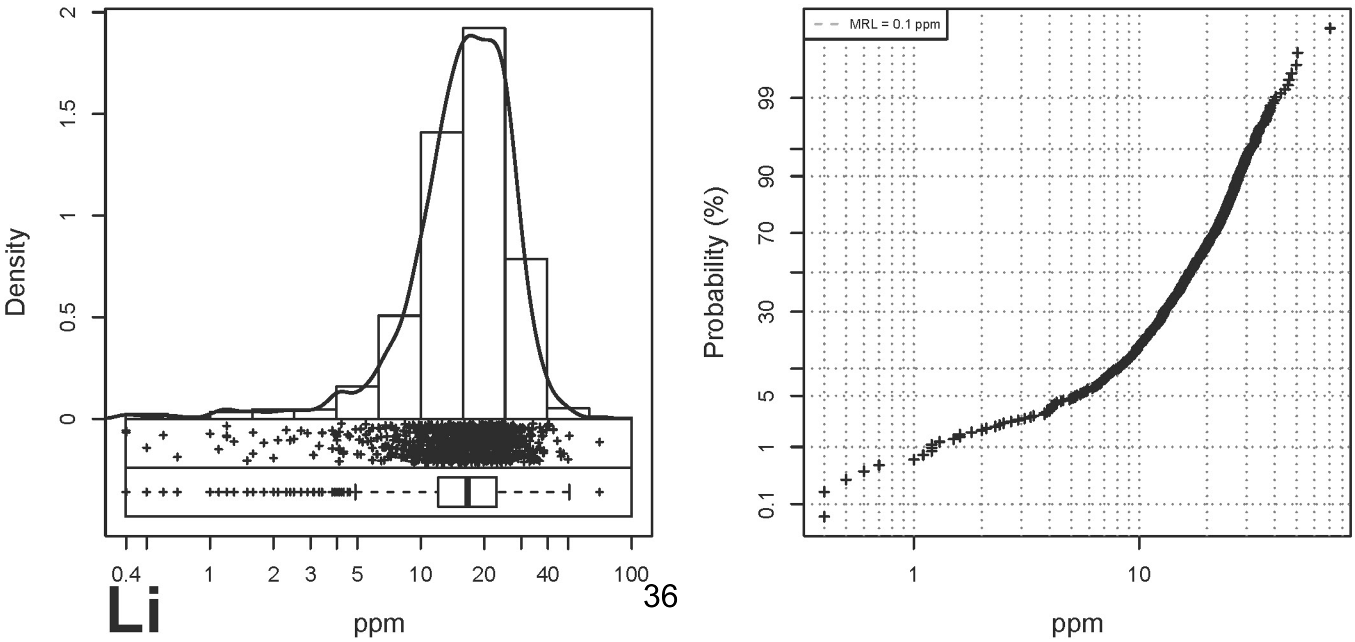
In


Density
Probability (%)
MRL = 0.01 %
%
%

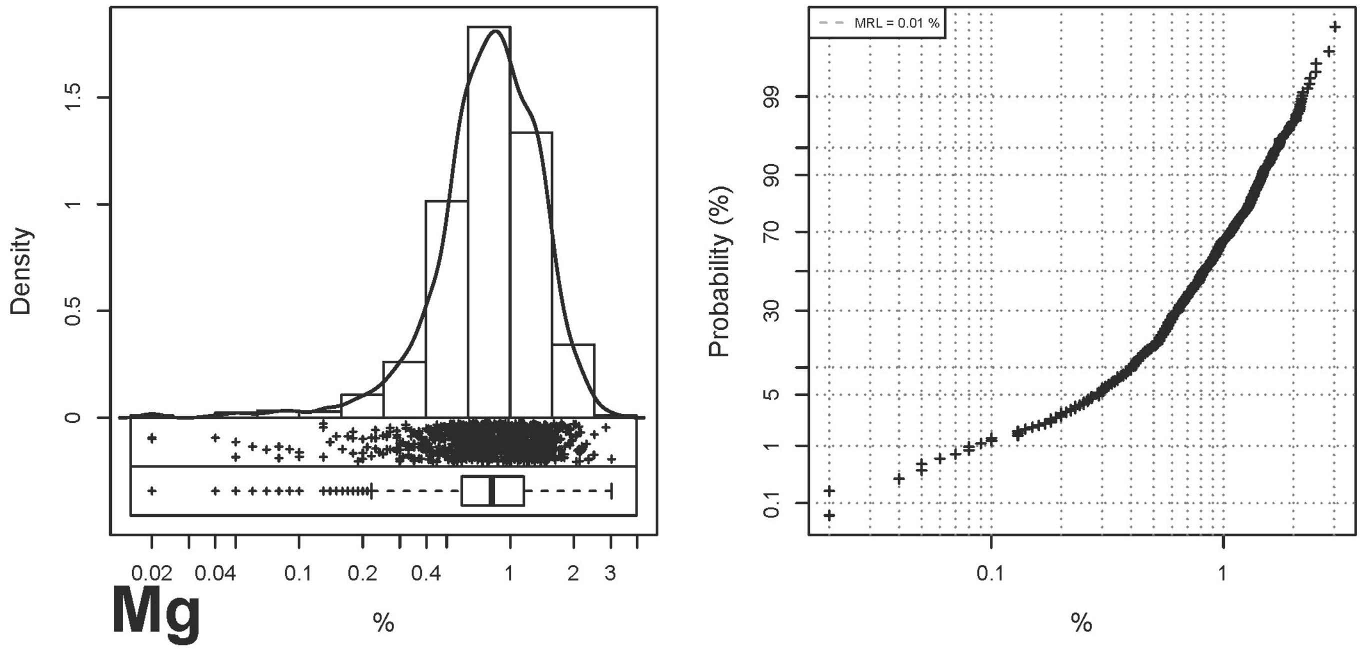
K


Density
Probability (%)
MRL = 0.2 ppm
ppm
ppm

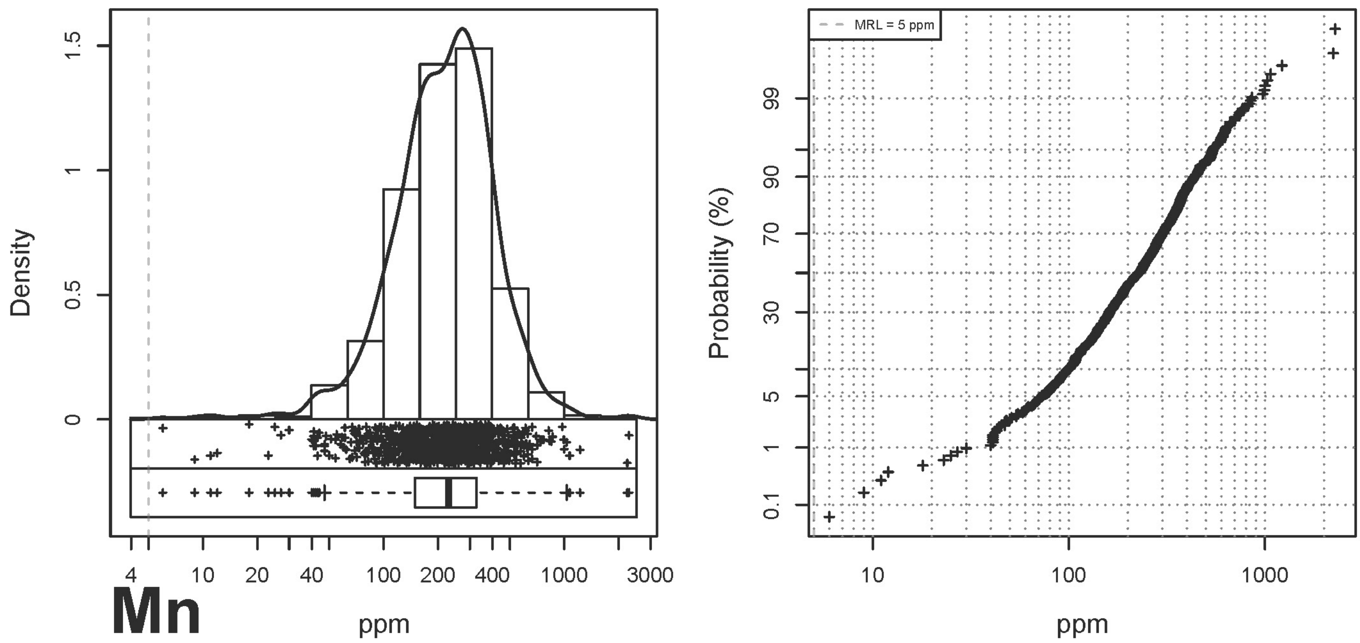
La


Density
Probability (%)
MRL = 0.1 ppm
ppm
ppm

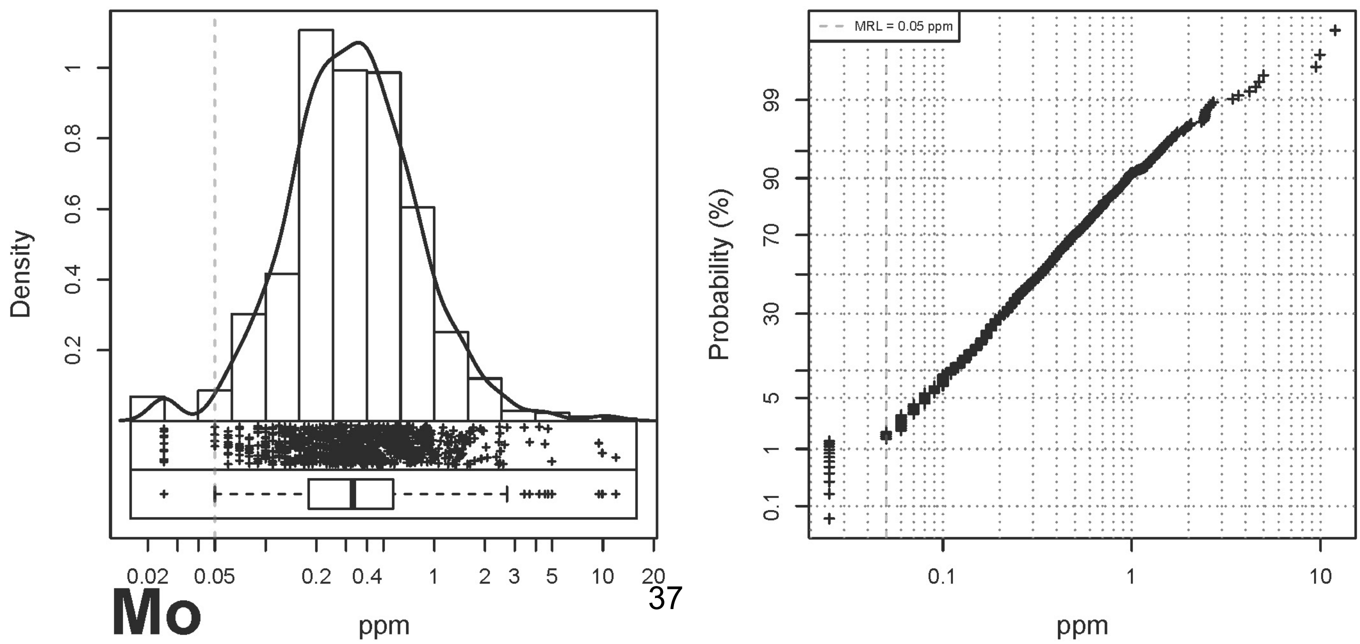
Li


Density
%
Probability (%)
MRL = 0.01 %
%

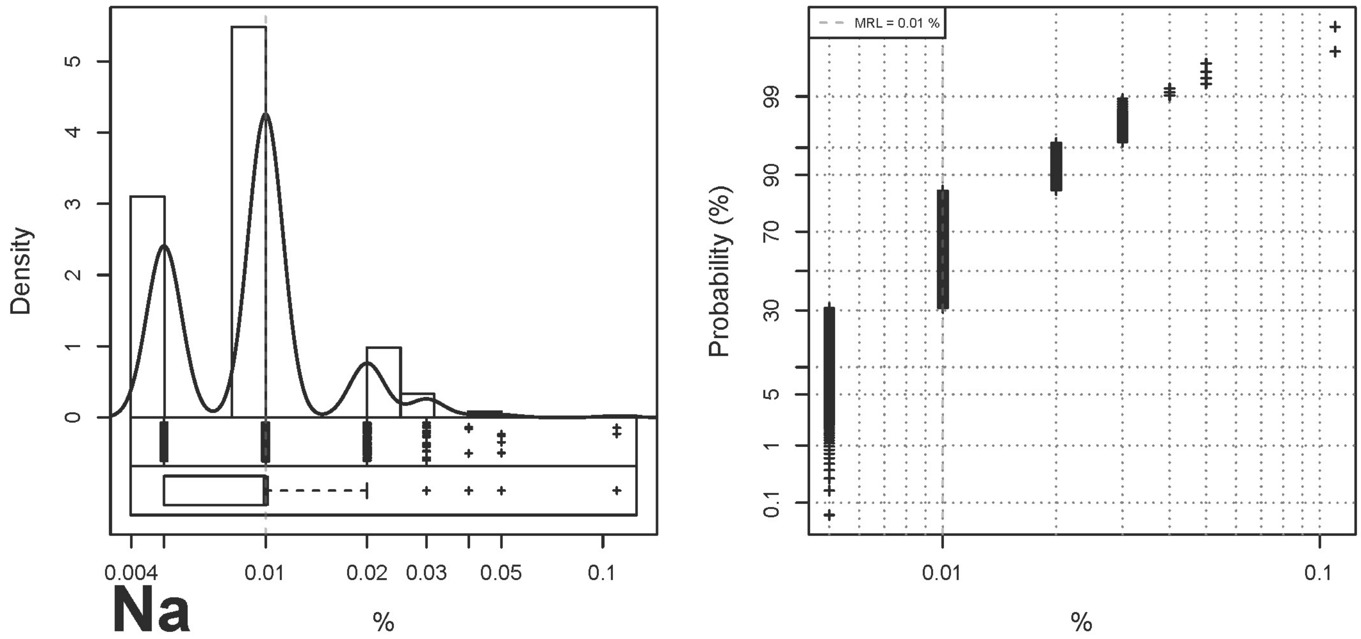
Mg

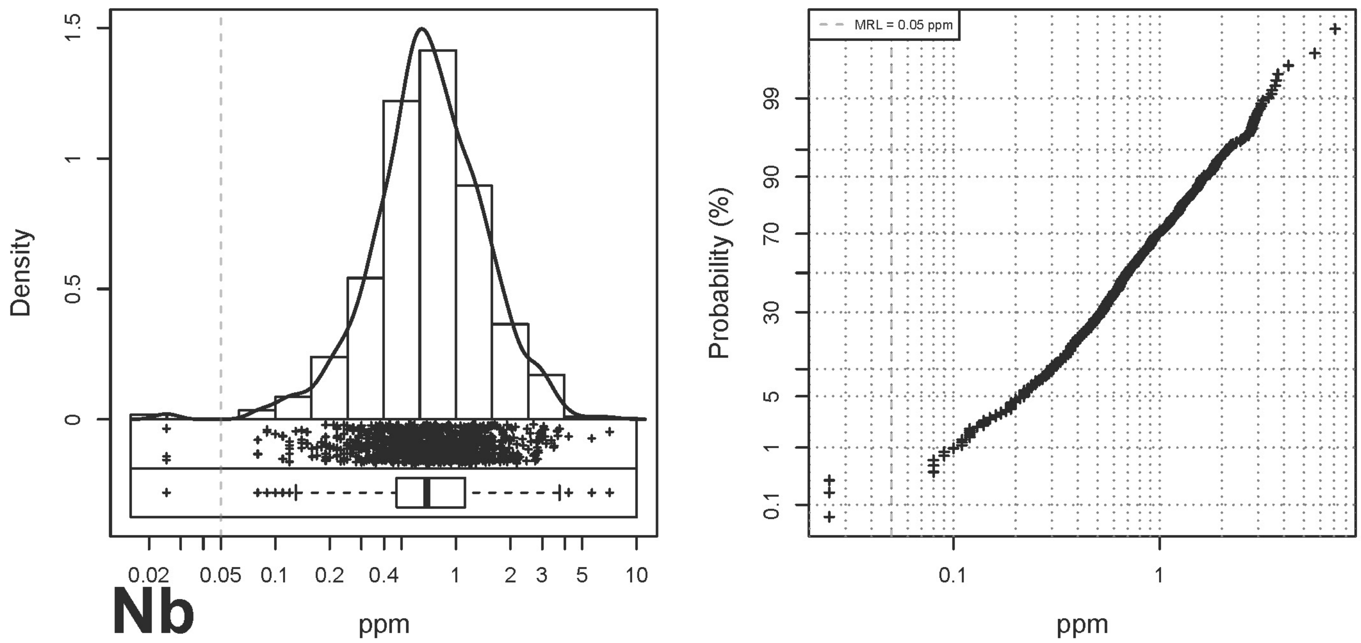

Density
ppm
Probability (%)
MRL = 5 ppm
ppm

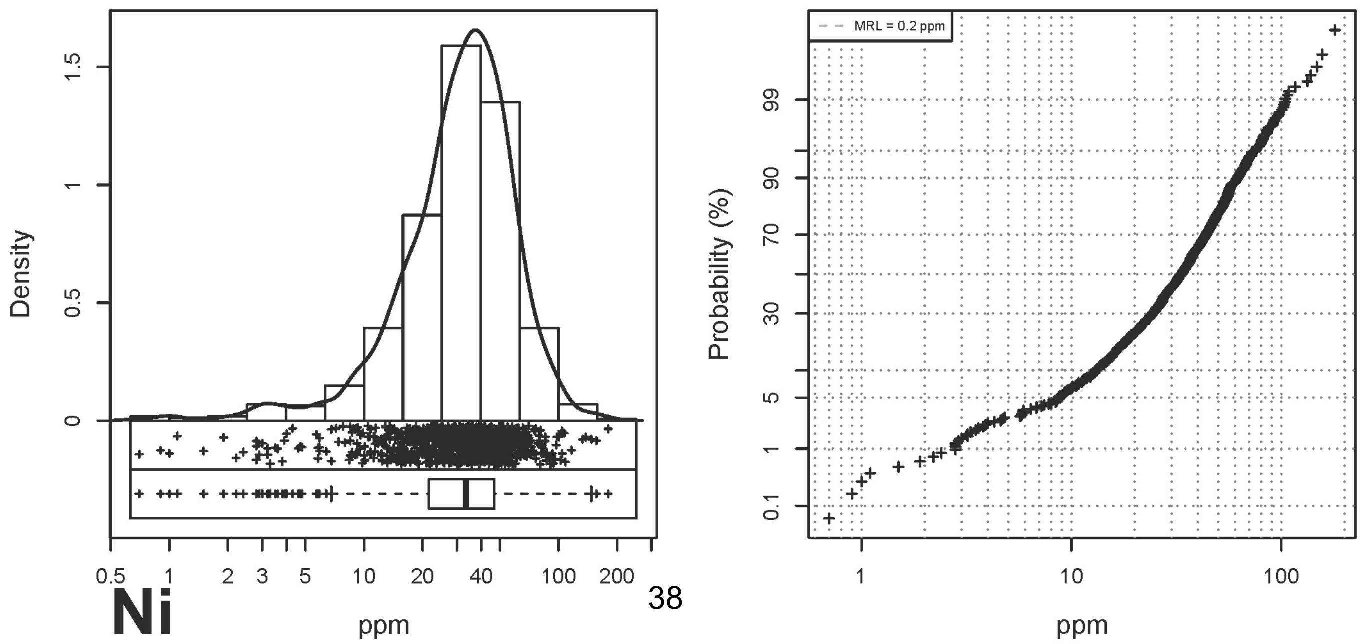
Mn

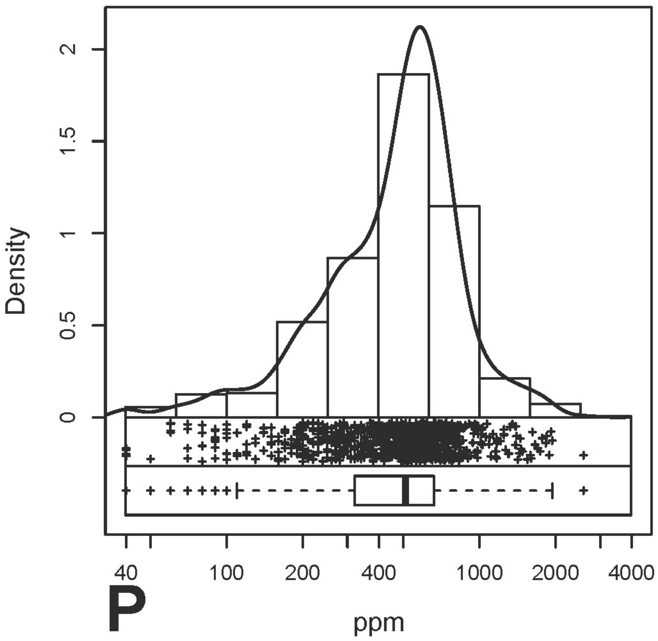

Density
ppm
Probability (%)
MRL = 0.05 ppm
ppm

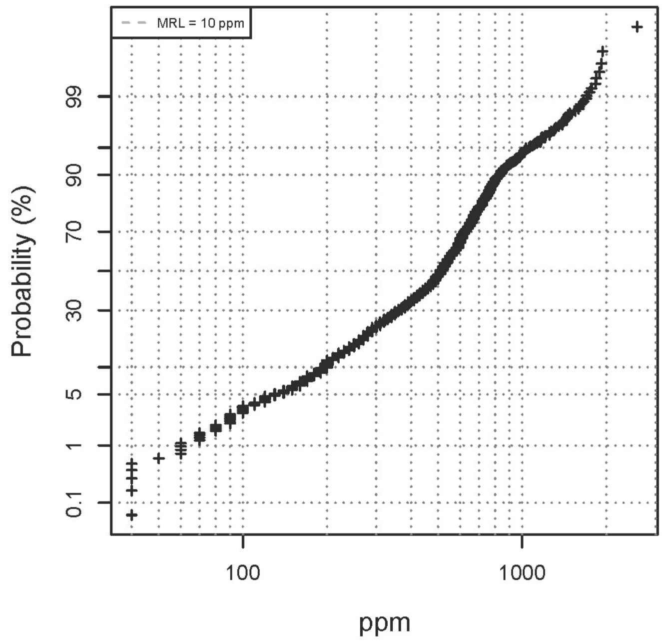
Mo


Density
0 1 2 3 4 5
0.004 0.01 0.02 0.03 0.05 0.1
Na
%
MRL = 0.01 %
Probability (%)
0.1 1 5 30 70 90 99
0.01 0.1
%

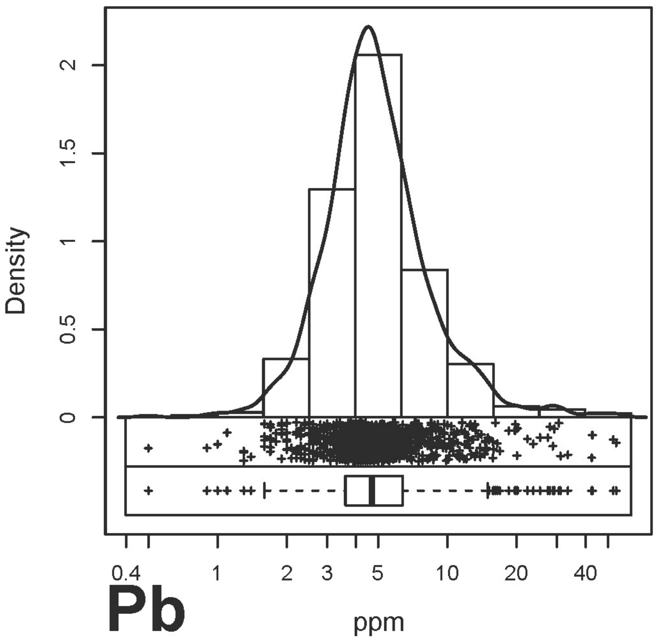

Density
0 0.5 1 1.5
0.02 0.05 0.1 0.2 0.4 1 2 3 5 10
Nb
ppm
MRL = 0.05 ppm
Probability (%)
0.1 1 5 30 70 90 99
0.1 1
ppm

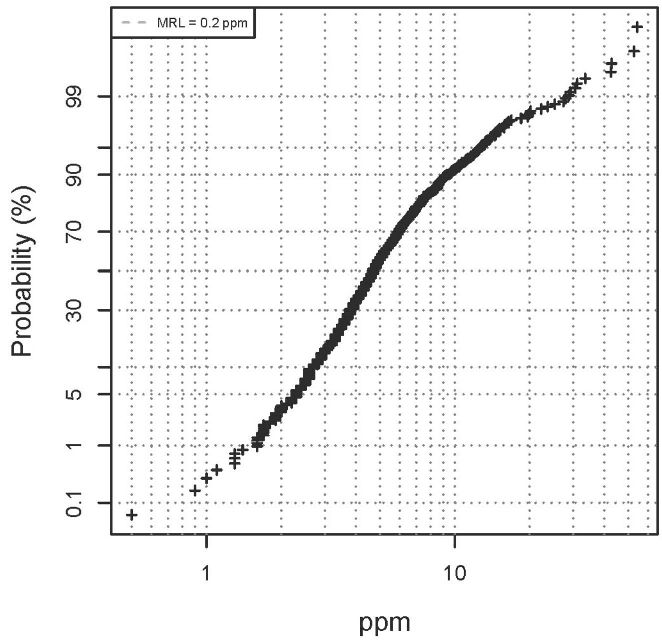

Density
0 0.5 1 1.5
0.5 1 2 3 5 10 20 40 100 200
Ni
ppm
MRL = 0.2 ppm
Probability (%)
0.1 1 5 30 70 90 99
1 10 100
ppm


Density
0
0.5
1
1.5
2
40
100
200
400
1000
2000
4000
ppm

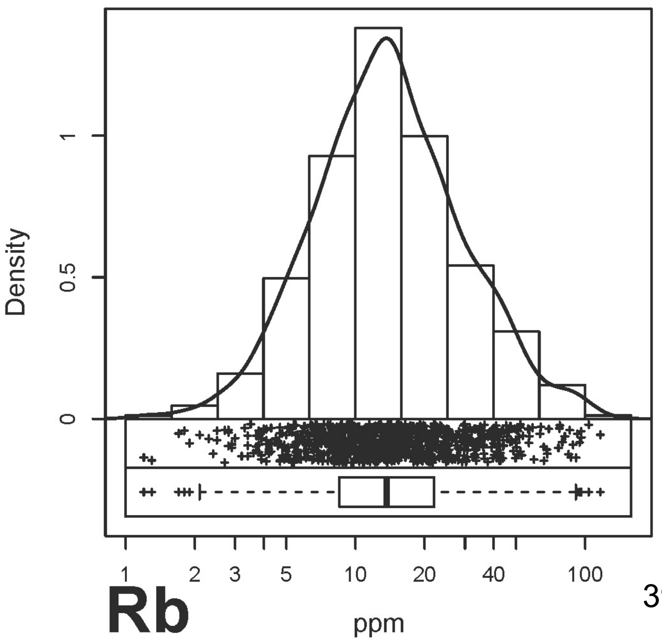

MRL = 10 ppm
Probability (%)
0.1
1
5
30
70
90
99
100
1000
ppm

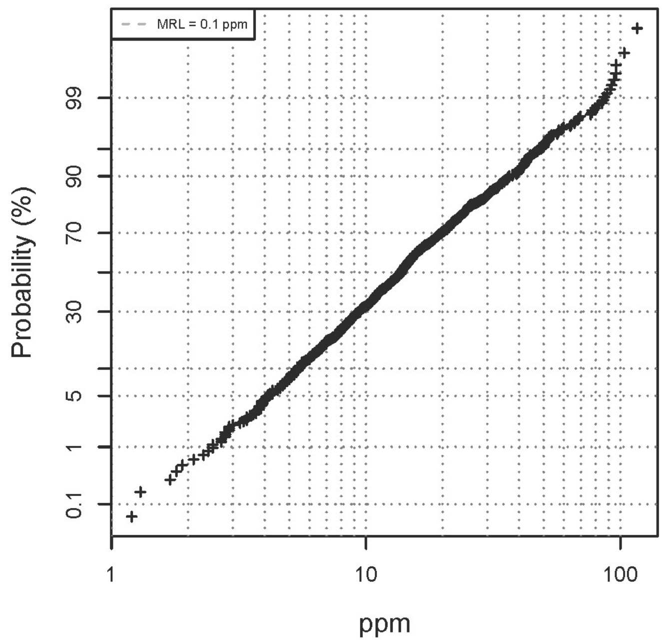
P


Density
0
0.5
1
1.5
2
0.4
1
2
3
5
10
20
40
ppm

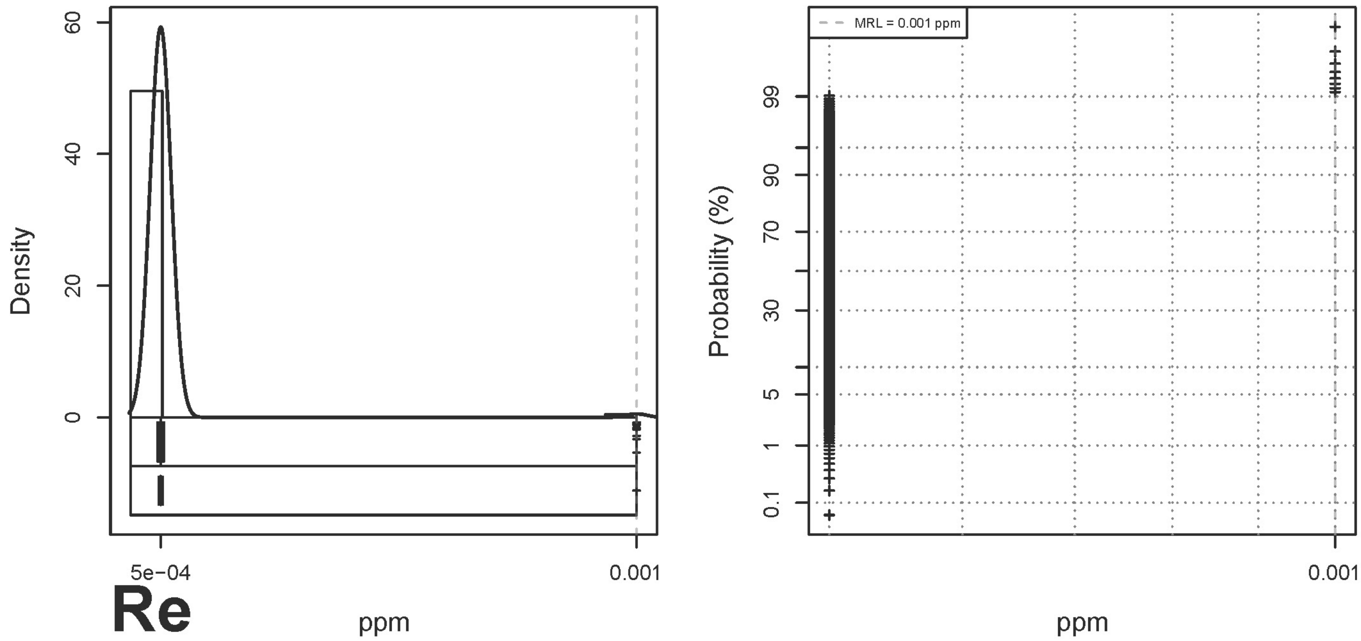

MRL = 0.2 ppm
Probability (%)
0.1
1
5
30
70
90
99
1
10
ppm

Pb

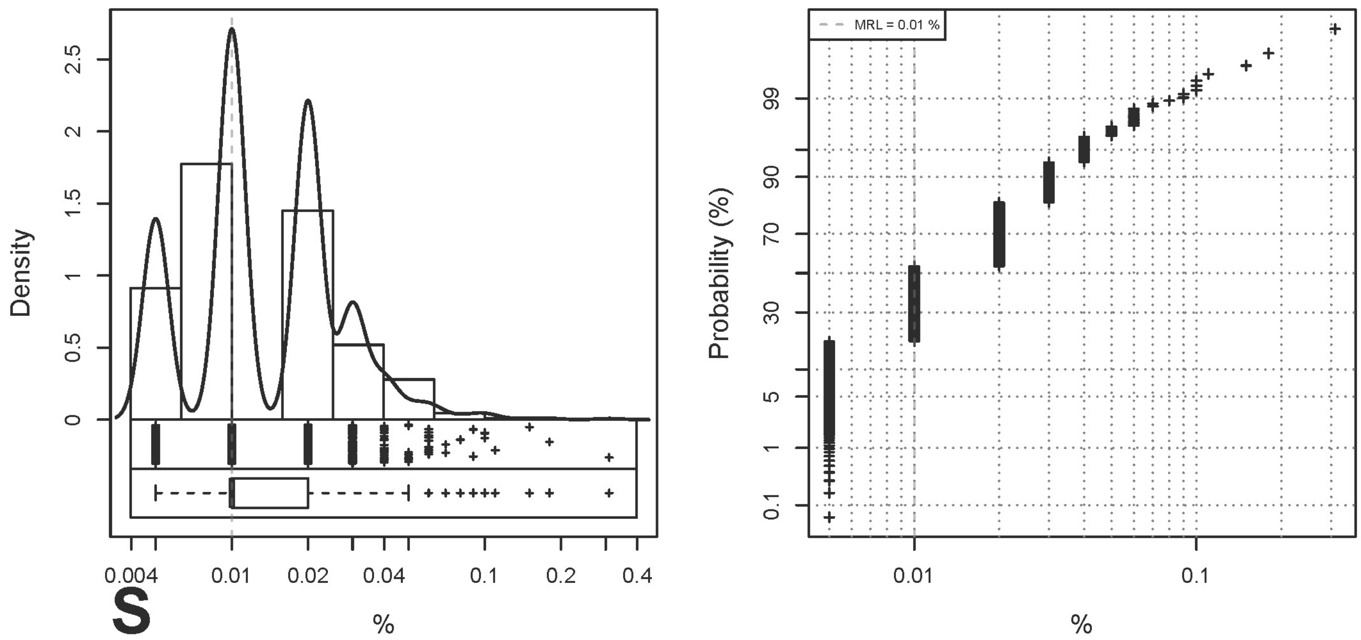

Density
0
0.5
1
1
2
3
5
10
20
40
100
ppm


MRL = 0.1 ppm
Probability (%)
0.1
1
5
30
70
90
99
1
10
100
ppm

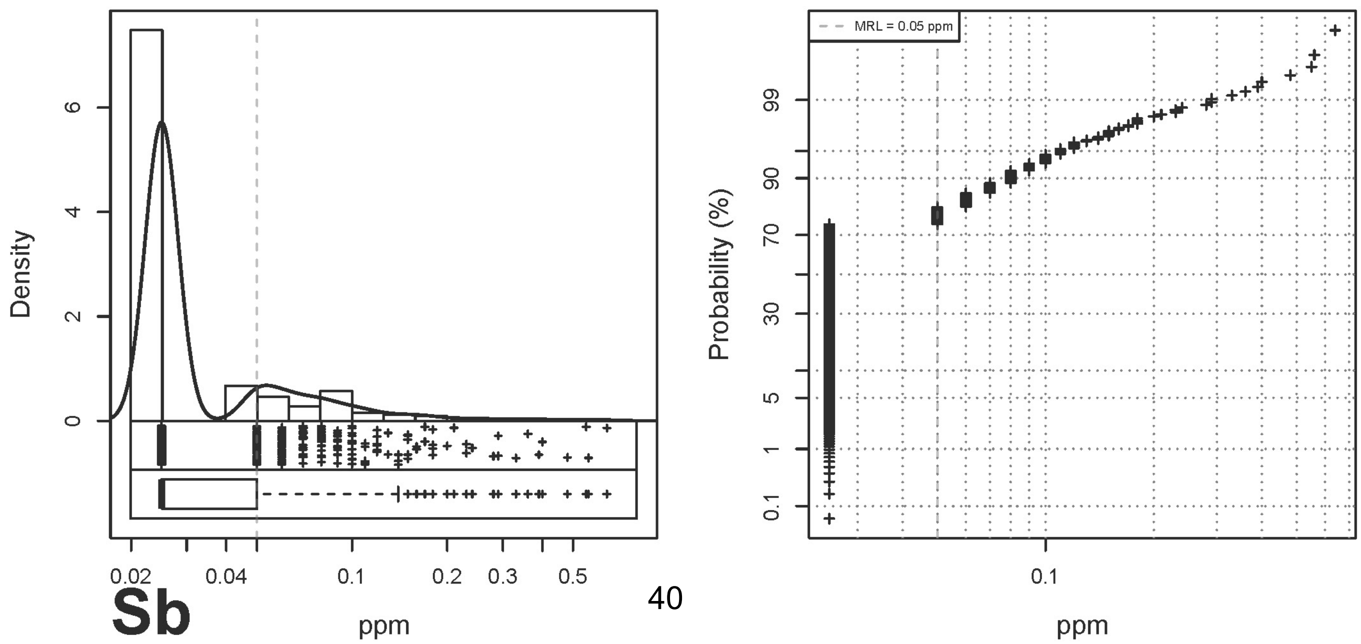
Rb


Density
60
40
20
0
5e−04
0.001
ppm
MRL = 0.001 ppm
Probability (%)
99
90
70
30
5
1
0.1
0.001
ppm

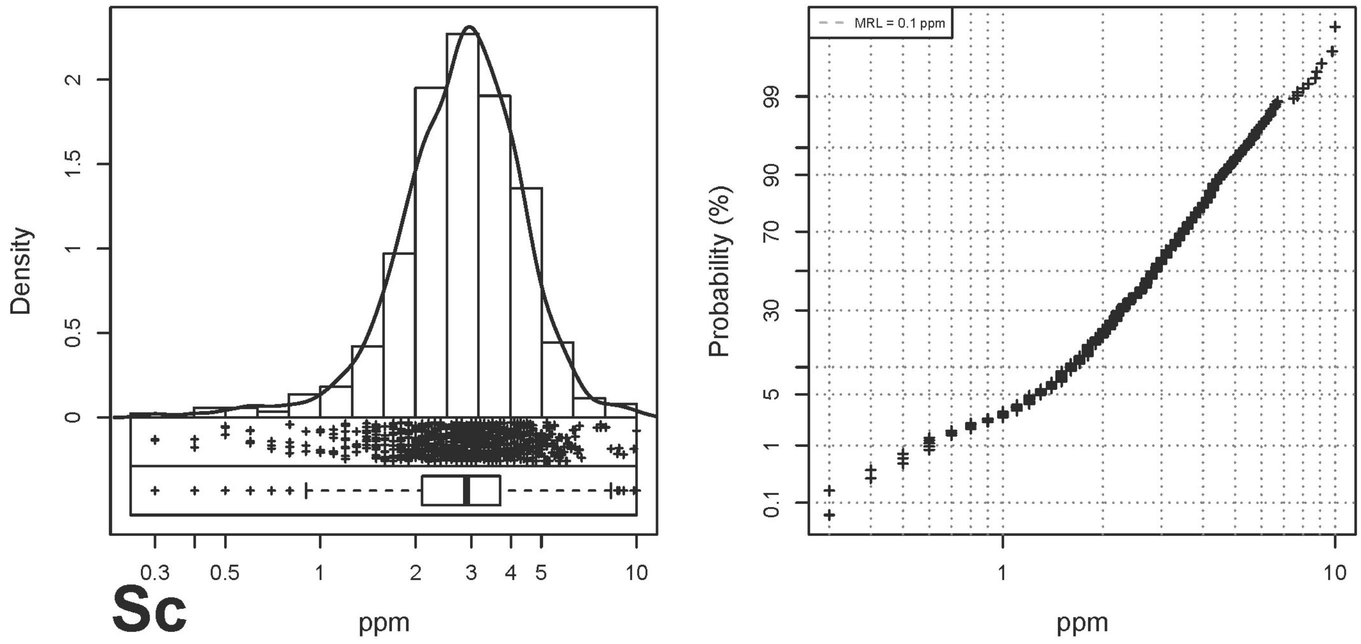
Re

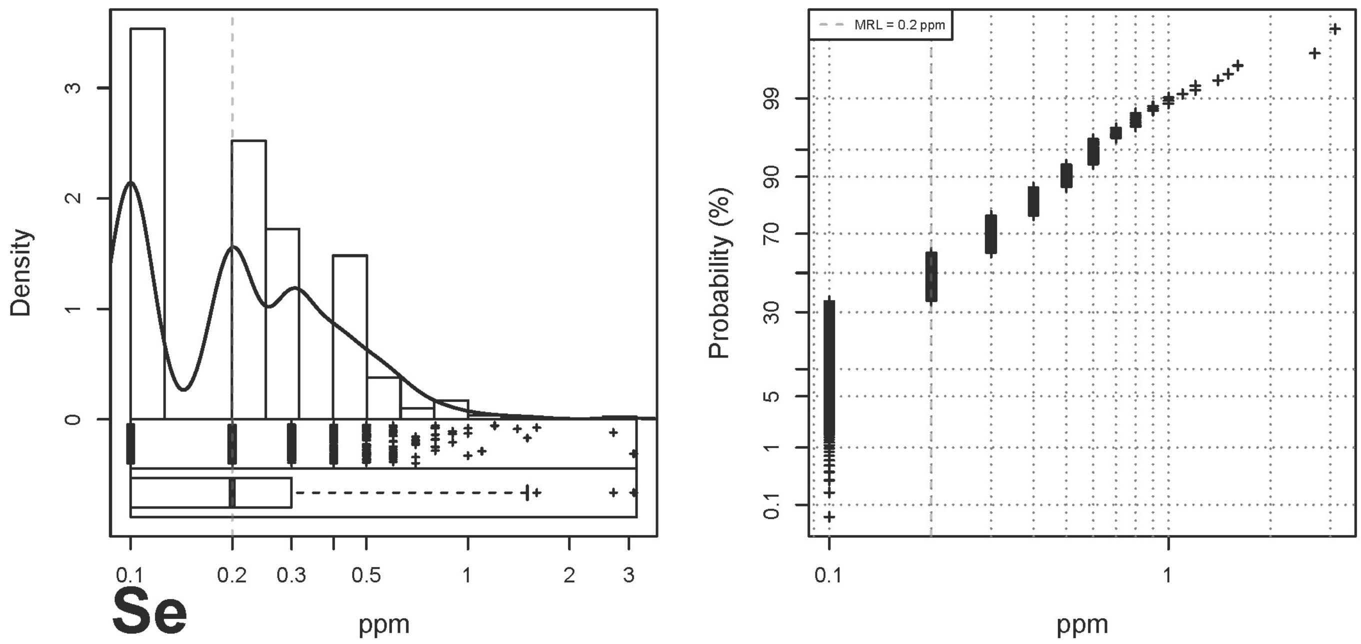

Density
2.5
2
1.5
1
0.5
0
0.004
0.01
0.02
0.04
0.1
0.2
0.4
%
MRL = 0.01 %
Probability (%)
99
90
70
30
5
1
0.1
0.01
0.1
%

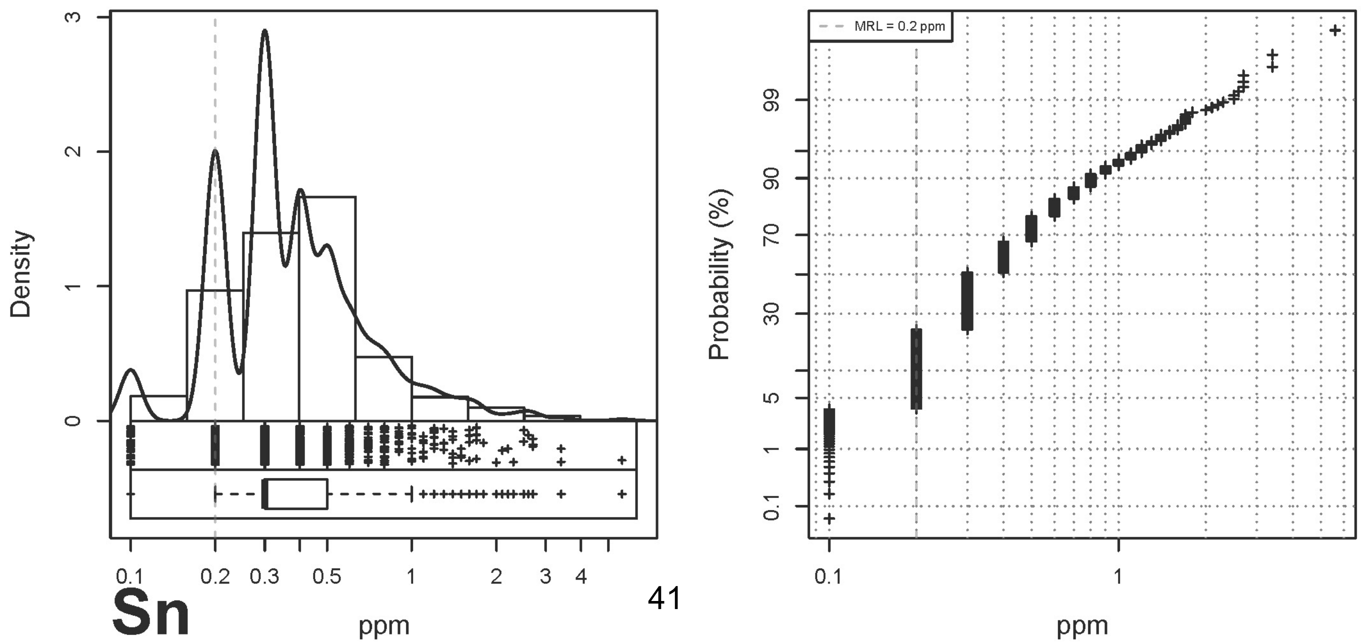
S


Density
6
4
2
0
0.02
0.04
0.1
0.2
0.3
0.5
ppm
MRL = 0.05 ppm
Probability (%)
99
90
70
30
5
1
0.1
0.1
ppm

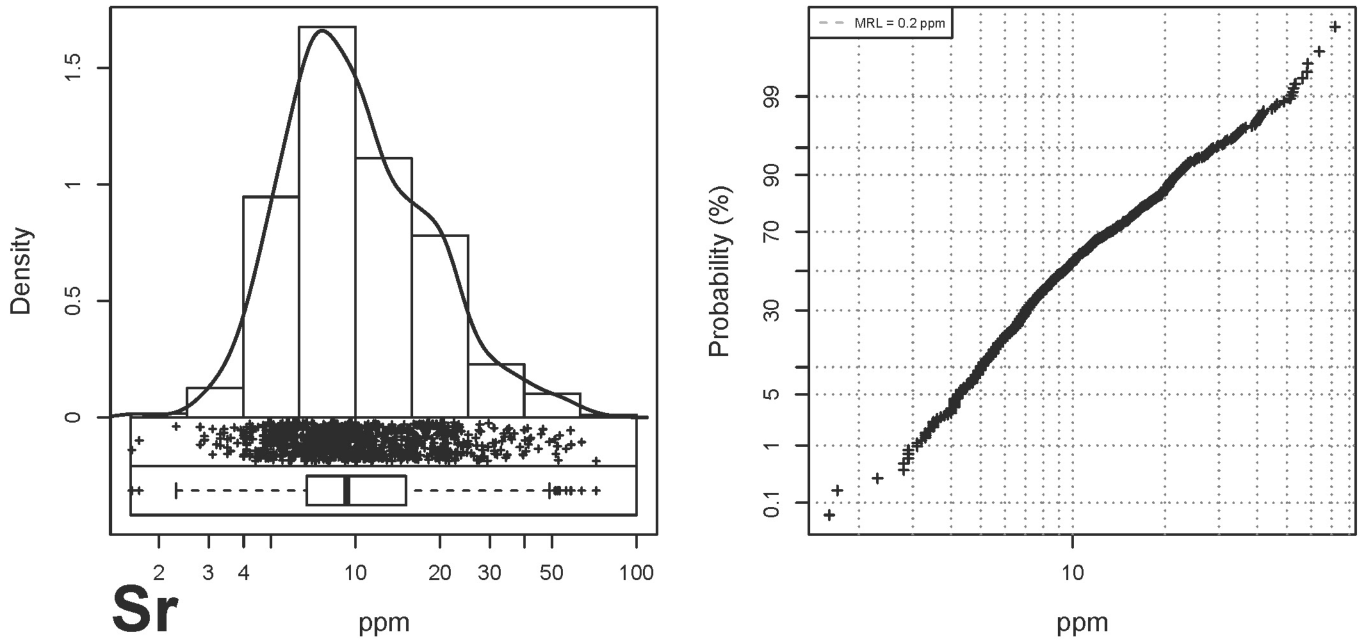
Sb


Density
ppm
Sc
Probability (%)
MRL = 0.1 ppm
ppm

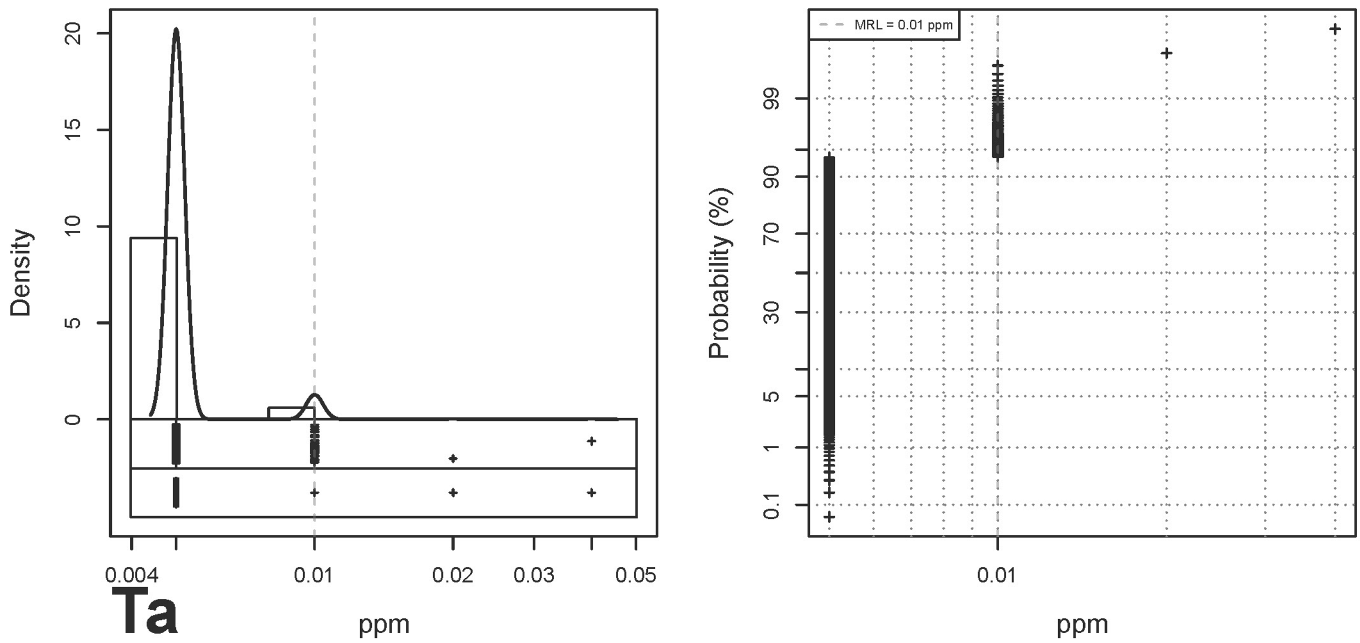

Density
ppm
Se
Probability (%)
MRL = 0.2 ppm
ppm


Density
ppm
Sn
Probability (%)
MRL = 0.2 ppm
ppm

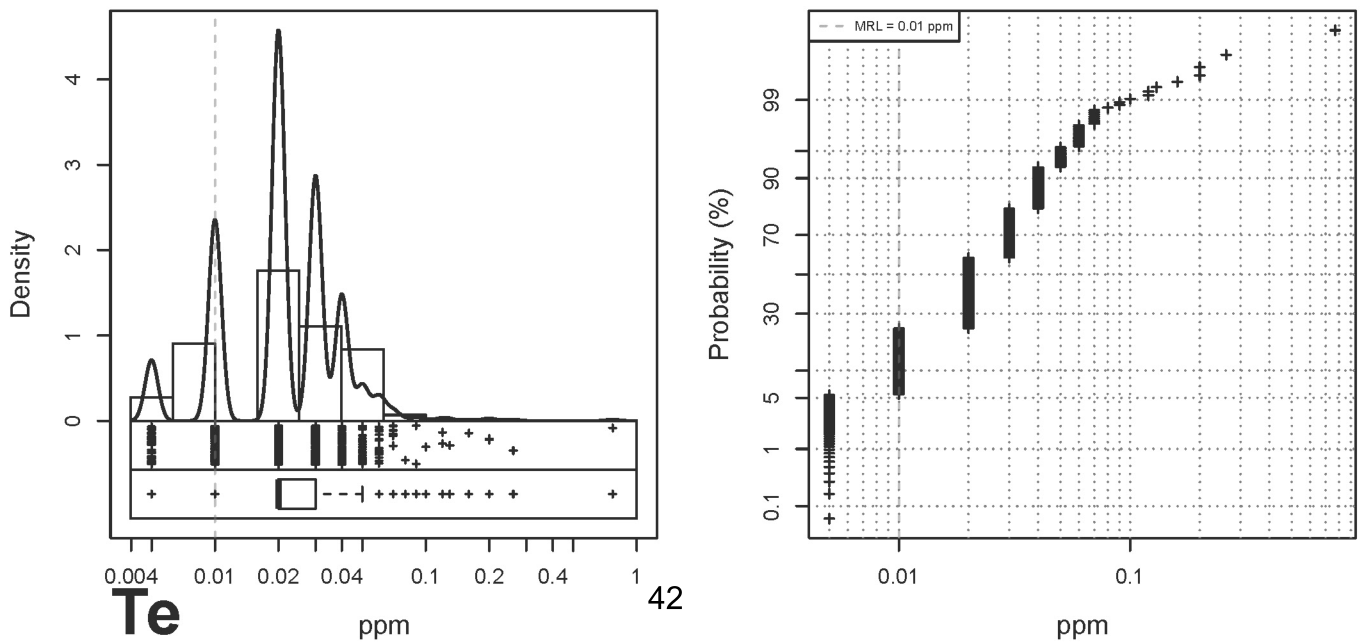
Sr

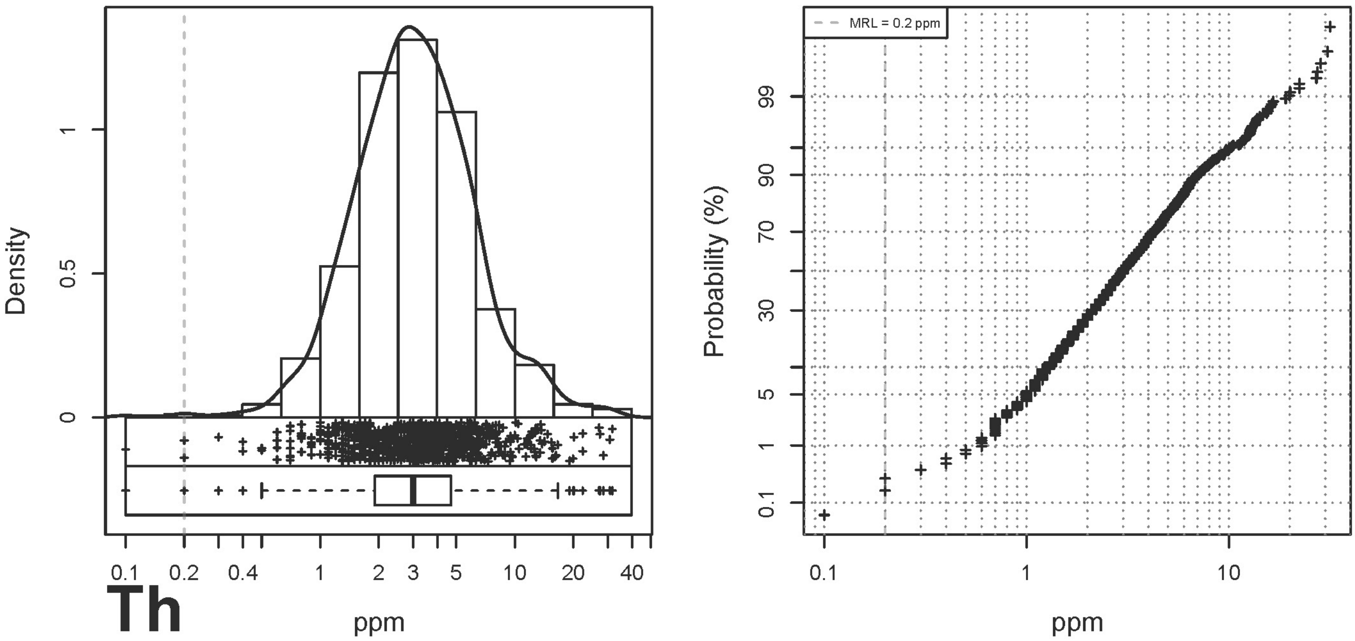

Density
0
0.5
1
1.5
2
3
4
10
20
30
50
100
ppm
MRL = 0.2 ppm
Probability (%)
0.1
1
5
30
70
90
99
10
ppm

Ta


Density
0
5
10
15
20
0.004
0.01
0.02
0.03
0.05
ppm
MRL = 0.01 ppm
Probability (%)
0.1
1
5
30
70
90
99
0.01
ppm

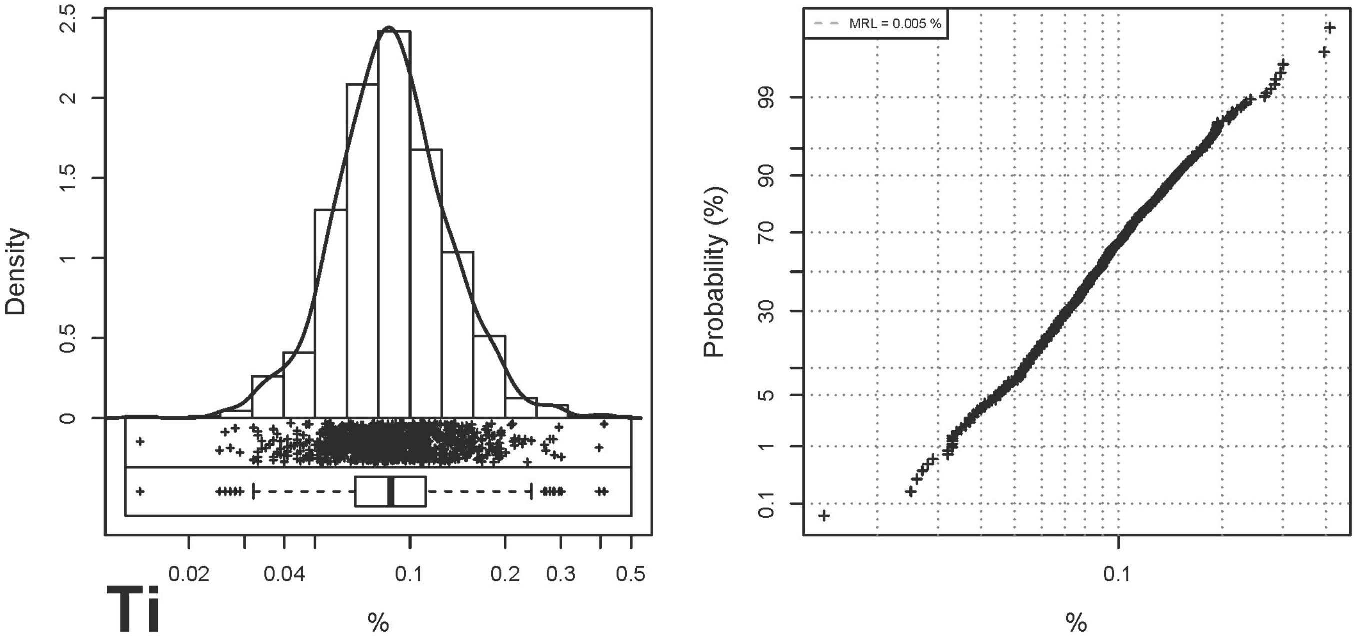
Te


Density
0
1
2
3
4
0.004
0.01
0.02
0.04
0.1
0.2
0.4
1
ppm
MRL = 0.01 ppm
Probability (%)
0.1
1
5
30
70
90
99
0.01
0.1
ppm



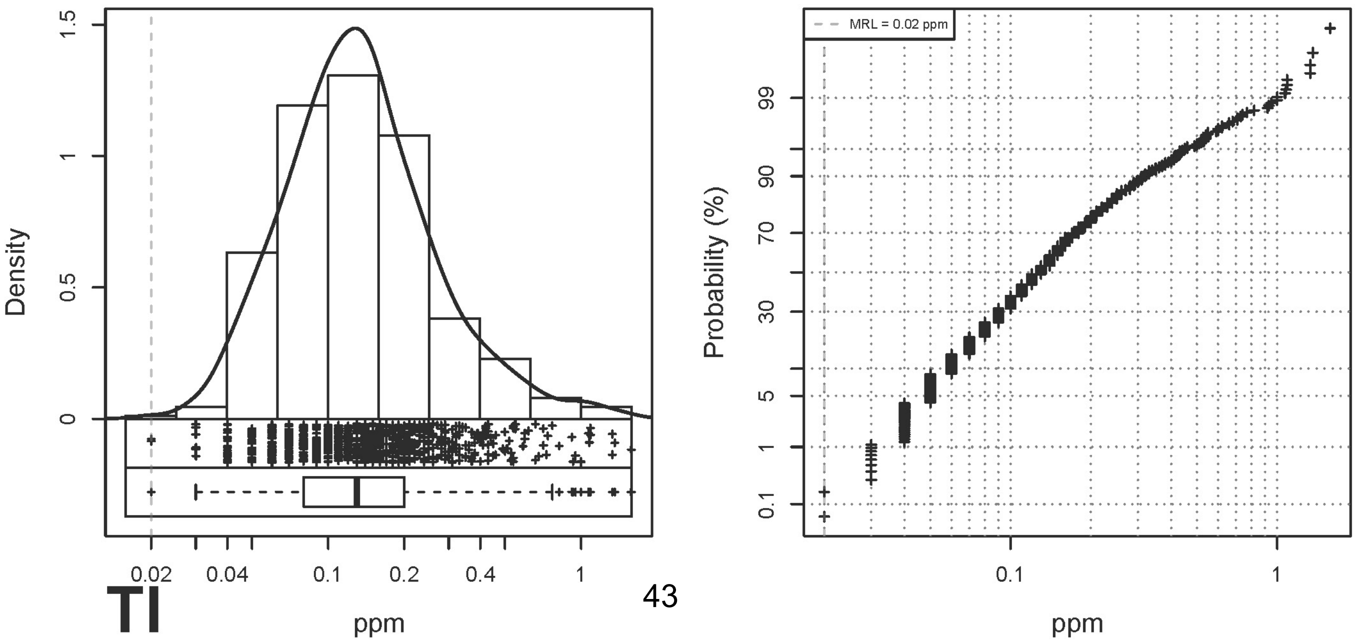
Density
ppm
Probability (%)
MRL = 0.2 ppm

Th



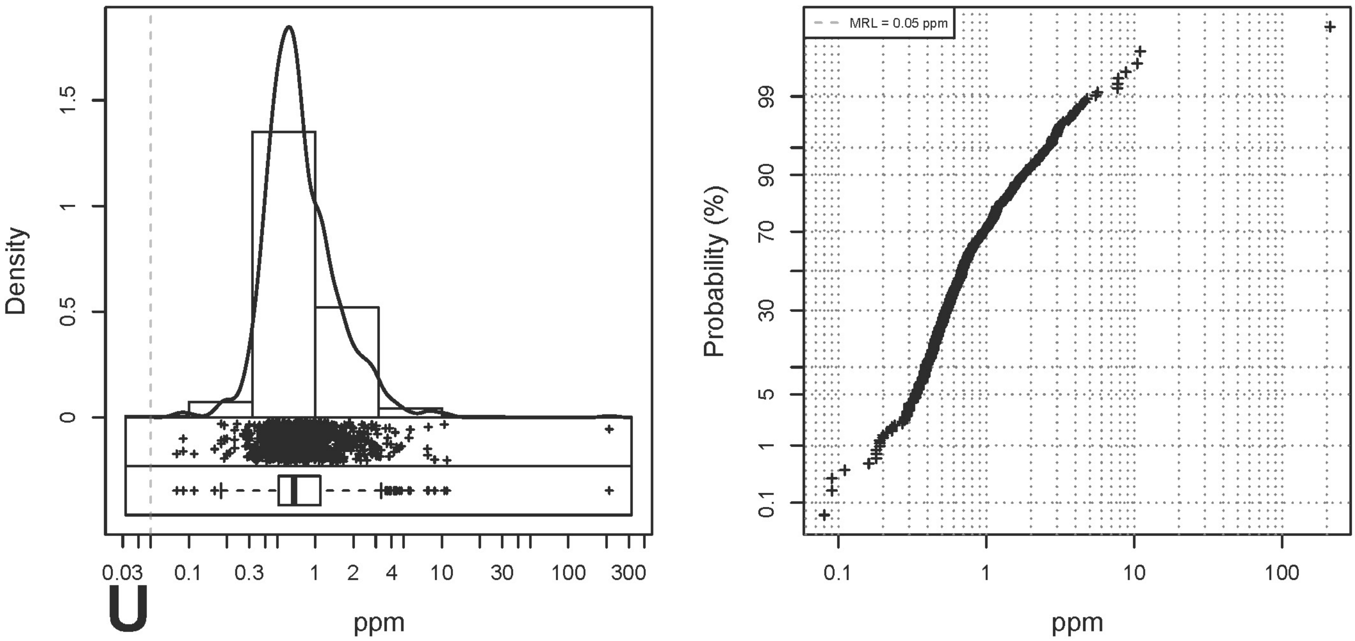
Density
%
Probability (%)
MRL = 0.005 %

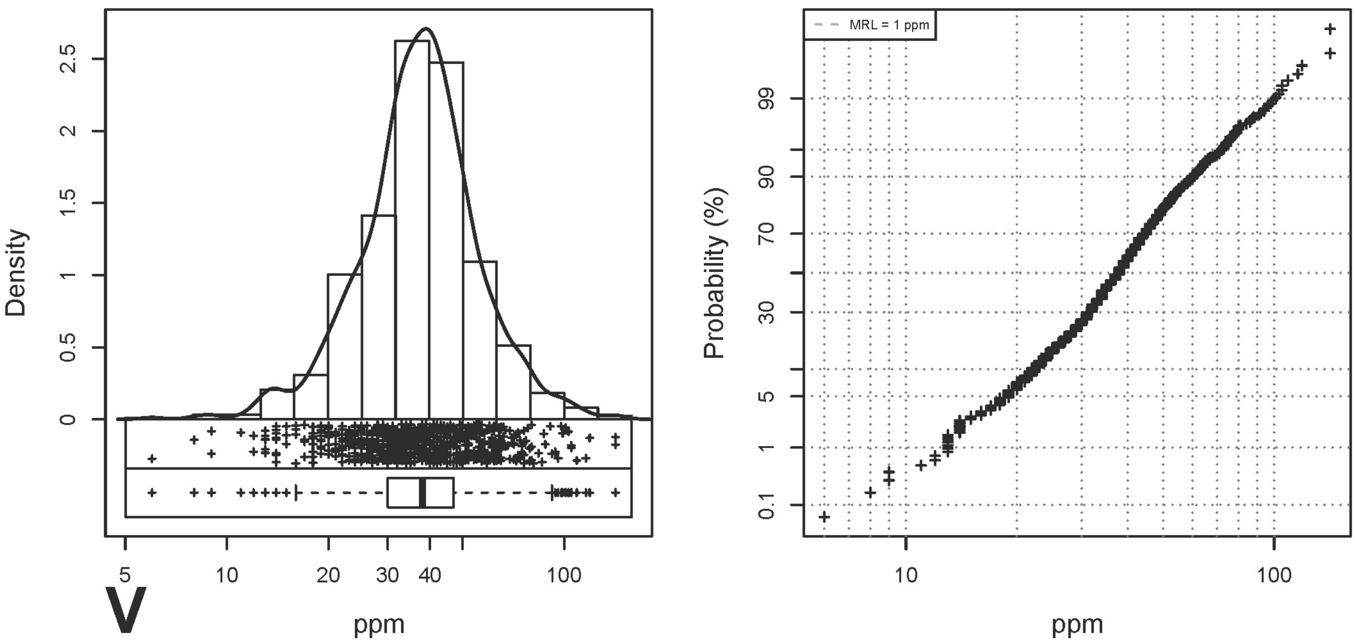
Ti

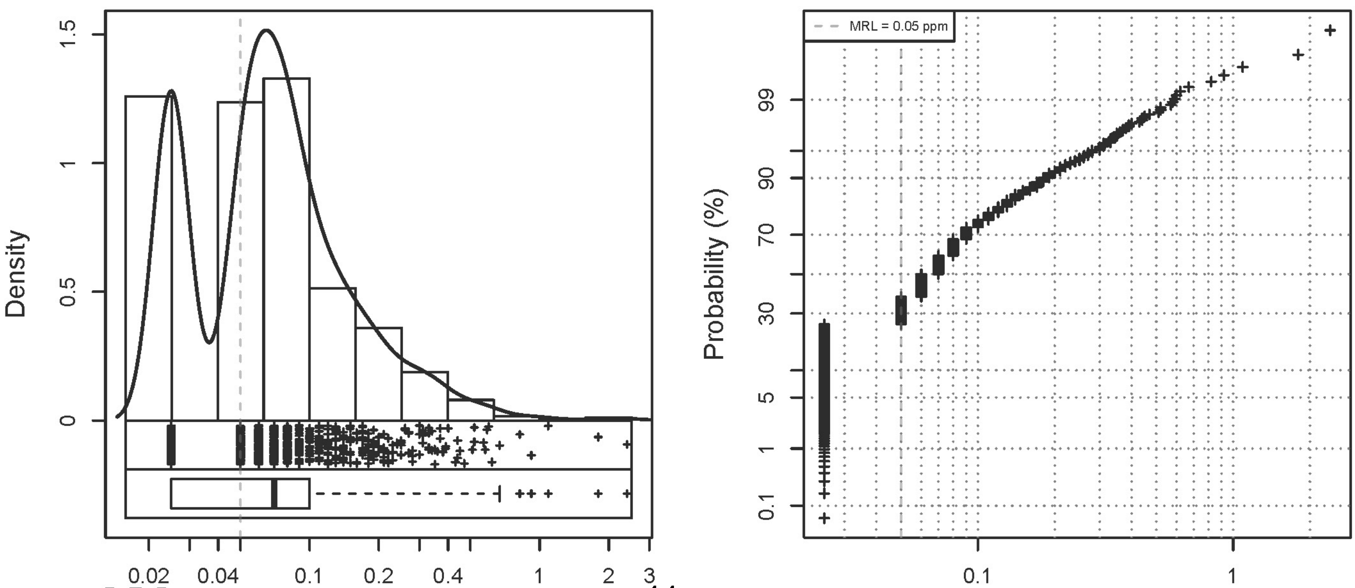


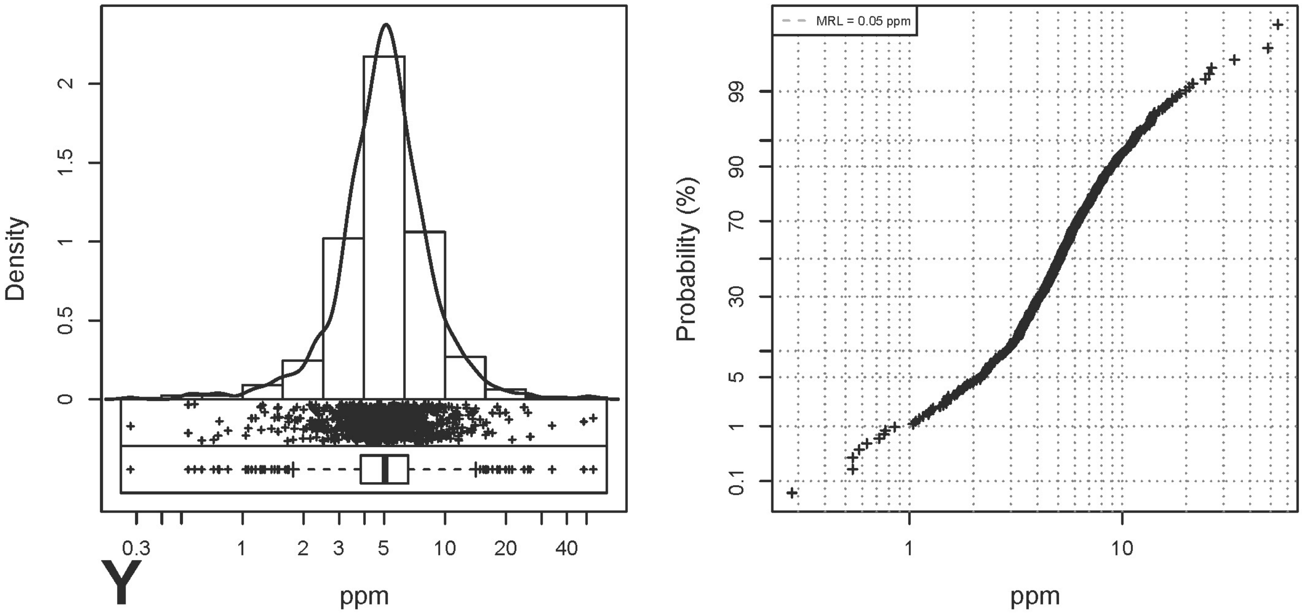
Density
ppm
Probability (%)
MRL = 0.02 ppm

Tl

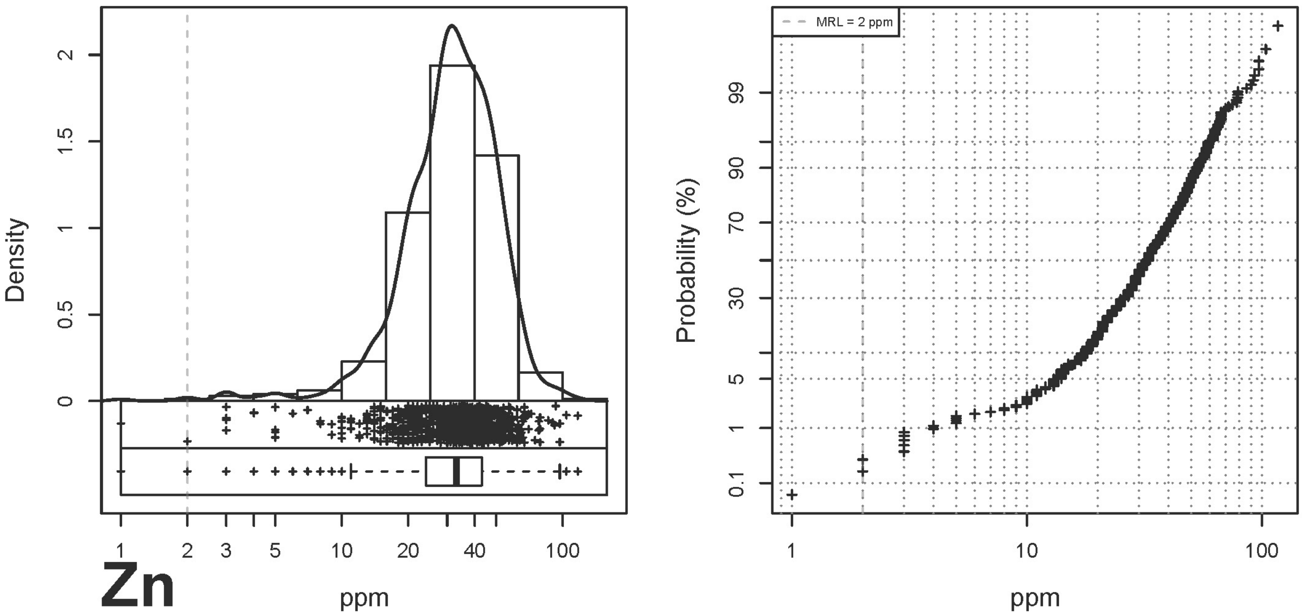

Density
1.5
1
0.5
0
0.03
0.1
0.3
1
2
4
10
30
100
300
U
ppm
MRL = 0.05 ppm
Probability (%)
99
90
70
30
5
1
0.1
0.1
1
10
100
ppm


Density
2.5
2
1.5
1
0.5
0
5
10
20
30
40
100
V
ppm
MRL = 1 ppm
Probability (%)
99
90
70
30
5
1
0.1
10
100
ppm

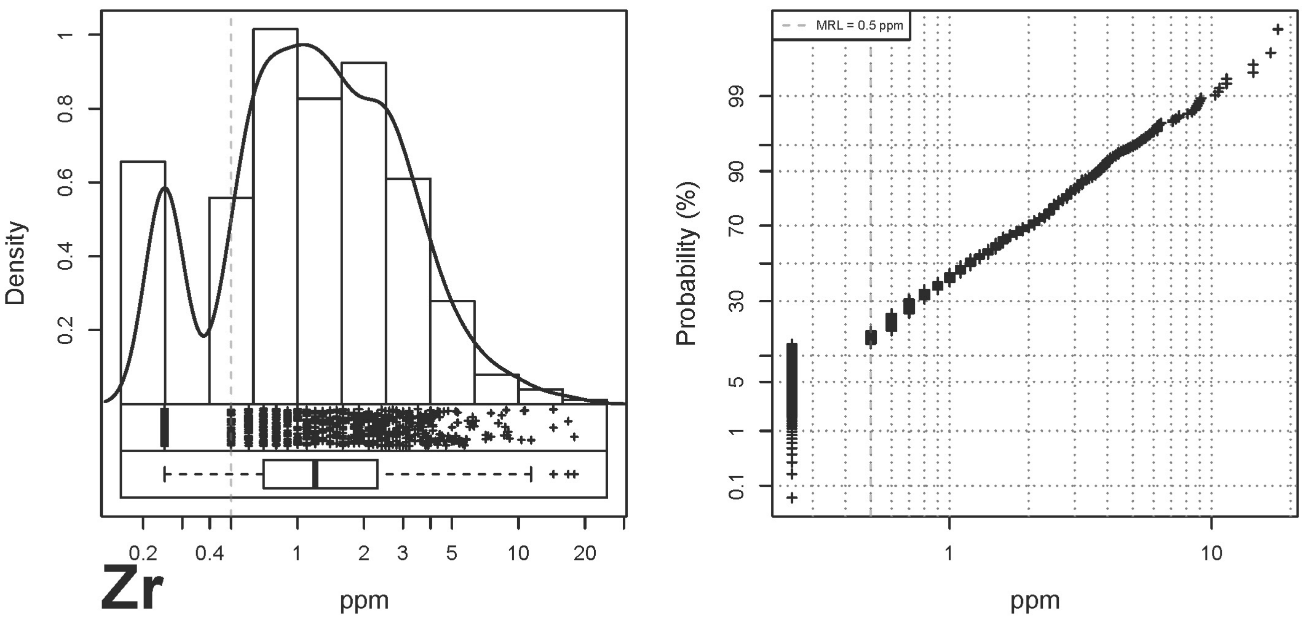

Density
1.5
1
0.5
0
0.02
0.04
0.1
0.2
0.4
1
2
3
W
ppm
MRL = 0.05 ppm
Probability (%)
99
90
70
30
5
1
0.1
0.1
1
ppm


Density
ppm
MRL = 0.05 ppm
Probability (%)
ppm

Y

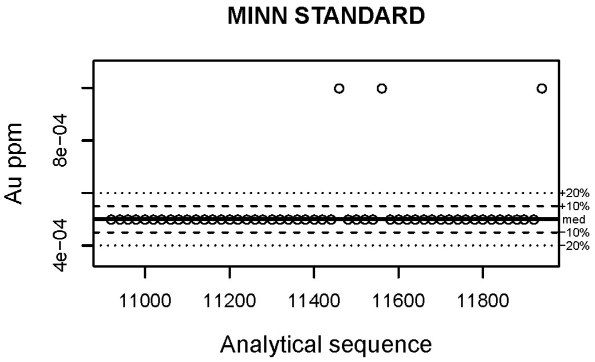

Density
ppm
MRL = 2 ppm
Probability (%)
ppm

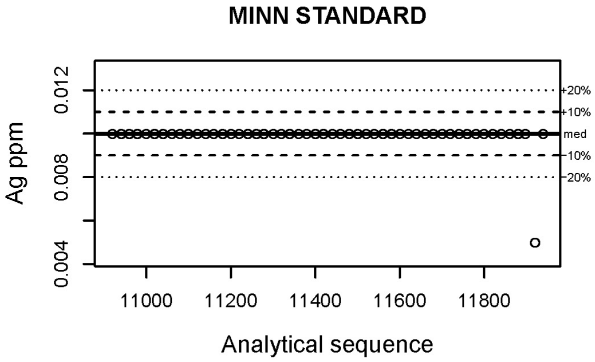
Zn

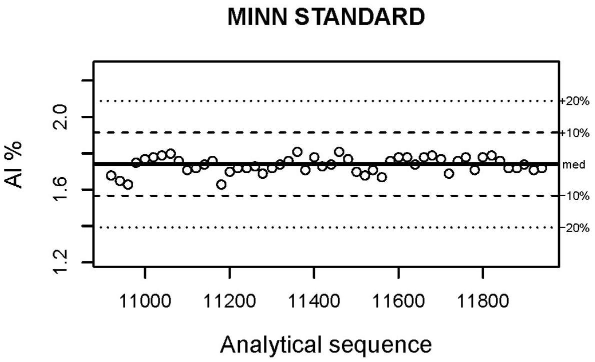

Density
ppm
MRL = 0.5 ppm
Probability (%)
ppm

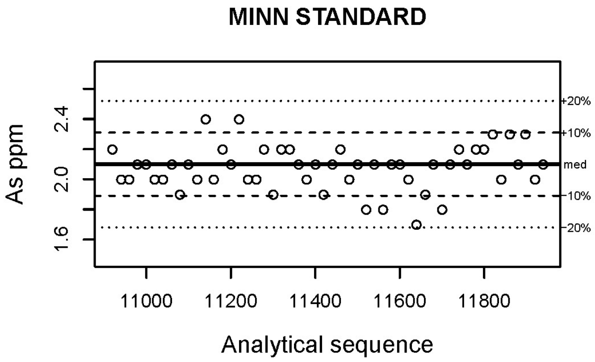
Zr

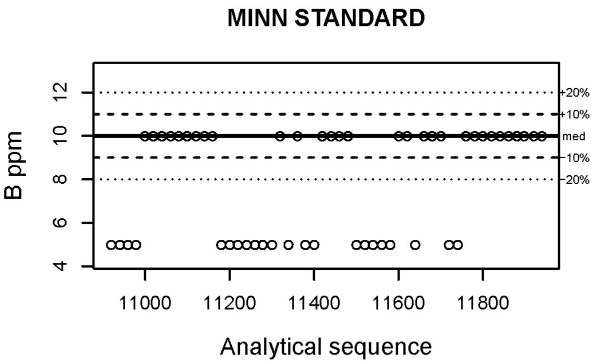
Appendix II X-charts for MINN standard and Sagelva standard

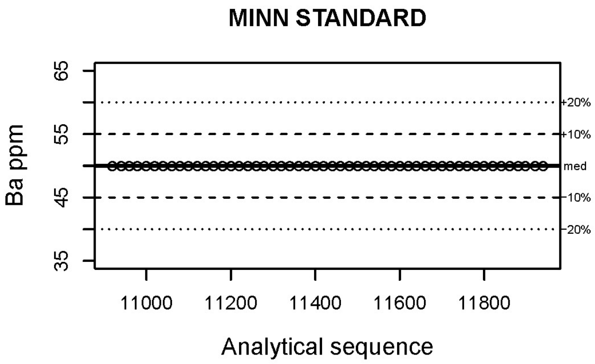

MINN STANDARD
Au ppm
4e−04
8e−04
+20%
+10%
med
−10%
−20%
11000
11200
11400
11600
11800
Analytical sequence

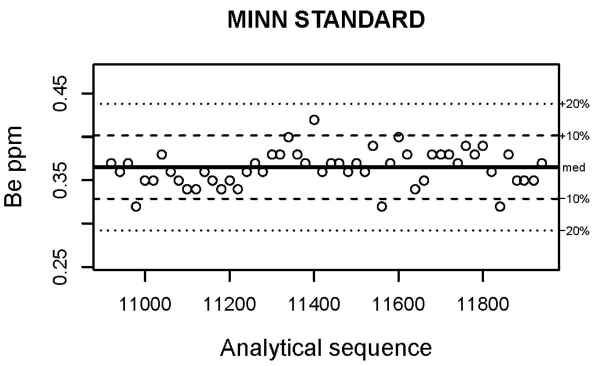

MINN STANDARD
Ag ppm
0.004
0.008
0.012
+20%
+10%
med
−10%
−20%
11000
11200
11400
11600
11800
Analytical sequence

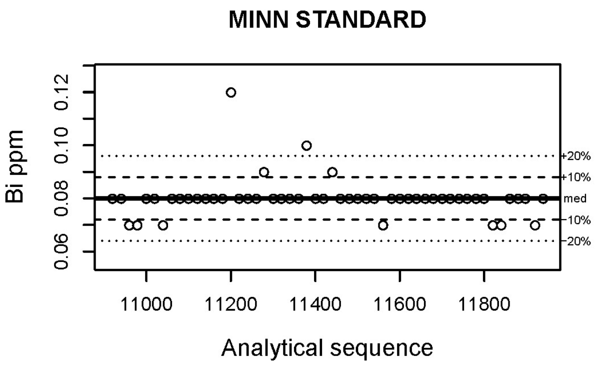

MINN STANDARD
Al %
1.2
1.6
2.0
+20%
+10%
med
−10%
−20%
11000
11200
11400
11600
11800
Analytical sequence

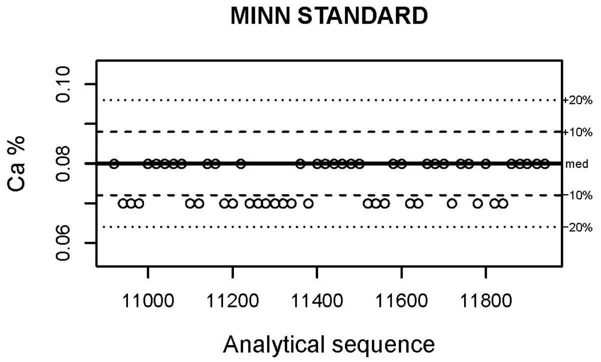

MINN STANDARD
As ppm
1.6
2.0
2.4
+20%
+10%
med
−10%
−20%
11000
11200
11400
11600
11800
Analytical sequence

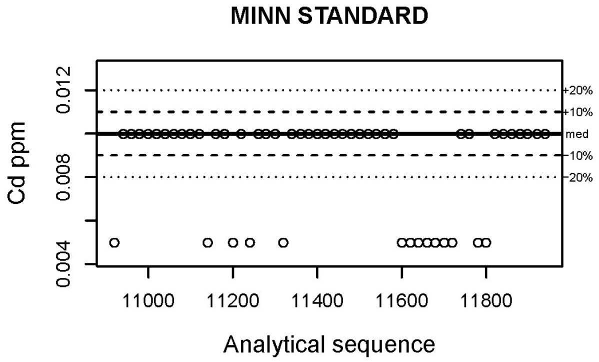

MINN STANDARD
B ppm
4
6
8
10
12
+20%
+10%
med
−10%
−20%
11000
11200
11400
11600
11800
Analytical sequence

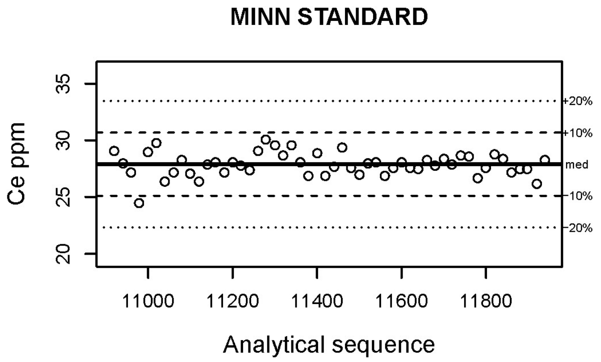

MINN STANDARD
Ba ppm
35
45
55
65
+20%
+10%
med
−10%
−20%
11000
11200
11400
11600
11800
Analytical sequence

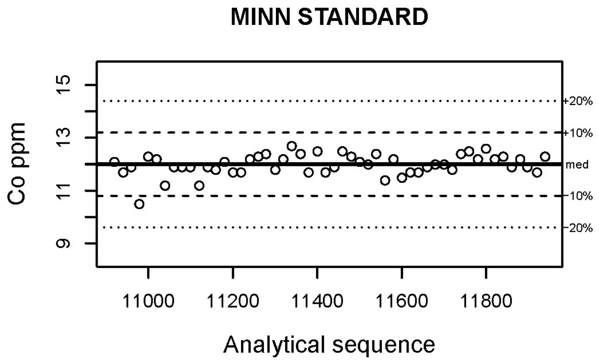

MINN STANDARD
Be ppm
0.25
0.35
0.45
+20%
+10%
med
−10%
−20%
11000
11200
11400
11600
11800
Analytical sequence

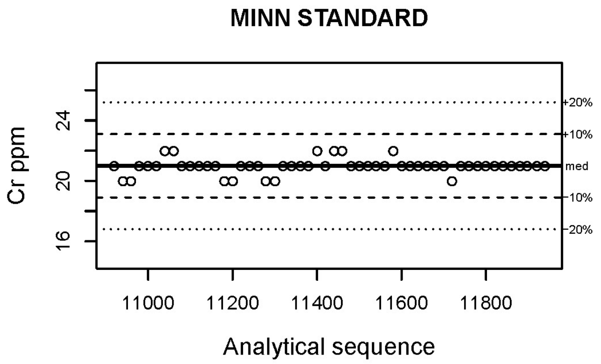

MINN STANDARD
Bi ppm
0.06
0.08
0.10
0.12
+20%
+10%
med
−10%
−20%
11000
11200
11400
11600
11800
Analytical sequence

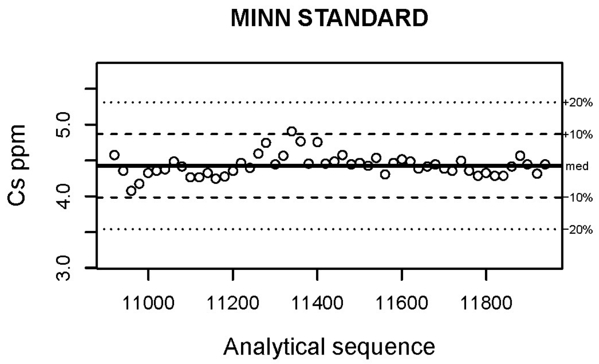

MINN STANDARD
Ca %
0.06
0.08
0.10
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

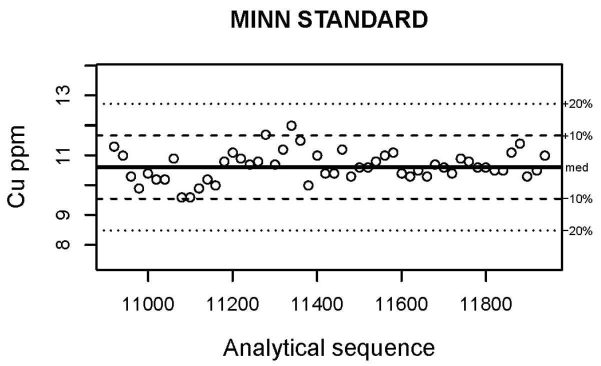

MINN STANDARD
Cd ppm
0.004
0.008
0.012
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

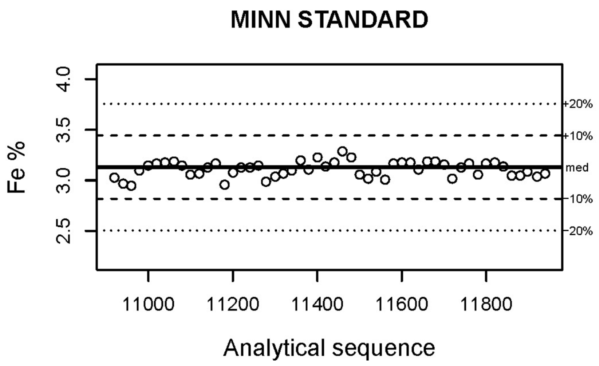

MINN STANDARD
Ce ppm
20
25
30
35
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

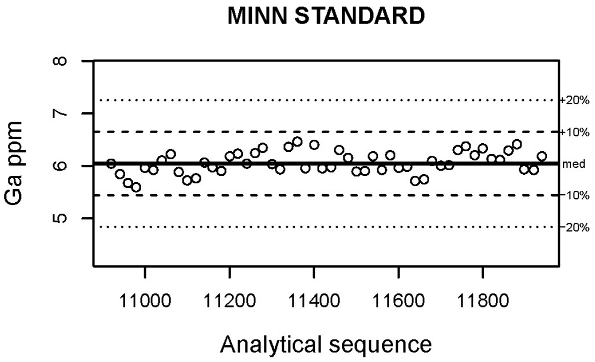

MINN STANDARD
Co ppm
9
11
13
15
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

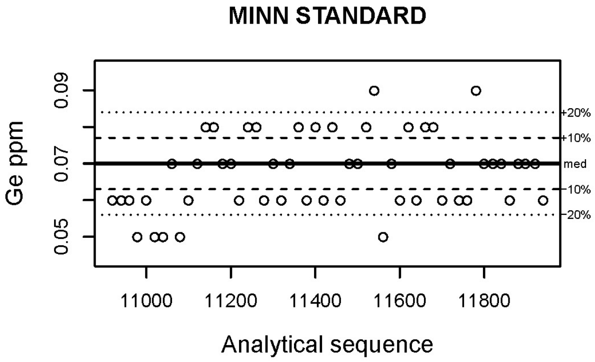

MINN STANDARD
Cr ppm
16
20
24
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

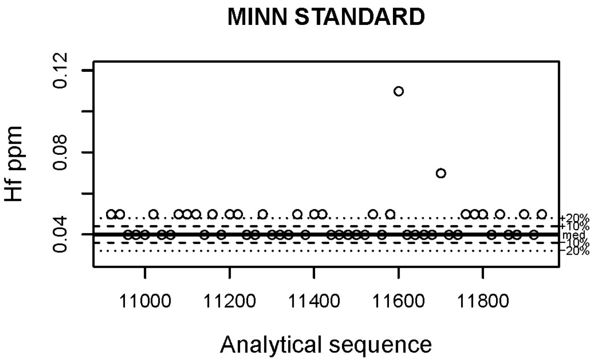

MINN STANDARD
Cs ppm
3.0
4.0
5.0
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

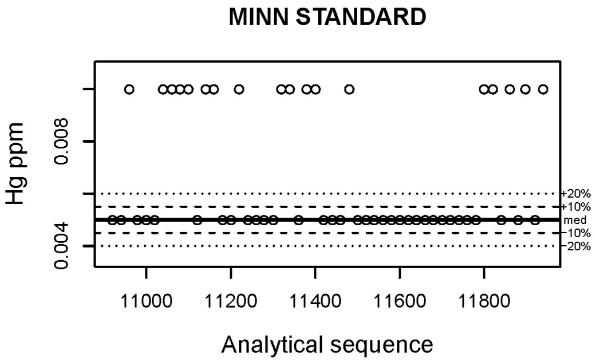

MINN STANDARD
Cu ppm
8
9
11
13
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

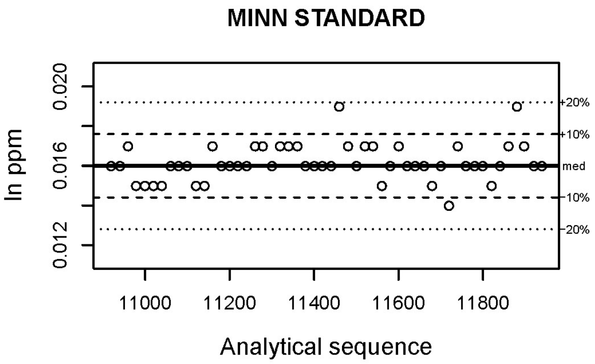

MINN STANDARD
Fe %
2.5
3.0
3.5
4.0
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

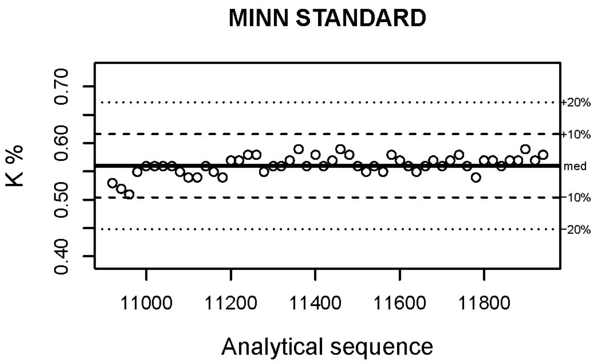

MINN STANDARD
Ga ppm
5
6
7
8
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

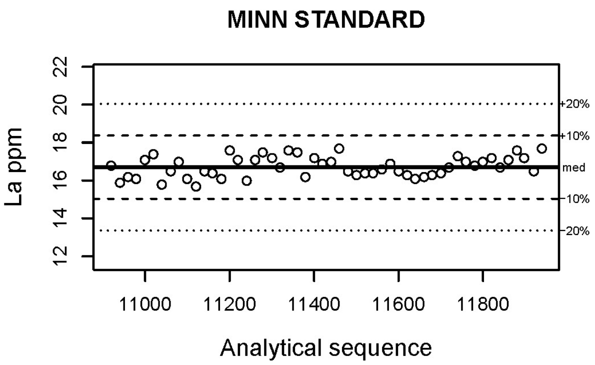

MINN STANDARD
Ge ppm
0.05
0.07
0.09
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

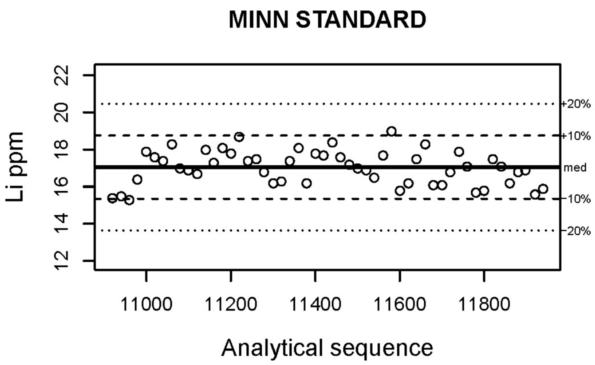

MINN STANDARD
Hf ppm
0.04
0.08
0.12
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

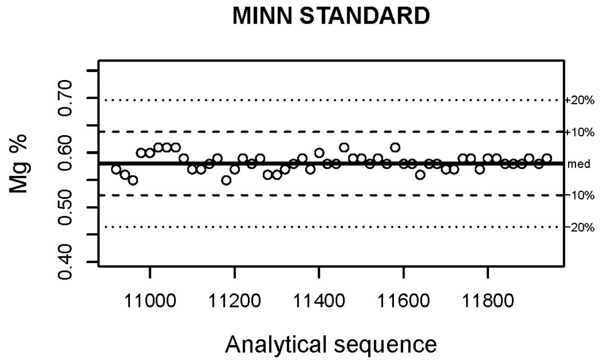

MINN STANDARD
Hg ppm
0.004
0.008
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

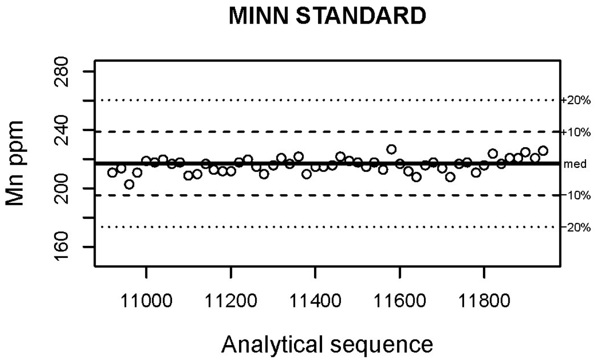

MINN STANDARD
In ppm
0.012
0.016
0.020
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

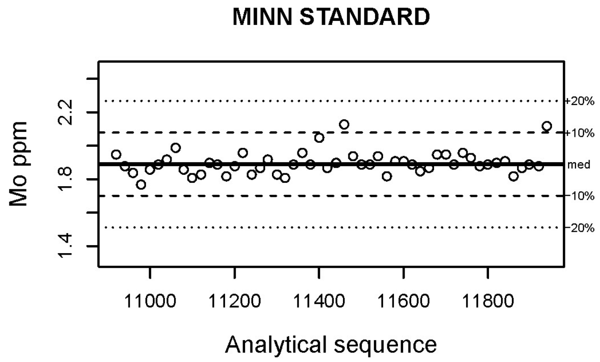

MINN STANDARD
K %
0.40
0.50
0.60
0.70
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

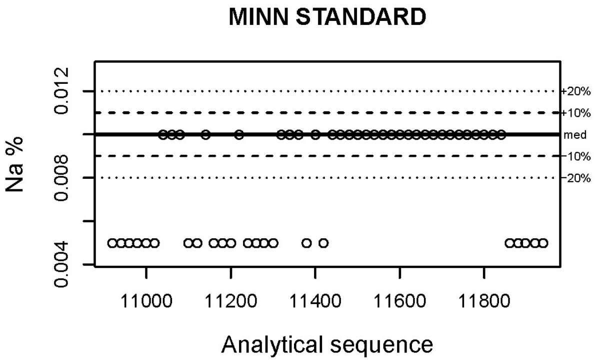

MINN STANDARD
La ppm
12
14
16
18
20
22
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

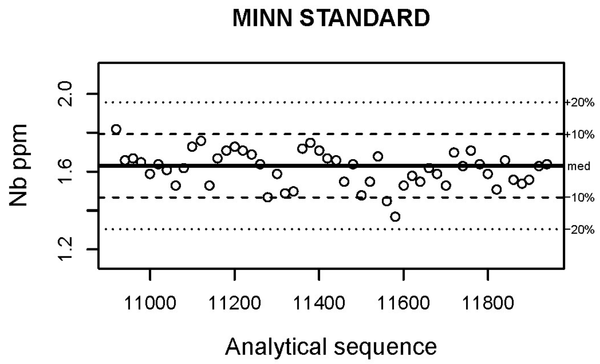

MINN STANDARD
Li ppm
12
14
16
18
20
22
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

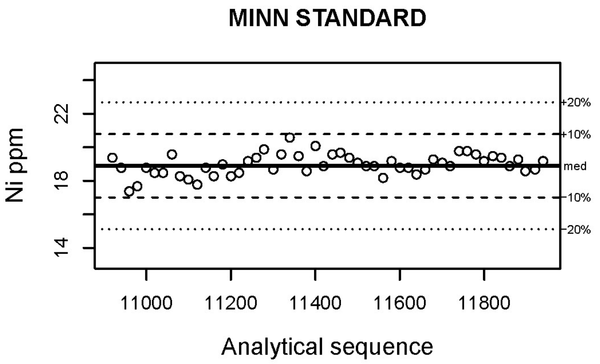

MINN STANDARD
Mg %
0.40
0.50
0.60
0.70
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

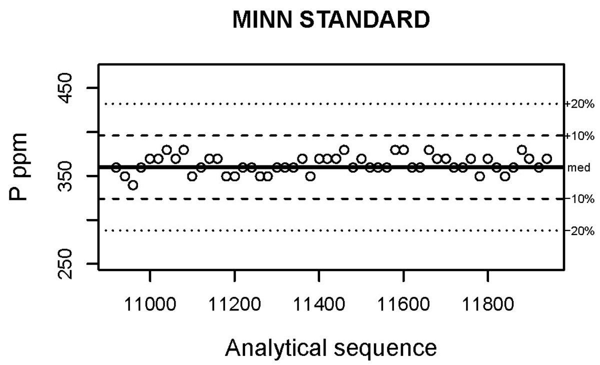

MINN STANDARD
Mn ppm
160
200
240
280
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

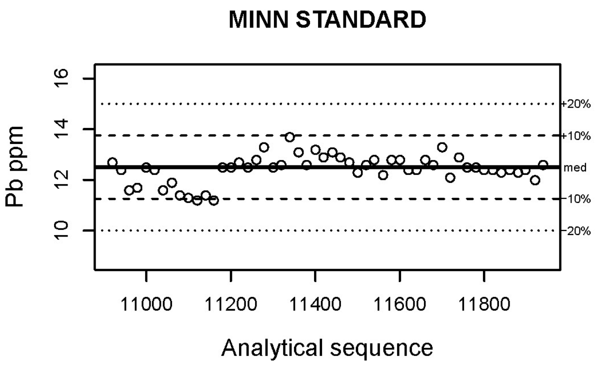

MINN STANDARD
Mo ppm
1.4
1.8
2.2
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

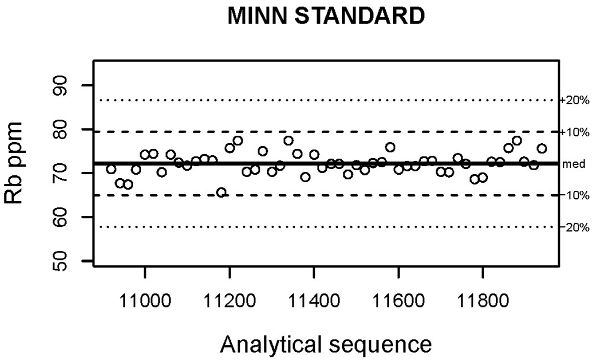

MINN STANDARD
Na %
0.004
0.008
0.012
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

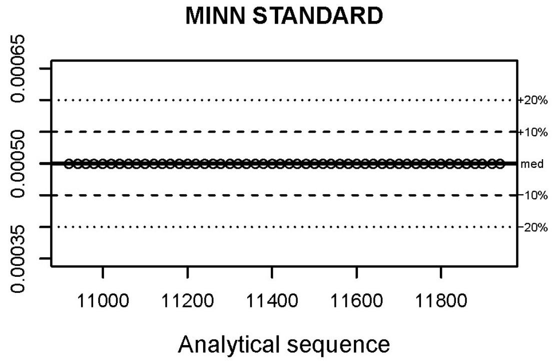

MINN STANDARD
Nb ppm
1.2
1.6
2.0
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

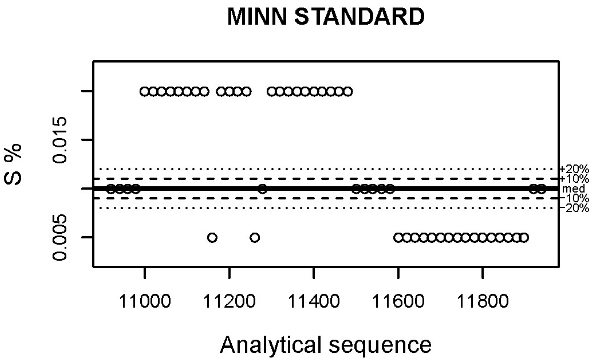

MINN STANDARD
Ni ppm
14
18
22
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence


MINN STANDARD
P ppm
250
350
450
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence


MINN STANDARD
Pb ppm
10
12
14
16
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence


MINN STANDARD
Rb ppm
50
60
70
80
90
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence


MINN STANDARD
Re ppm
0.00035
0.00050
0.00065
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence


MINN STANDARD
S %
0.005
0.015
+20%
+10%
med
-10%
-20%
11000
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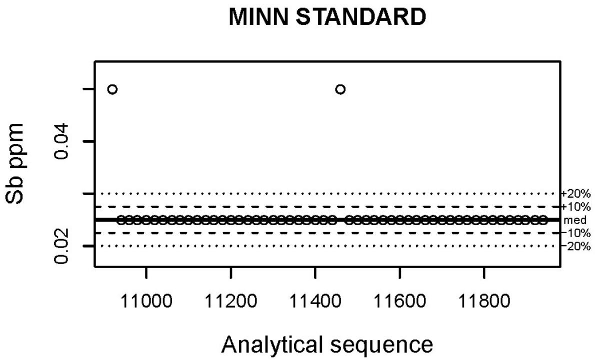
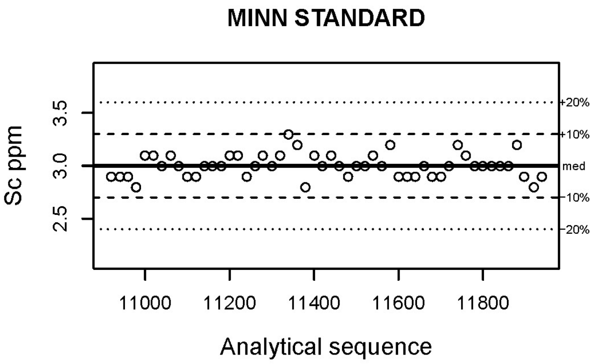
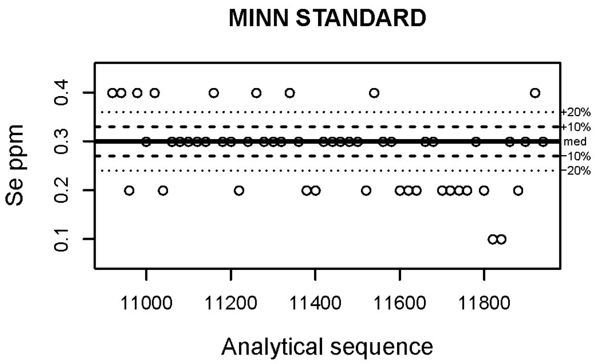
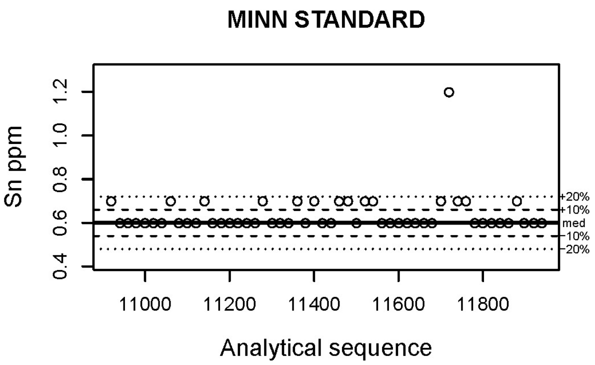
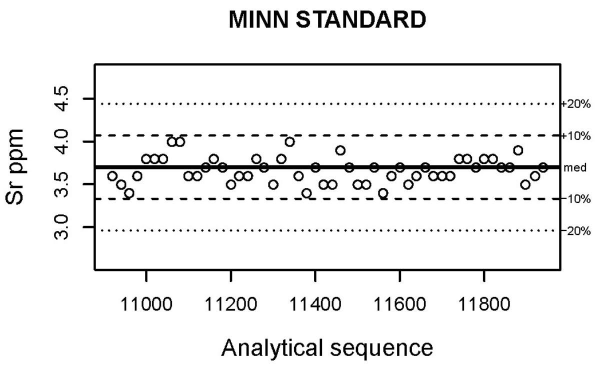
11600
11800
Analytical sequence

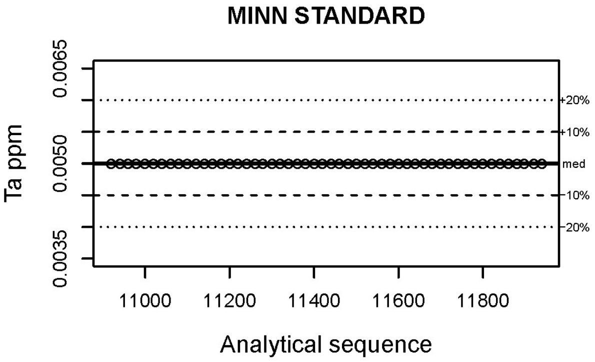

MINN STANDARD
Sb ppm
0.02
0.04
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

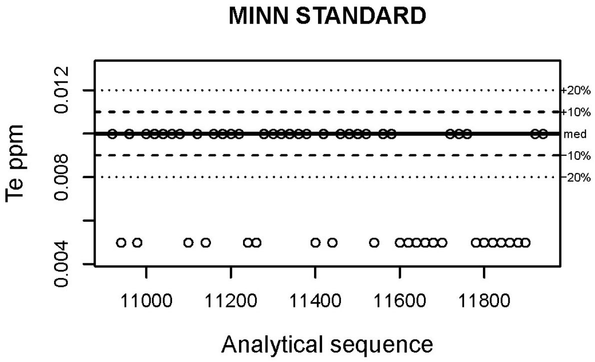

MINN STANDARD
Sc ppm
2.5
3.0
3.5
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

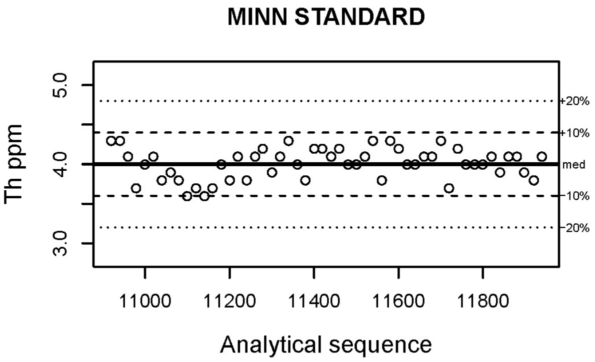

MINN STANDARD
Se ppm
0.1
0.2
0.3
0.4
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

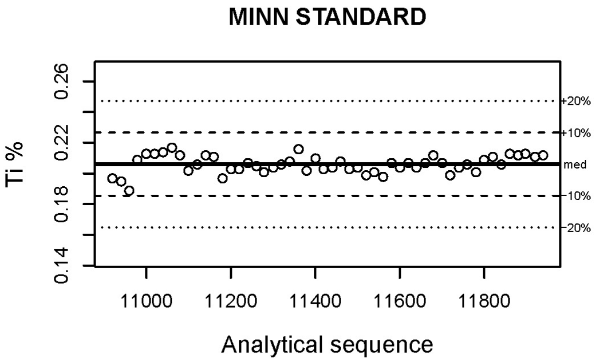

MINN STANDARD
Sn ppm
0.4
0.6
0.8
1.0
1.2
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

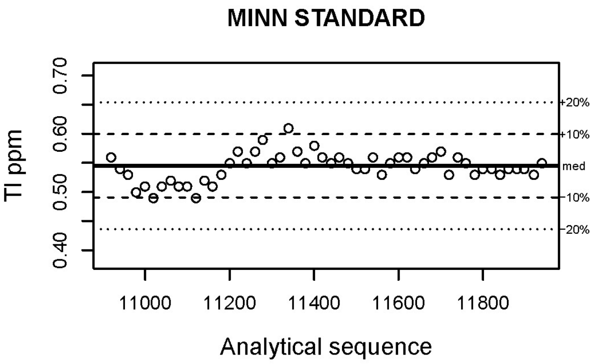

MINN STANDARD
Sr ppm
3.0
3.5
4.0
4.5
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

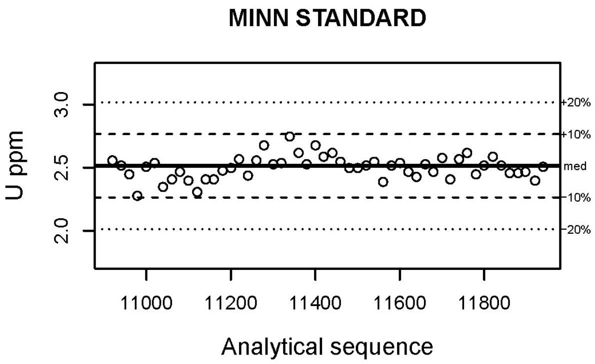

MINN STANDARD
Ta ppm
0.0035
0.0050
0.0065
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

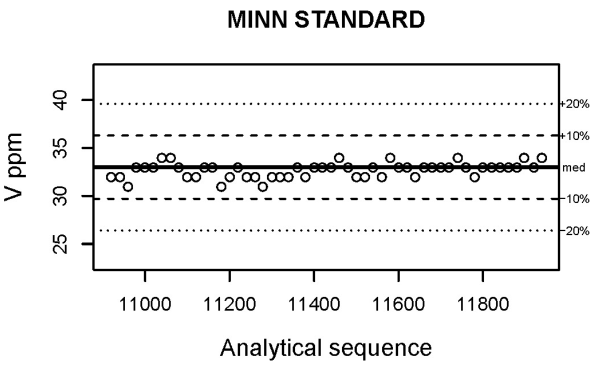

MINN STANDARD
Te ppm
0.004
0.008
0.012
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

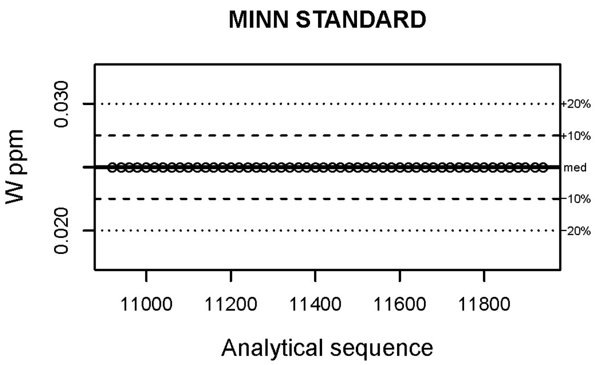

MINN STANDARD
Th ppm
3.0
4.0
5.0
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

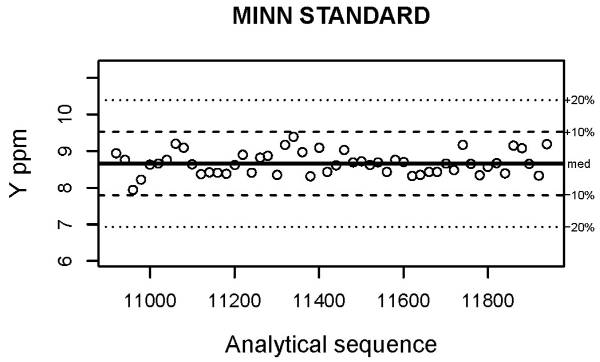

MINN STANDARD
Ti %
0.14
0.18
0.22
0.26
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

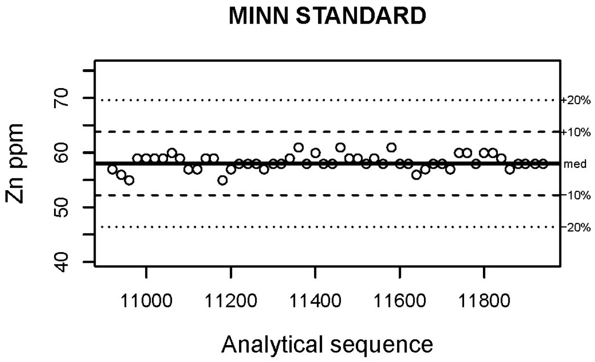

MINN STANDARD
Tl ppm
0.40
0.50
0.60
0.70
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

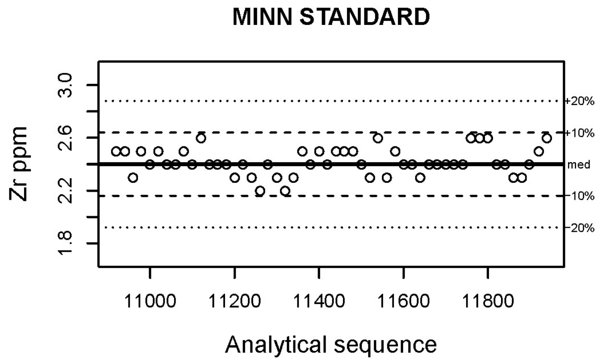

MINN STANDARD
U ppm
2.0
2.5
3.0
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

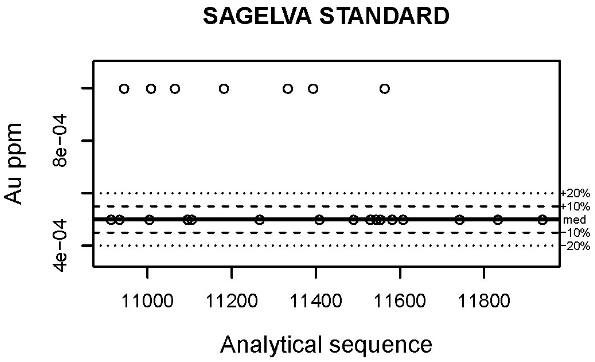

MINN STANDARD
V ppm
25
30
35
40
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

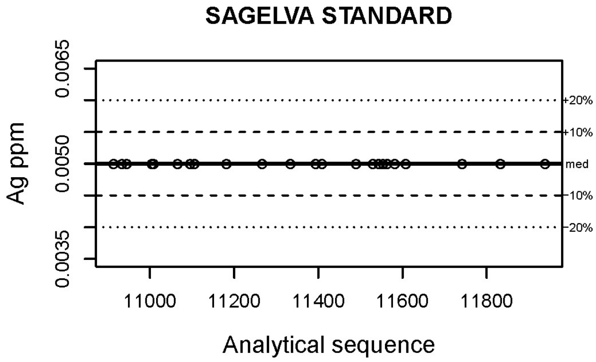

MINN STANDARD
W ppm
0.020
0.030
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

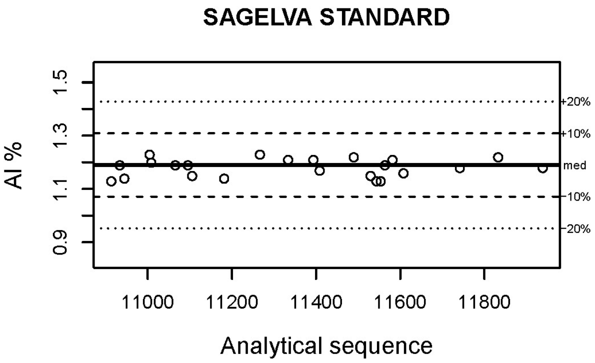

MINN STANDARD
Y ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

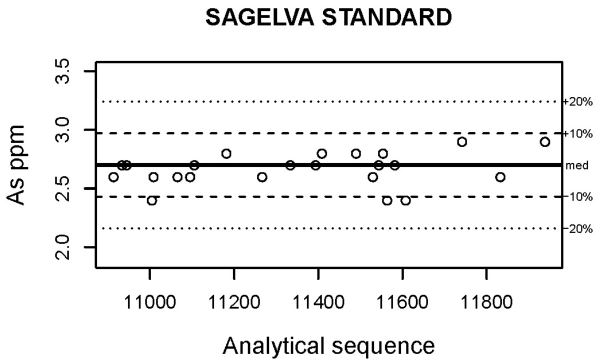

MINN STANDARD
Zn ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

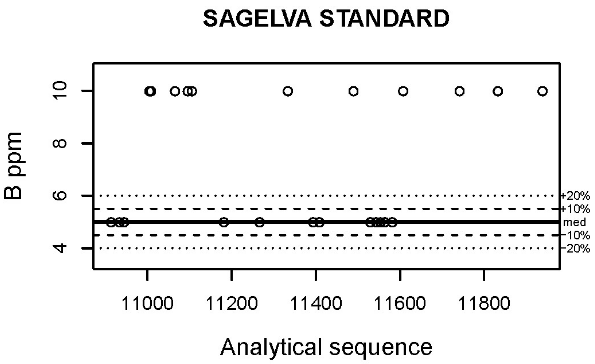

MINN STANDARD
Zr ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

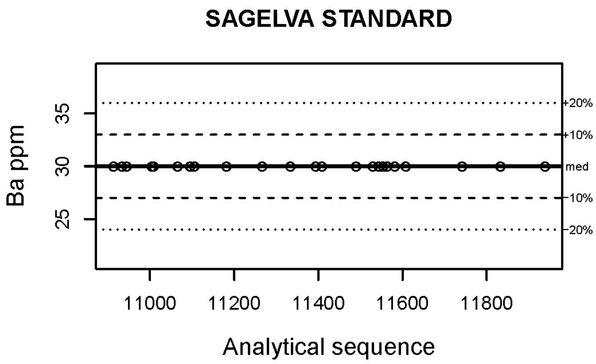

SAGELVA STANDARD
Au ppm
4e−04
8e−04
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

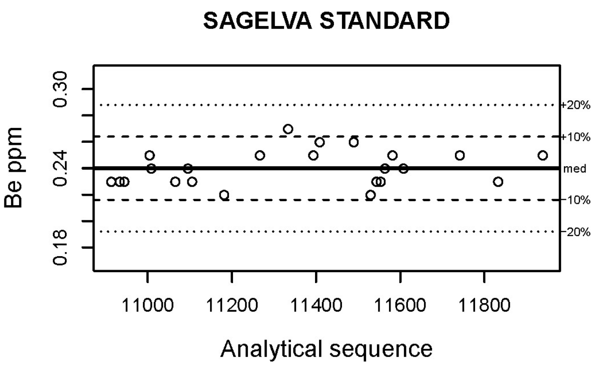

SAGELVA STANDARD
Ag ppm
0.0035
0.0050
0.0065
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

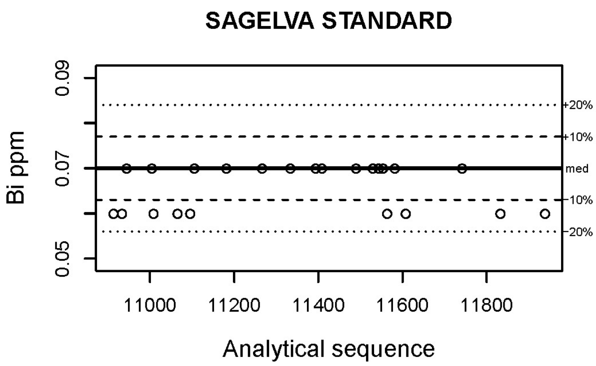

SAGELVA STANDARD
Al %
0.9
1.1
1.3
1.5
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

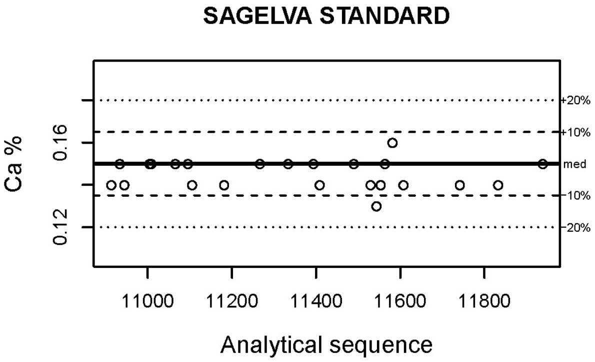

SAGELVA STANDARD
As ppm
2.0
2.5
3.0
3.5
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

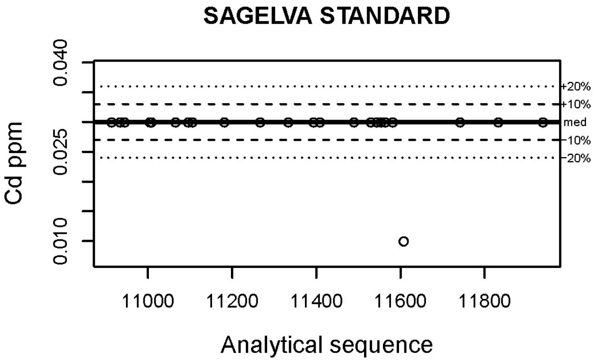

SAGELVA STANDARD
B ppm
4
6
8
10
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

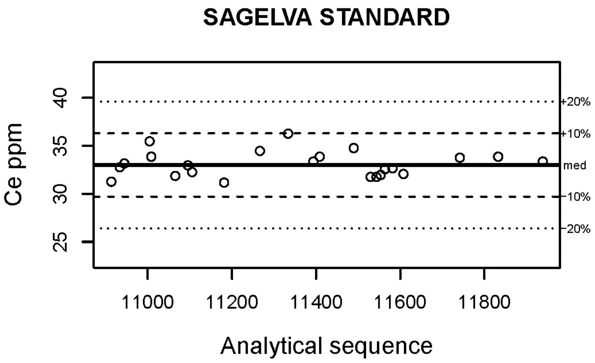

SAGELVA STANDARD
Ba ppm
25
30
35
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

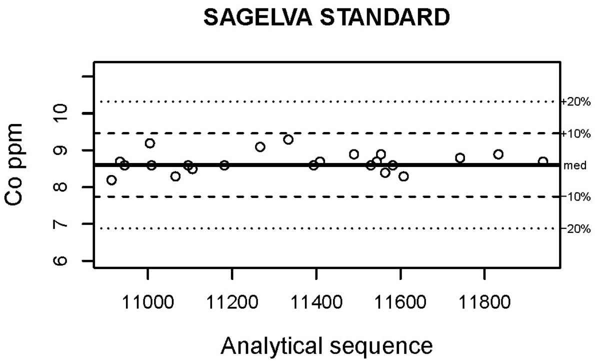

SAGELVA STANDARD
Be ppm
0.18
0.24
0.30
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

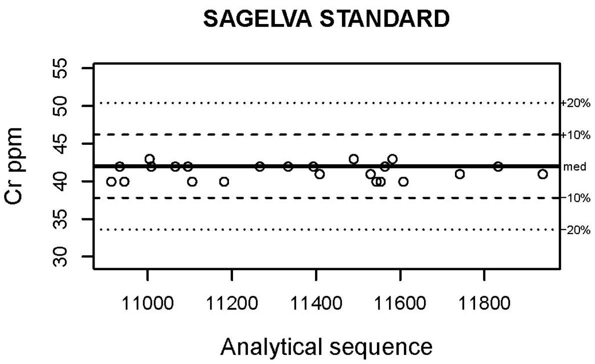

SAGELVA STANDARD
Bi ppm
0.05
0.07
0.09
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

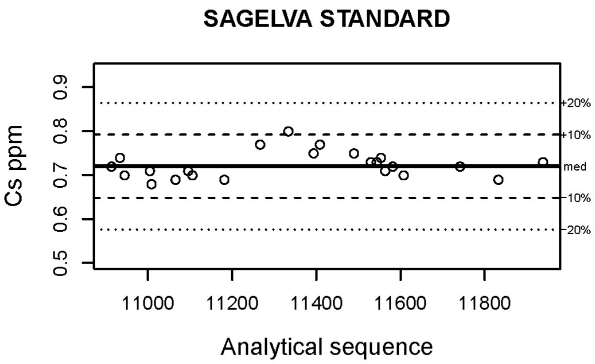

SAGELVA STANDARD
Ca %
Analytical sequence

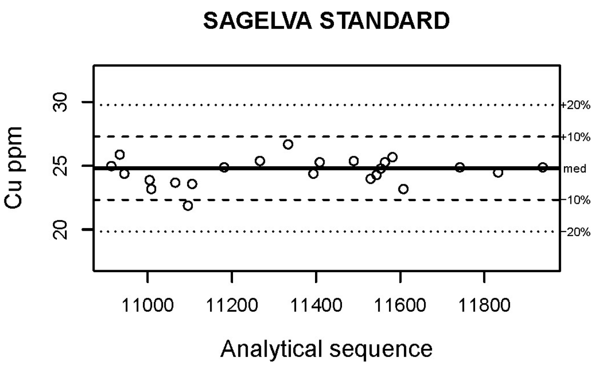

SAGELVA STANDARD
Cd ppm
Analytical sequence

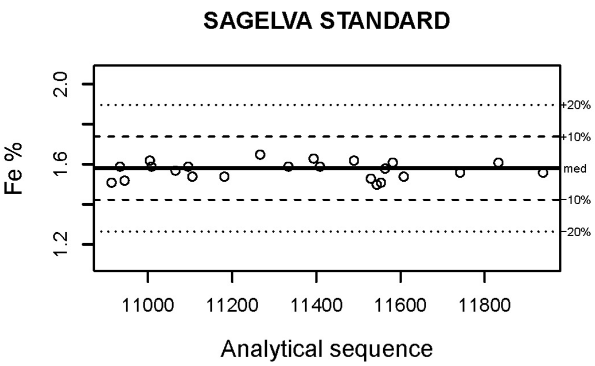

SAGELVA STANDARD
Ce ppm
Analytical sequence

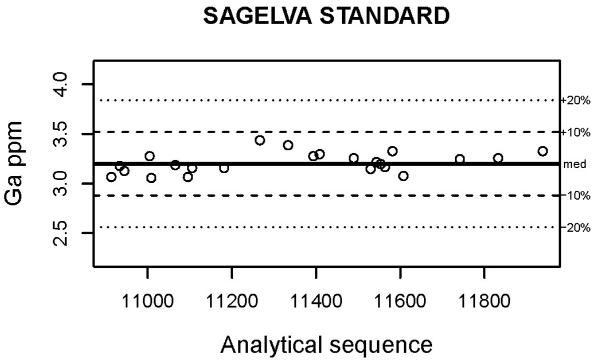

SAGELVA STANDARD
Co ppm
Analytical sequence

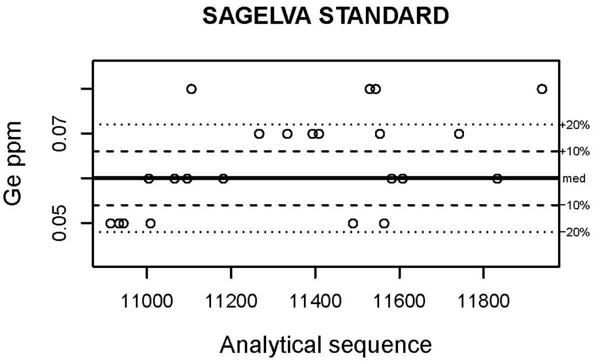

SAGELVA STANDARD
Cr ppm
Analytical sequence

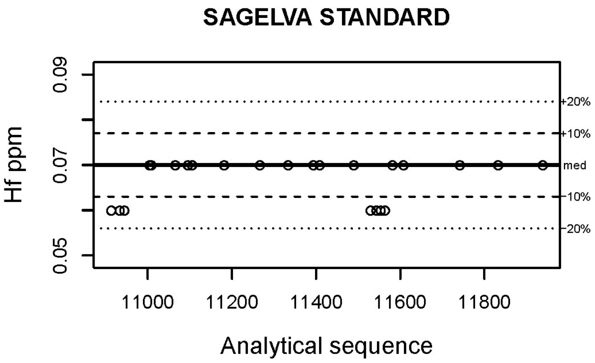

SAGELVA STANDARD
Cs ppm
Analytical sequence

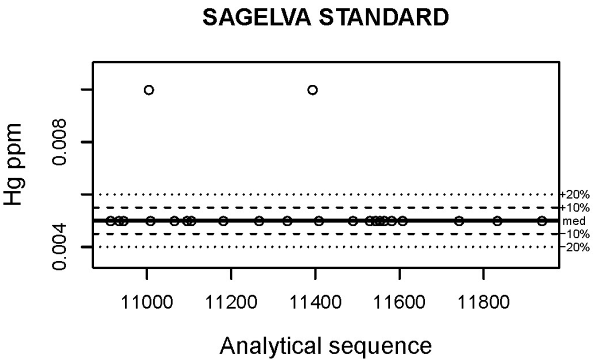

SAGELVA STANDARD
Cu ppm
Analytical sequence

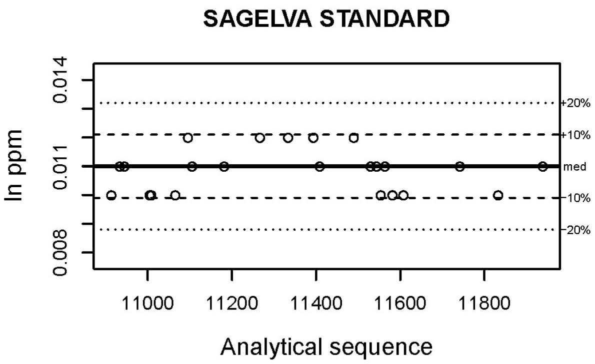

SAGELVA STANDARD
Fe %
Analytical sequence

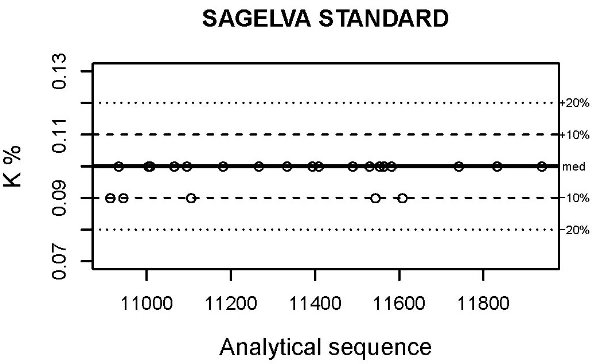

SAGELVA STANDARD
Ga ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

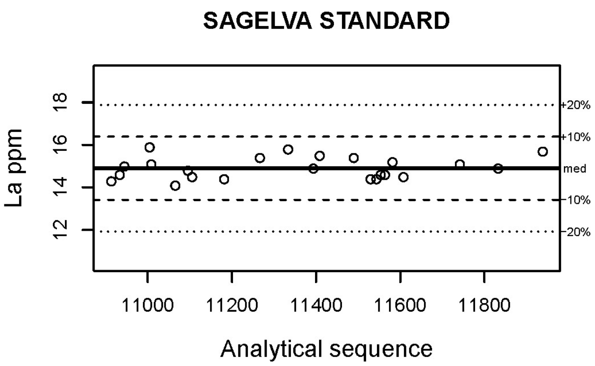

SAGELVA STANDARD
Ge ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

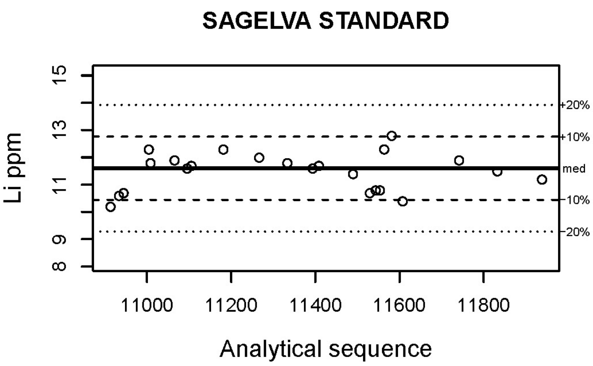

SAGELVA STANDARD
Hf ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

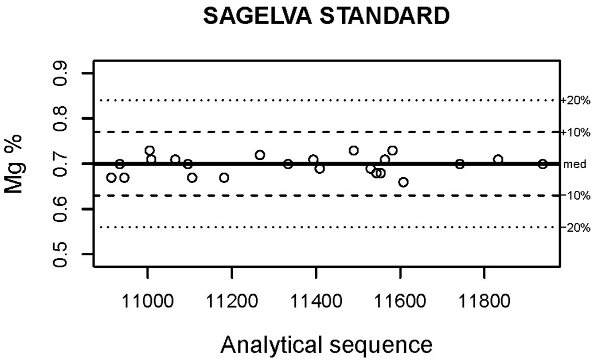

SAGELVA STANDARD
Hg ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

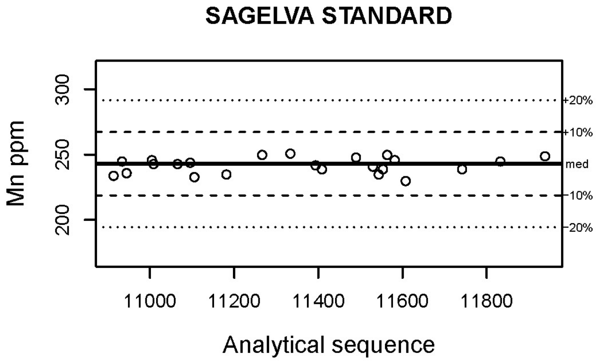

SAGELVA STANDARD
In ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

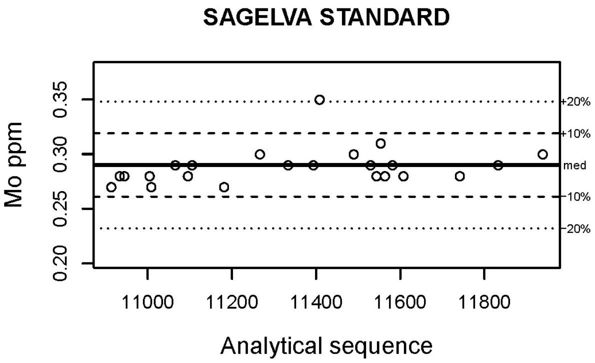

SAGELVA STANDARD
K %
Analytical sequence
+20%
+10%
med
-10%
-20%

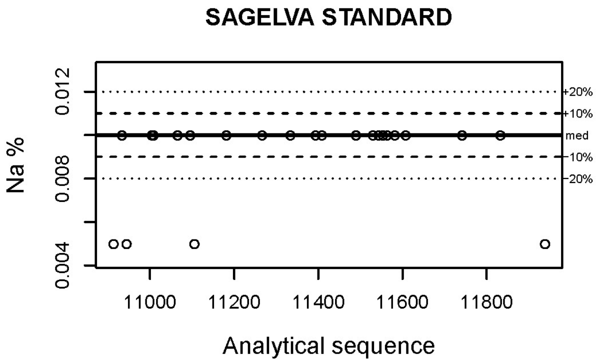

SAGELVA STANDARD
La ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

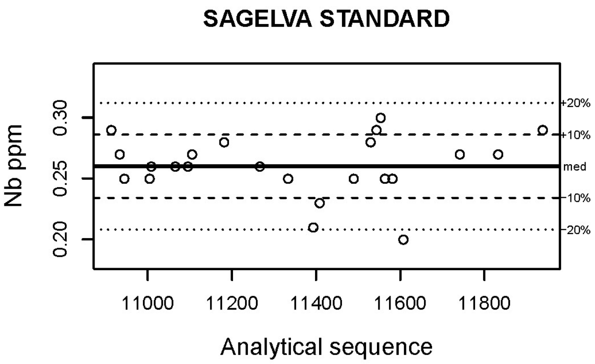

SAGELVA STANDARD
Li ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

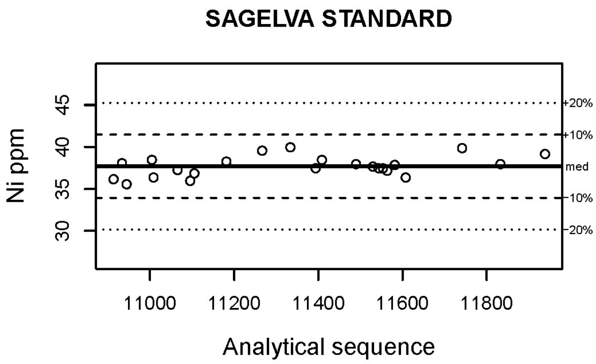

SAGELVA STANDARD
Mg %
Analytical sequence

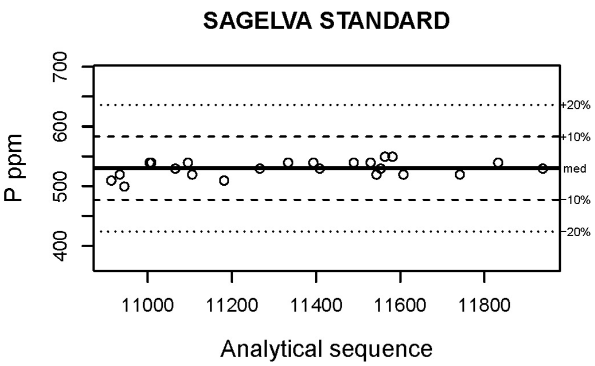

SAGELVA STANDARD
Mn ppm
Analytical sequence

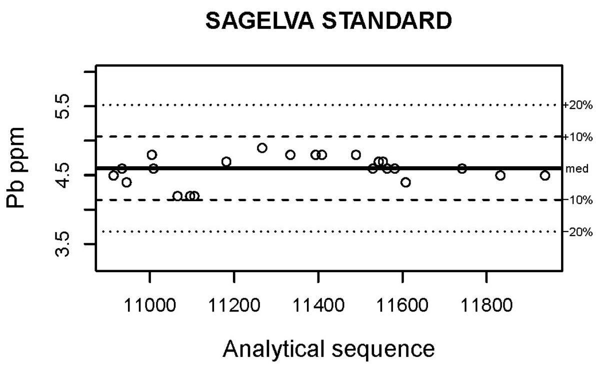

SAGELVA STANDARD
Mo ppm
Analytical sequence

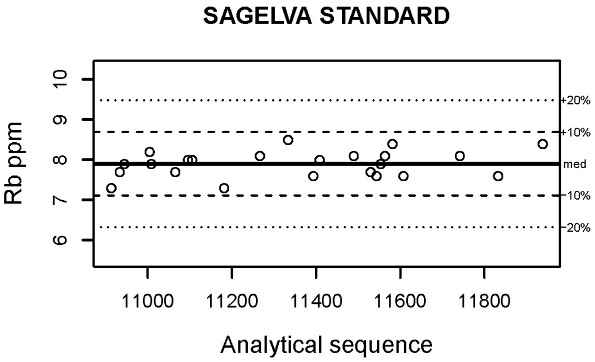

SAGELVA STANDARD
Na %
Analytical sequence

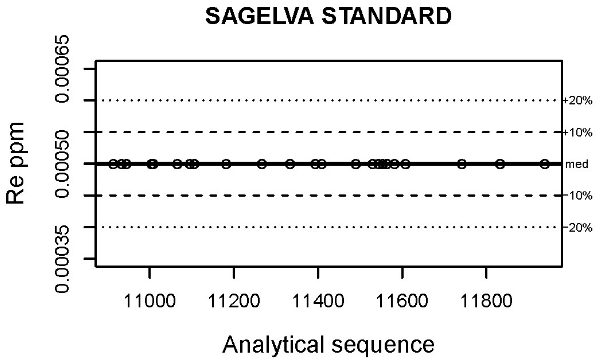

SAGELVA STANDARD
Nb ppm
Analytical sequence

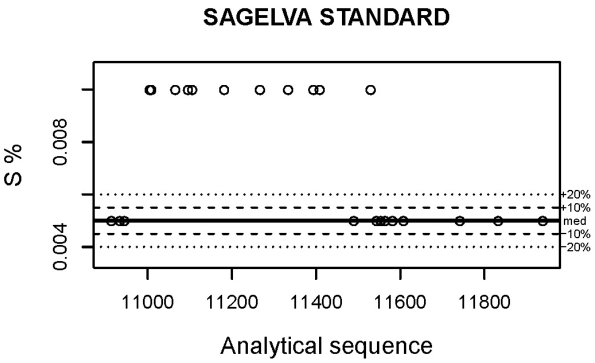

SAGELVA STANDARD
Ni ppm
Analytical sequence

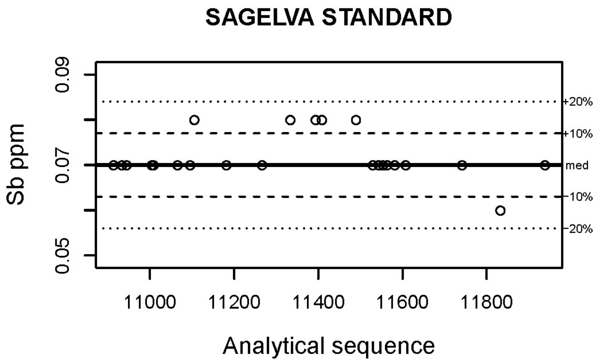

SAGELVA STANDARD
P ppm
Analytical sequence

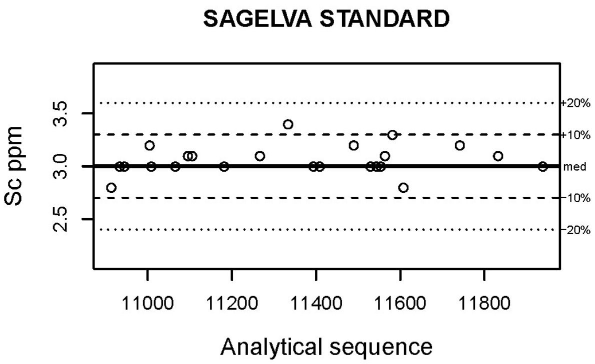

SAGELVA STANDARD
Pb ppm
Analytical sequence

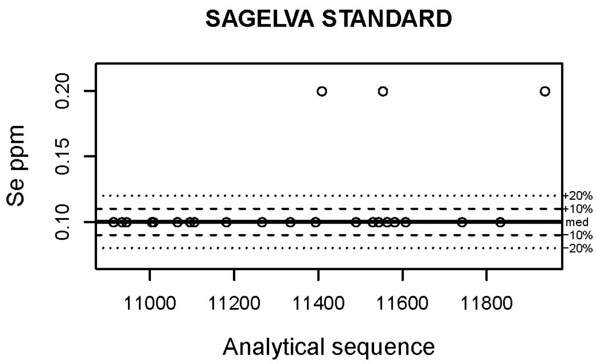

SAGELVA STANDARD
Rb ppm
6
7
8
9
10
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

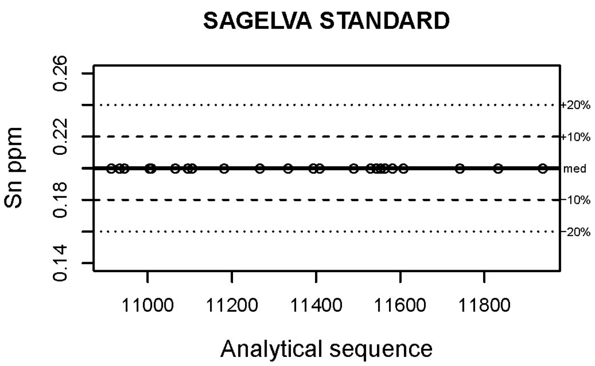

SAGELVA STANDARD
Re ppm
0.00035
0.00050
0.00065
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

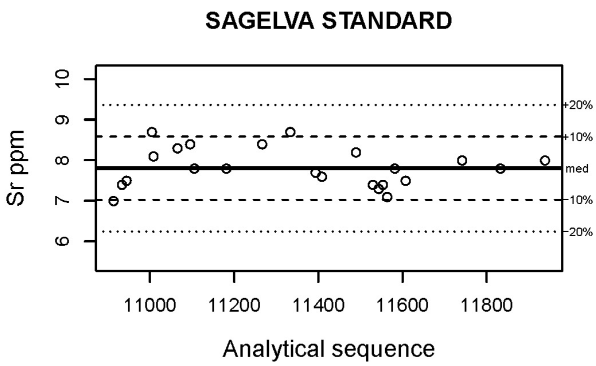

SAGELVA STANDARD
S %
0.004
0.008
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

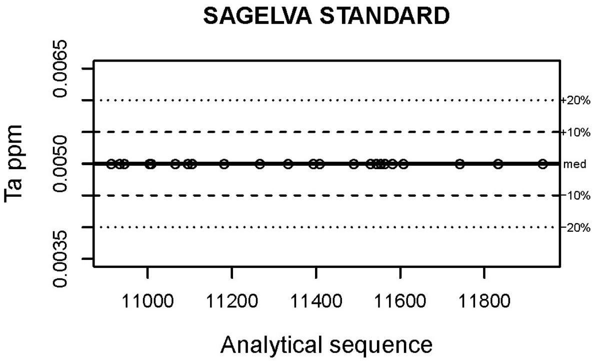

SAGELVA STANDARD
Sb ppm
0.05
0.07
0.09
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

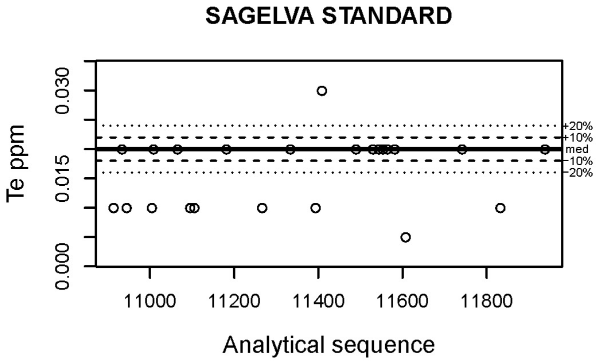

SAGELVA STANDARD
Sc ppm
2.5
3.0
3.5
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

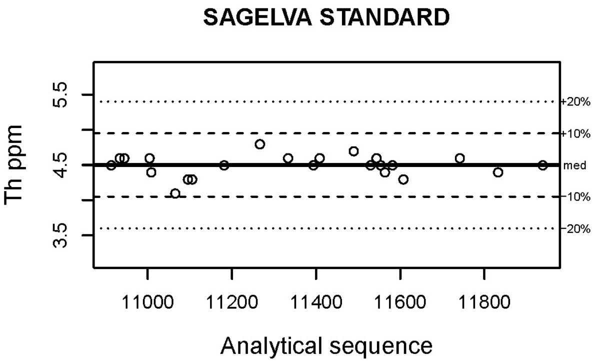

SAGELVA STANDARD
Se ppm
0.10
0.15
0.20
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

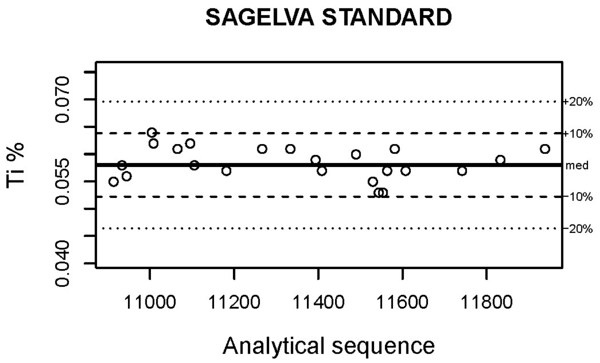

SAGELVA STANDARD
Sn ppm
0.14
0.18
0.22
0.26
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

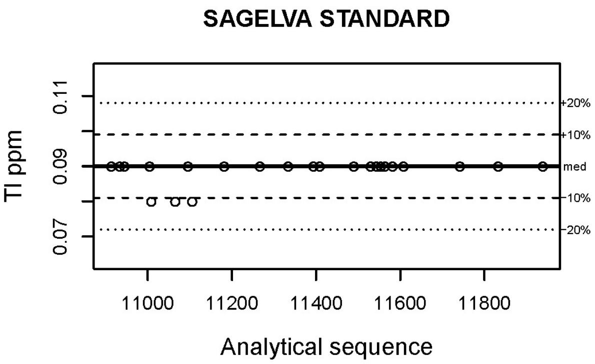

SAGELVA STANDARD
Sr ppm
6
7
8
9
10
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

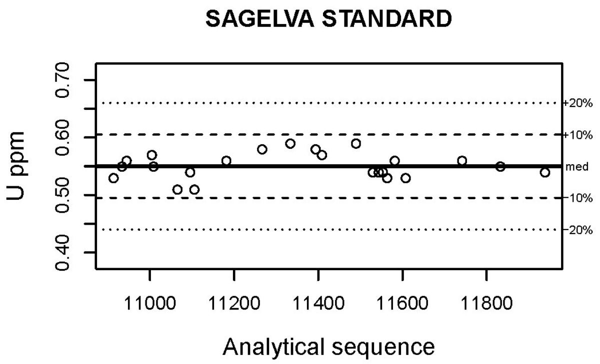

SAGELVA STANDARD
Ta ppm
0.0035
0.0050
0.0065
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

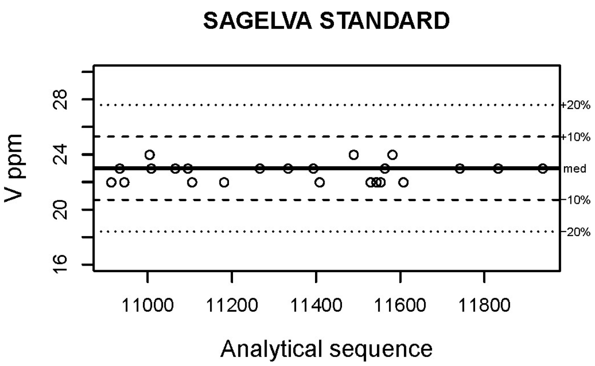

SAGELVA STANDARD
Te ppm
0.000
0.015
0.030
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

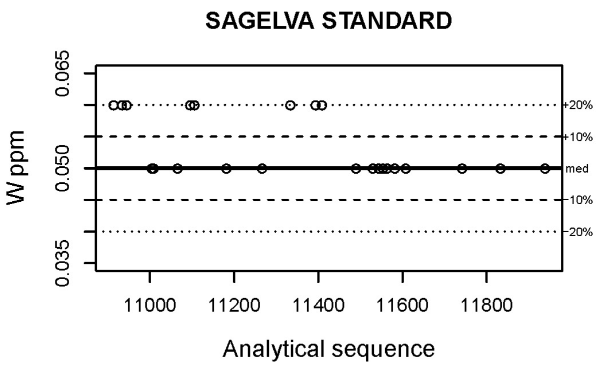

SAGELVA STANDARD
Th ppm
3.5
4.5
5.5
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

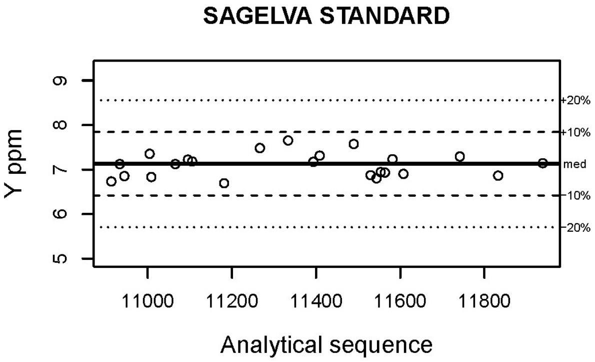

SAGELVA STANDARD
Ti %
0.040
0.055
0.070
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

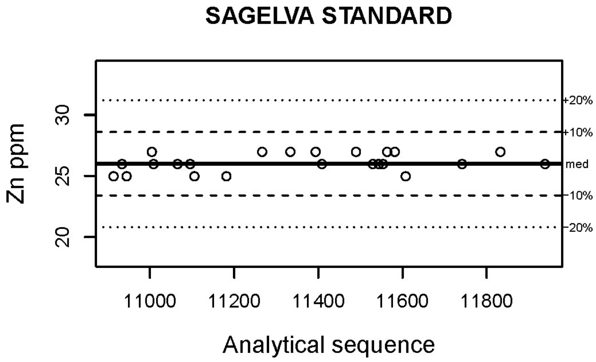

SAGELVA STANDARD
Tl ppm
0.07
0.09
0.11
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

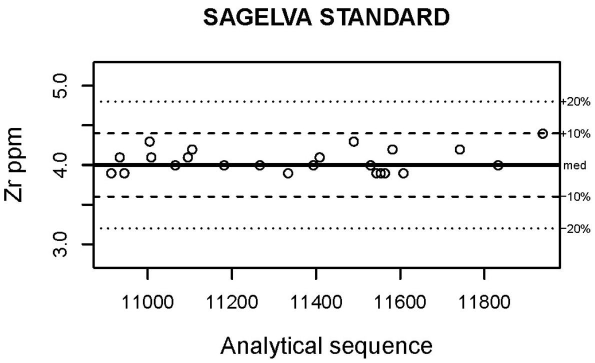

SAGELVA STANDARD
U ppm
0.40
0.50
0.60
0.70
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence


SAGELVA STANDARD
V ppm
16
20
24
28
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence


SAGELVA STANDARD
W ppm
0.035
0.050
0.065
+20%
+10%
med
-10%
-20%
11000
11200
11400
11600
11800
Analytical sequence

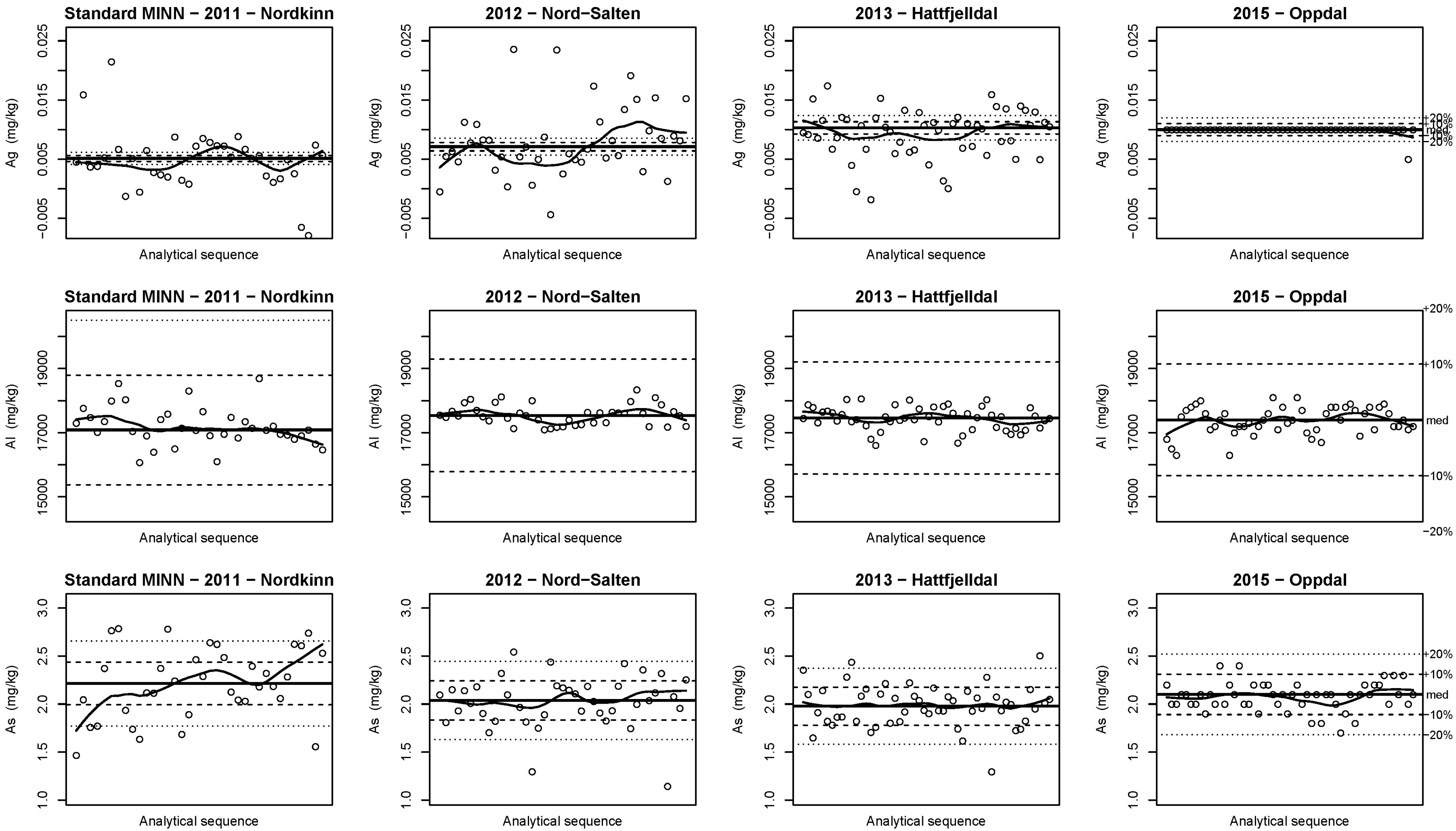

SAGELVA STANDARD
Y ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

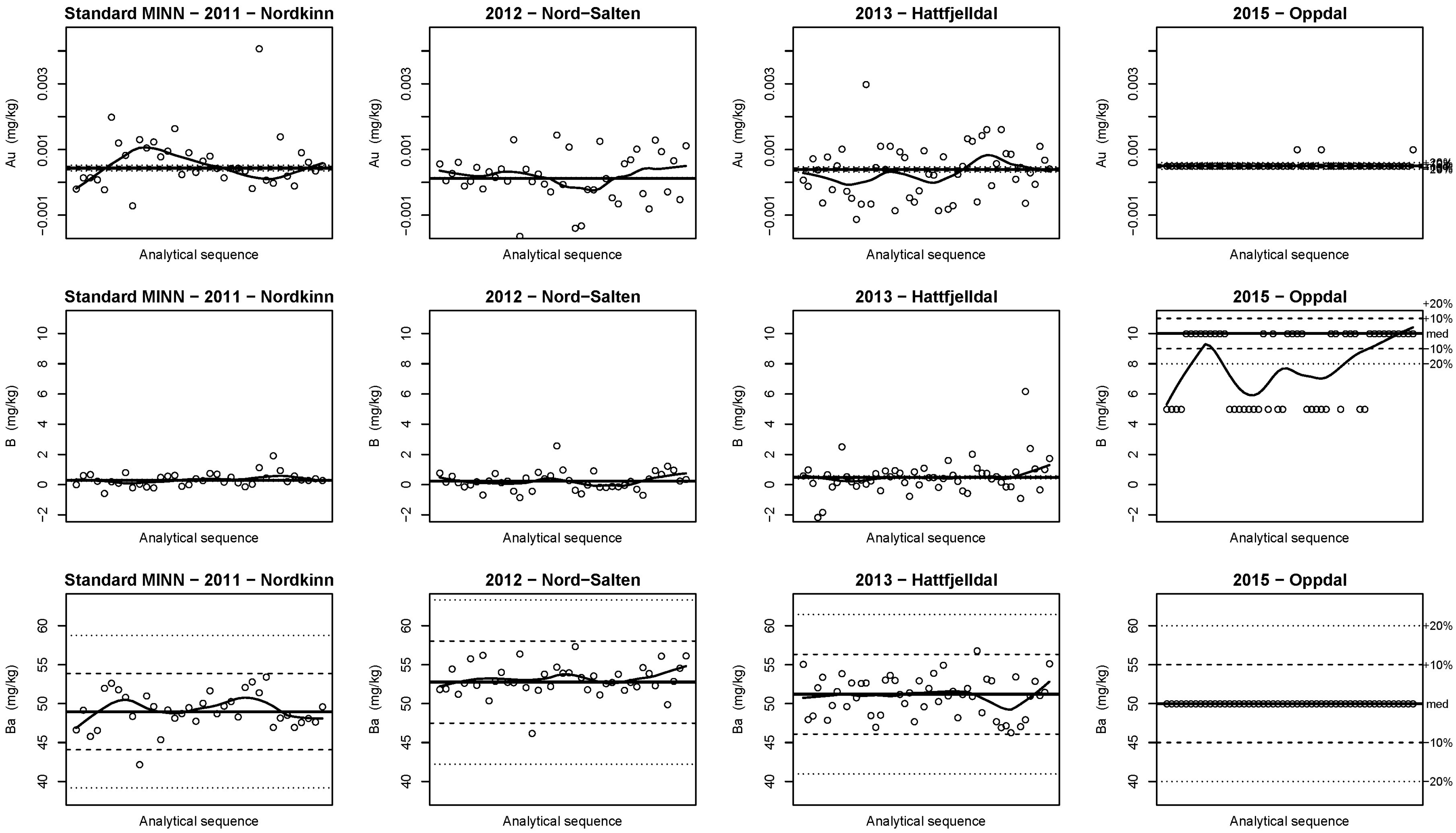

SAGELVA STANDARD
Zn ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

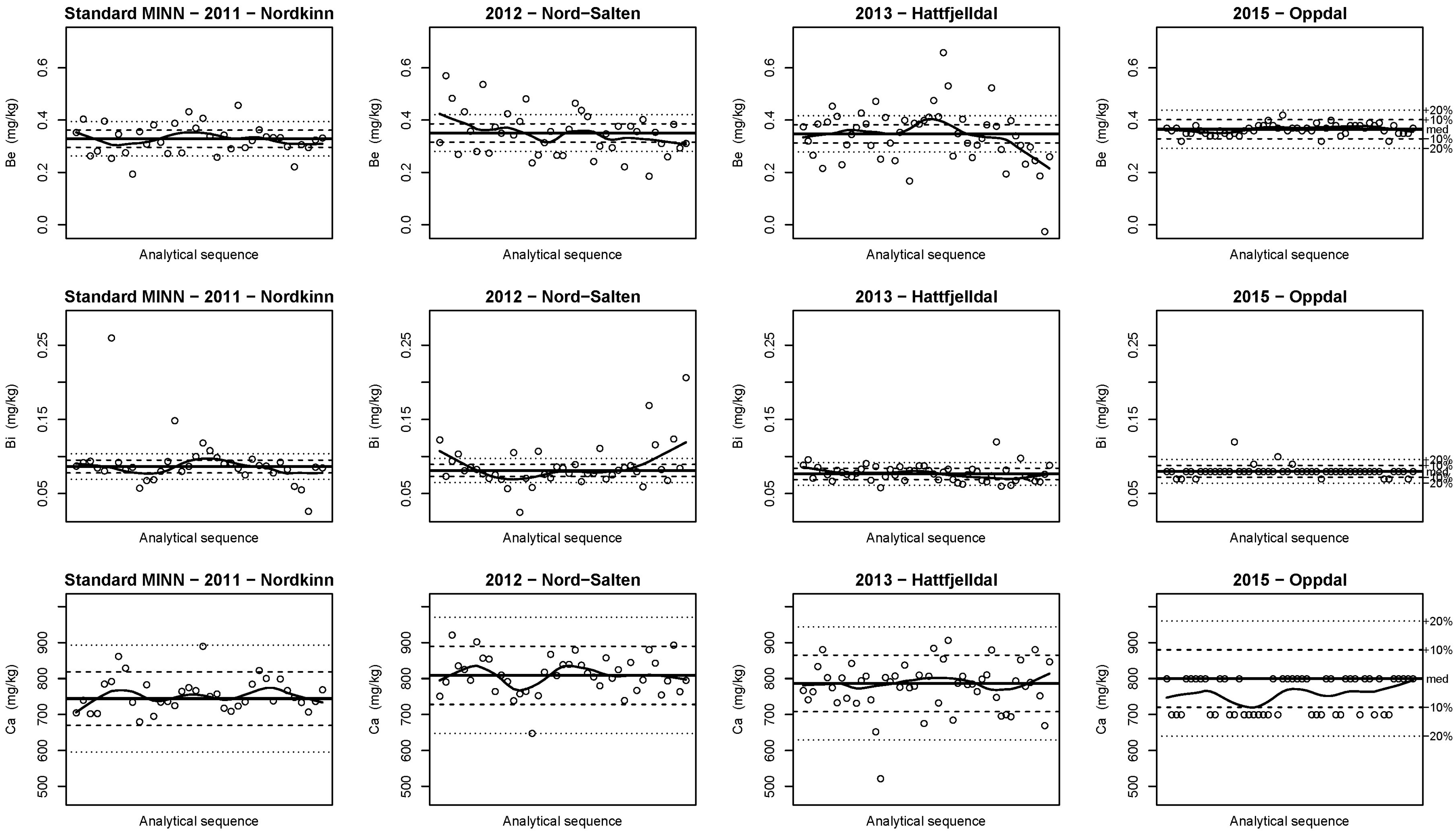

SAGELVA STANDARD
Zr ppm
Analytical sequence
+20%
+10%
med
-10%
-20%

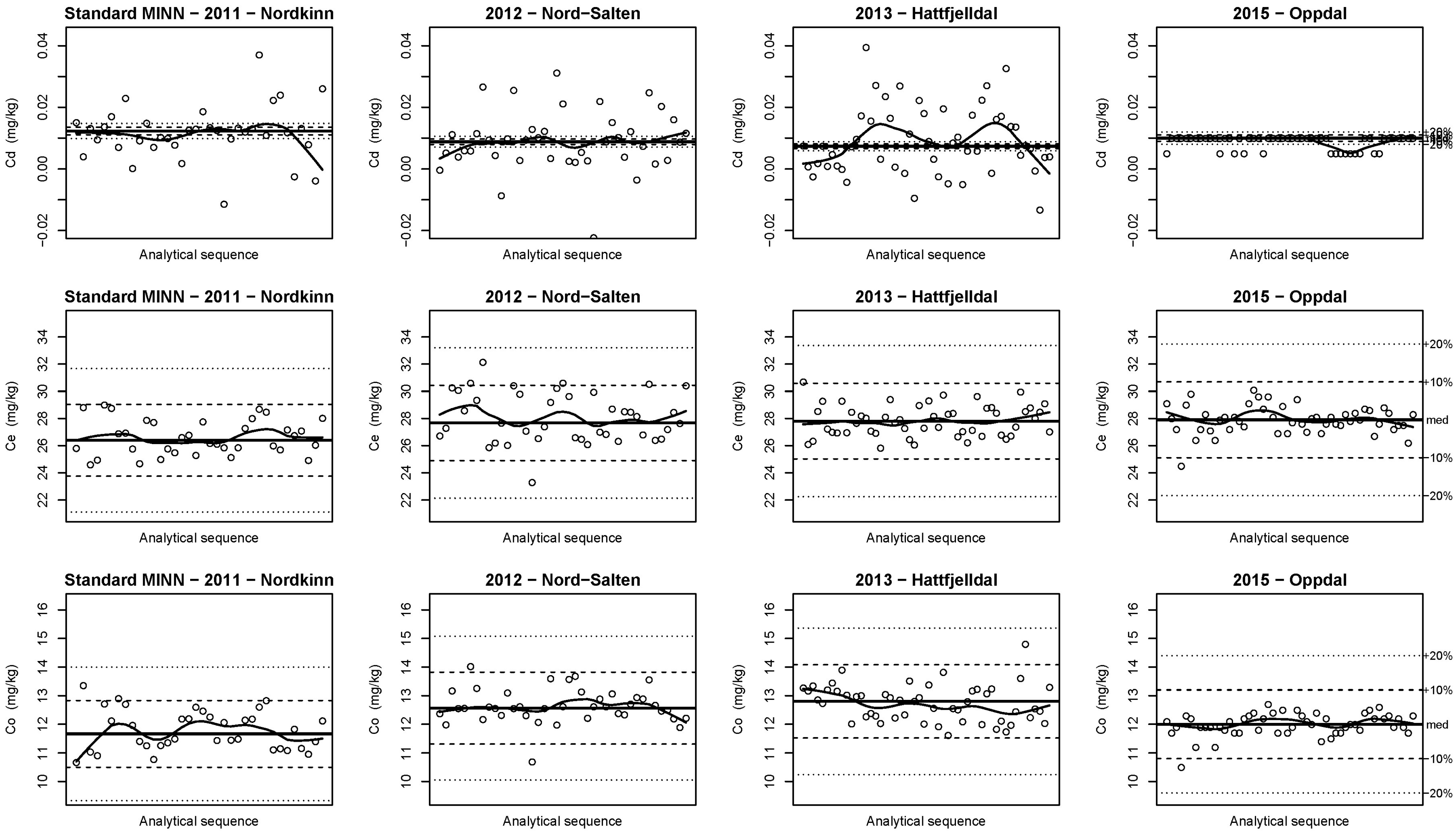
Appendix III Comparison of MINN standard over four campaigns

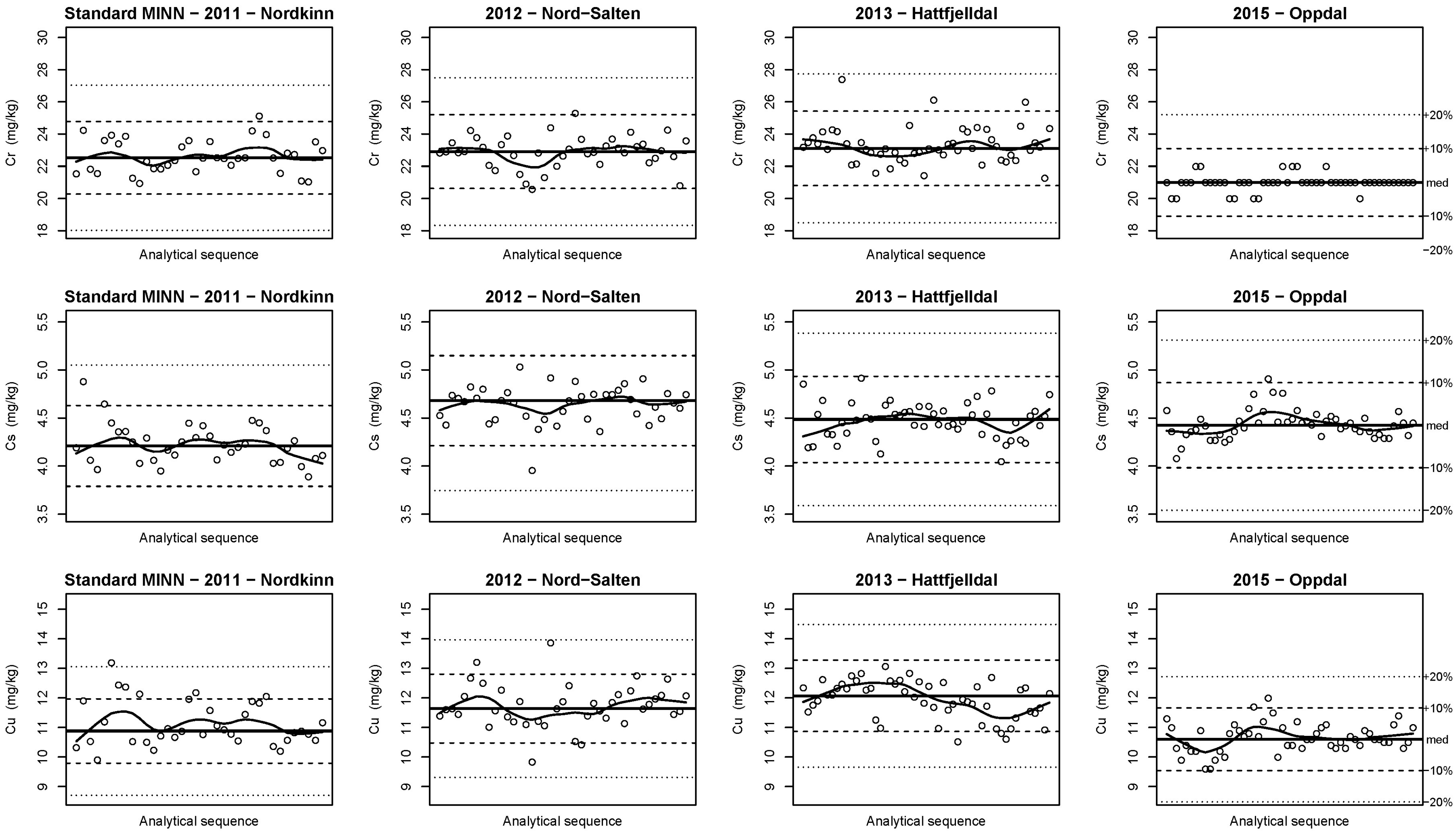
Nordkinn 2011, Nord-Salten 2012, Hattfjelldal 2013 and the present study

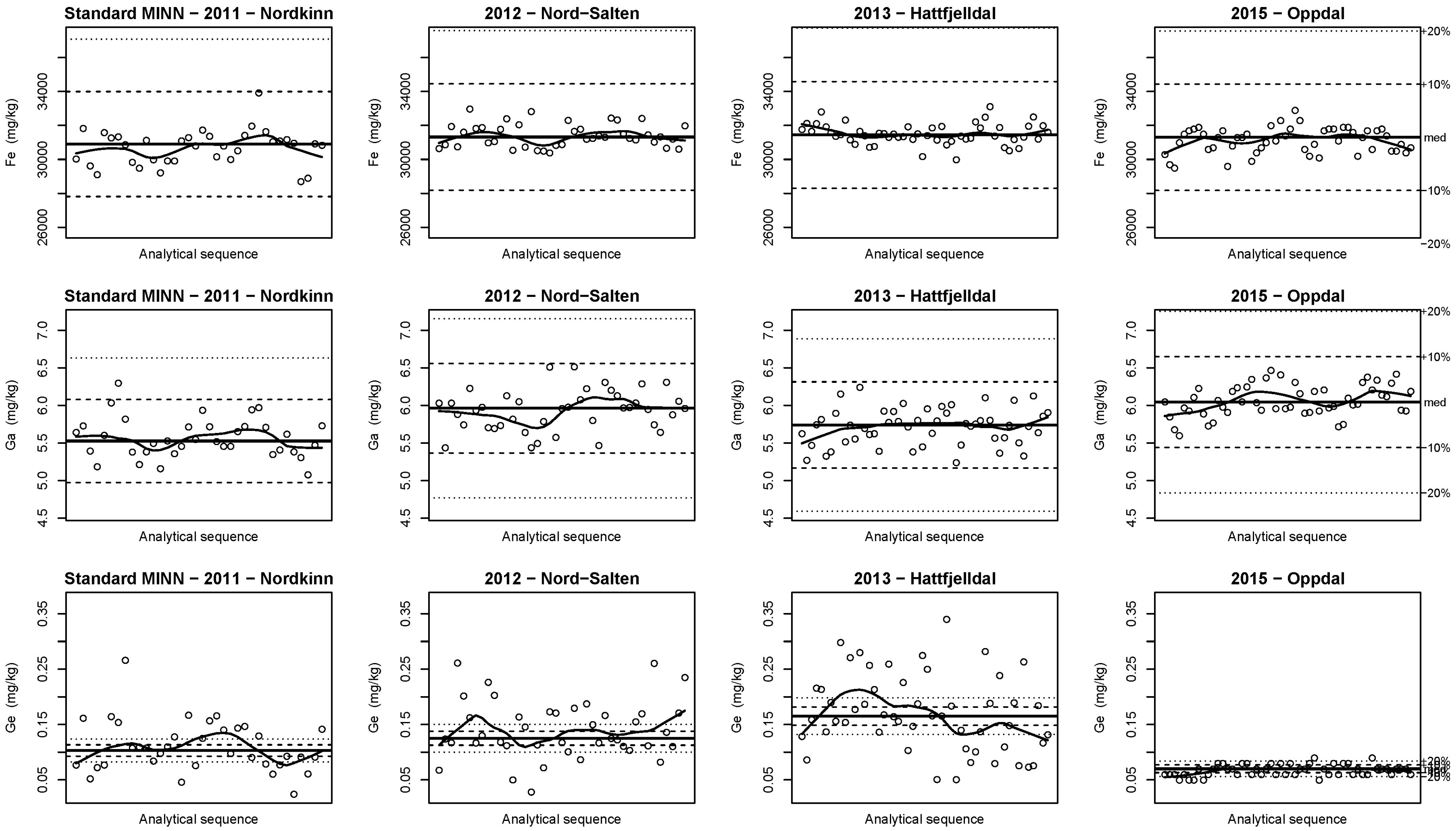

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Ag (mg/kg)
Al (mg/kg)
As (mg/kg)
Analytical sequence
+20%
+10%
med
−10%
−20%
−0.005
0.005
0.015
0.025
15000
17000
19000
1.0
1.5
2.0
2.5
3.0


Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Au (mg/kg)
B (mg/kg)
Ba (mg/kg)
Analytical sequence
+20%
+10%
med
-10%
-20%

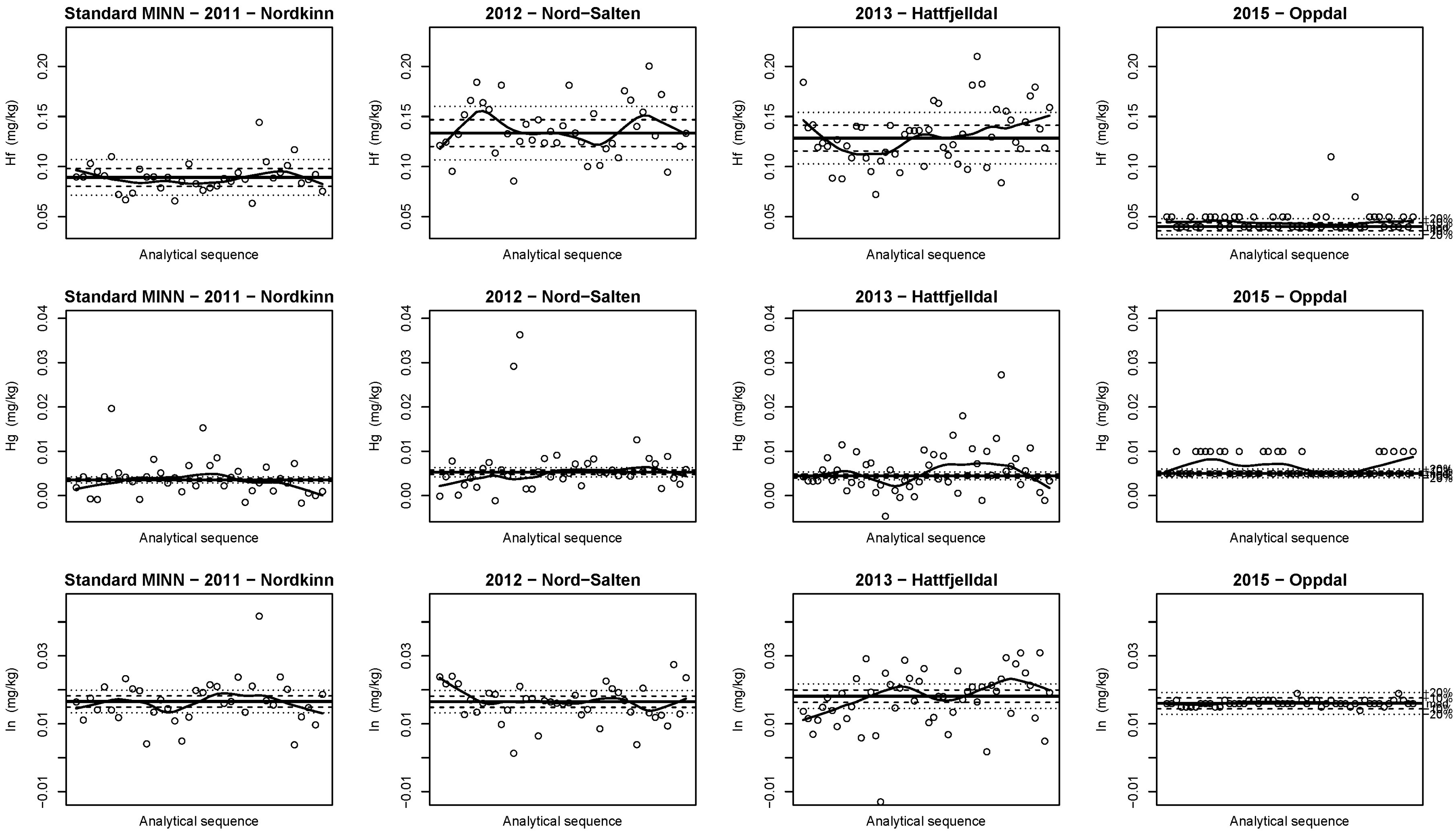

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Be (mg/kg)
0.0
0.2
0.4
0.6
+20%
+10%
med
−10%
−20%
Analytical sequence
Bi (mg/kg)
0.05
0.15
0.25
Ca (mg/kg)
500
600
700
800
900

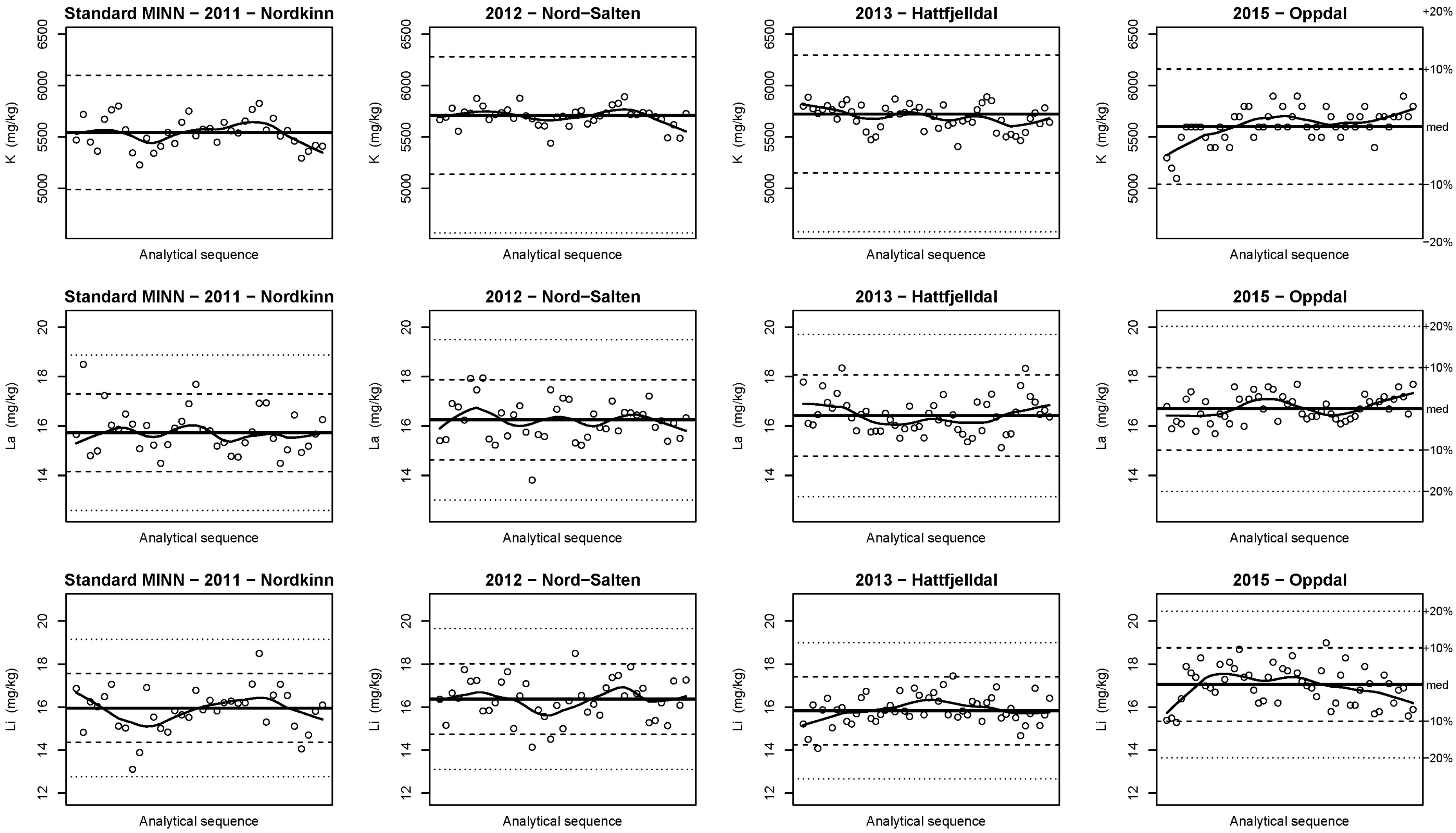

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Cd (mg/kg)
Ce (mg/kg)
Co (mg/kg)
Analytical sequence
+20%
+10%
med
−10%
−20%

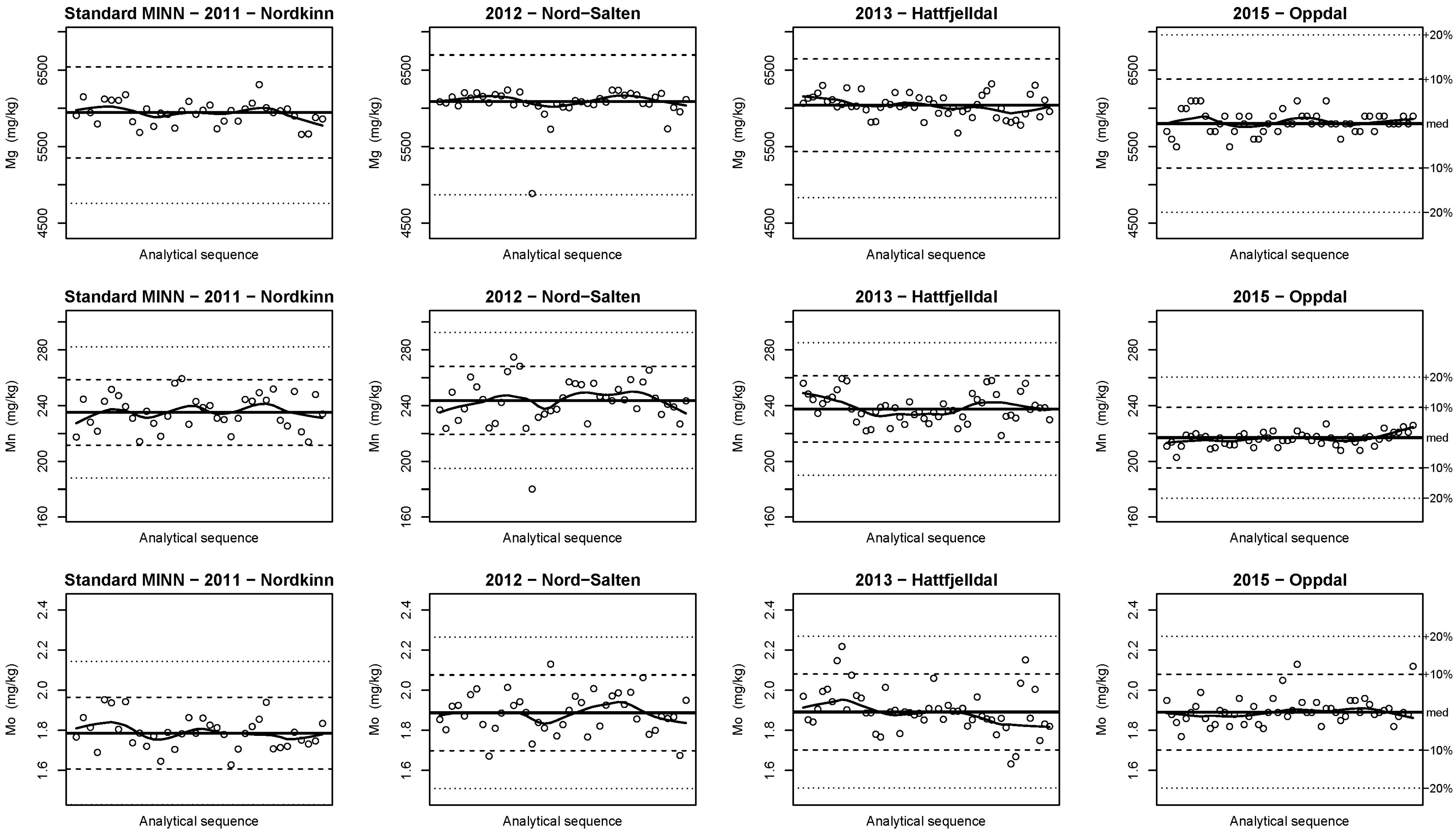

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Cr (mg/kg)
Cs (mg/kg)
Cu (mg/kg)
Analytical sequence
+20%
+10%
med
−10%
−20%

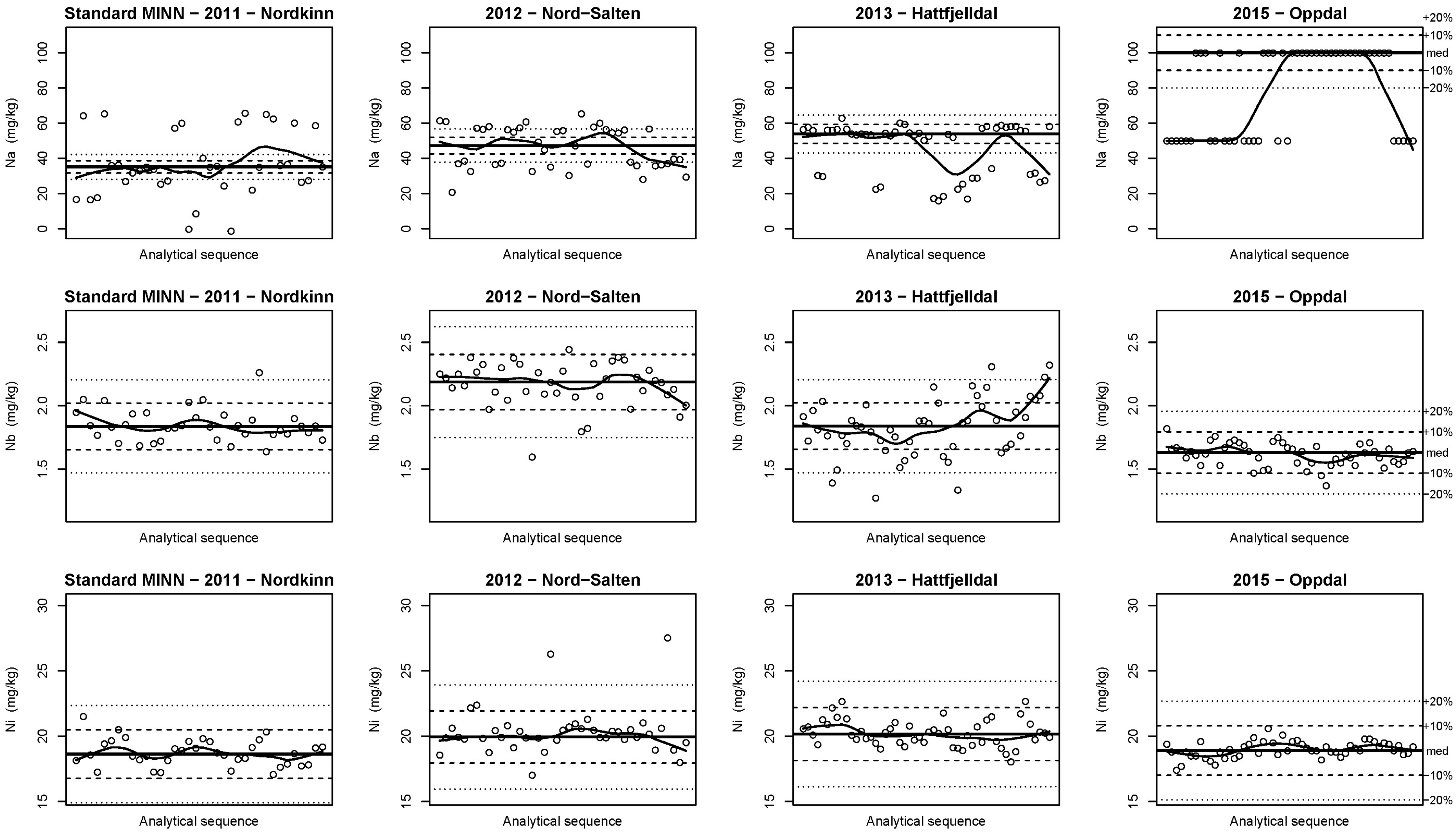


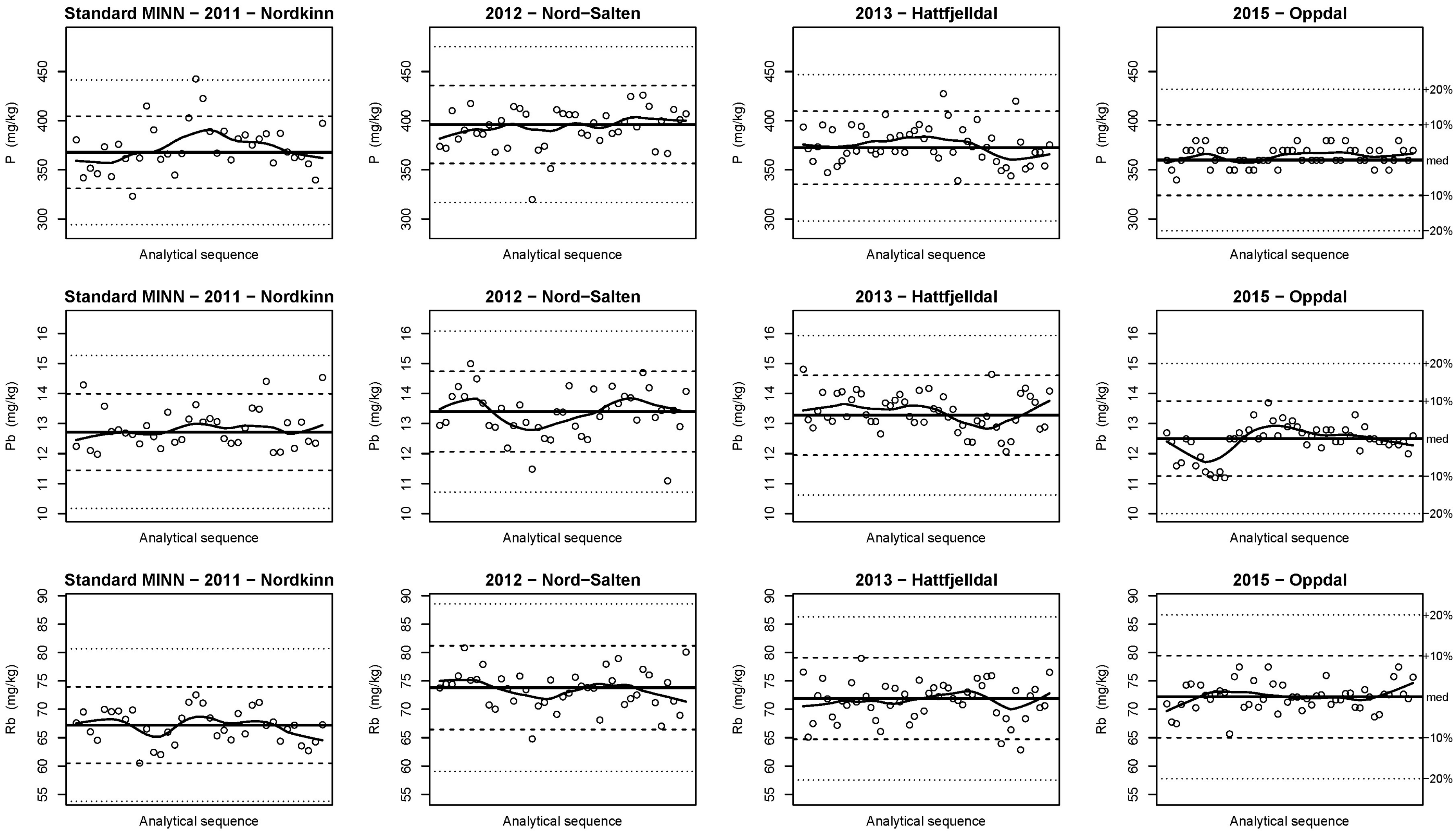
Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Fe (mg/kg)
26000
30000
34000
Ga (mg/kg)
4.5
5.0
5.5
6.0
6.5
7.0
Ge (mg/kg)
0.05
0.15
0.25
0.35
Analytical sequence
+20%
+10%
med
−10%
−20%

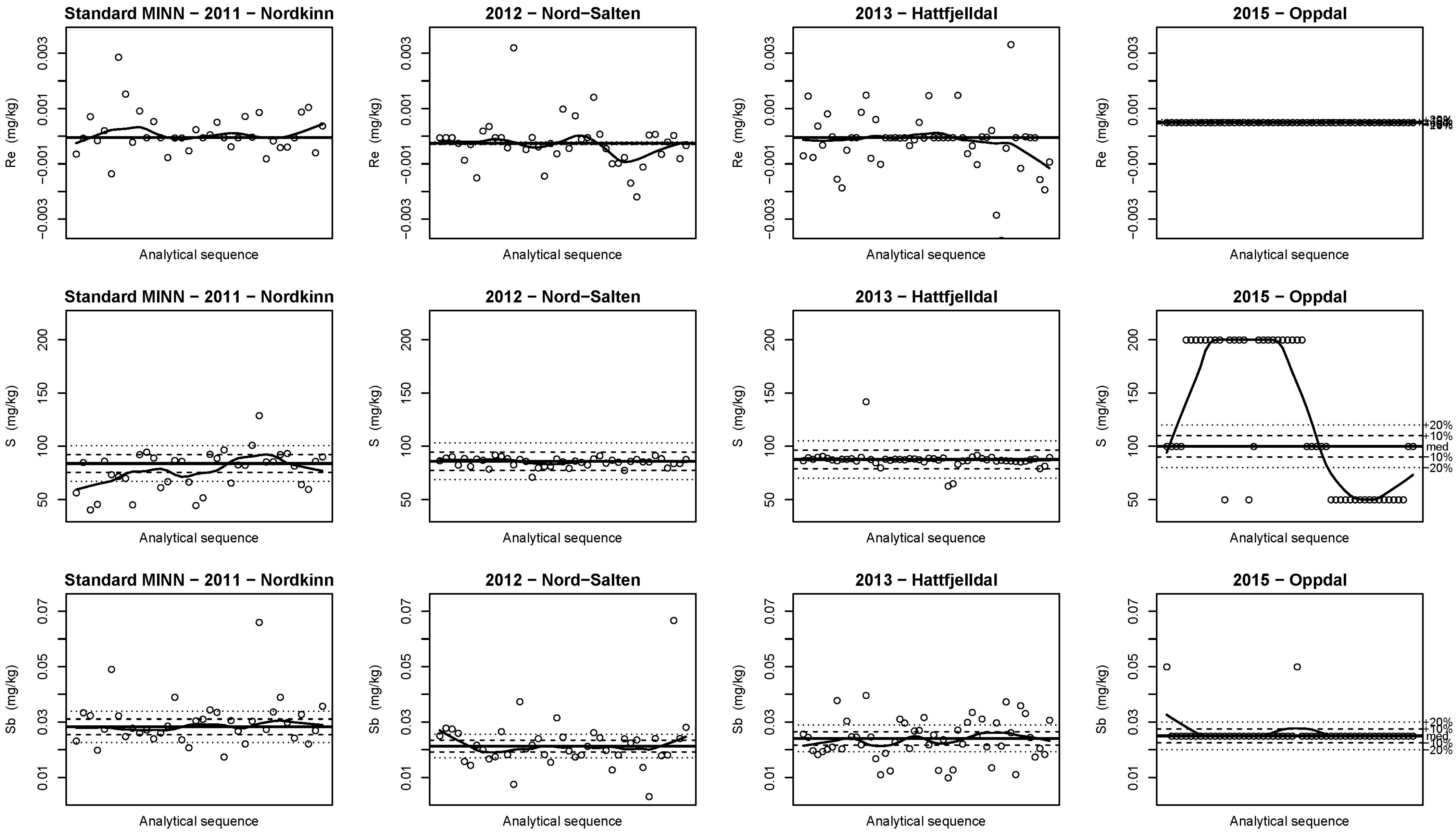

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Hf (mg/kg)
Hg (mg/kg)
In (mg/kg)
Analytical sequence
+20%
+10%
med
-10%
-20%

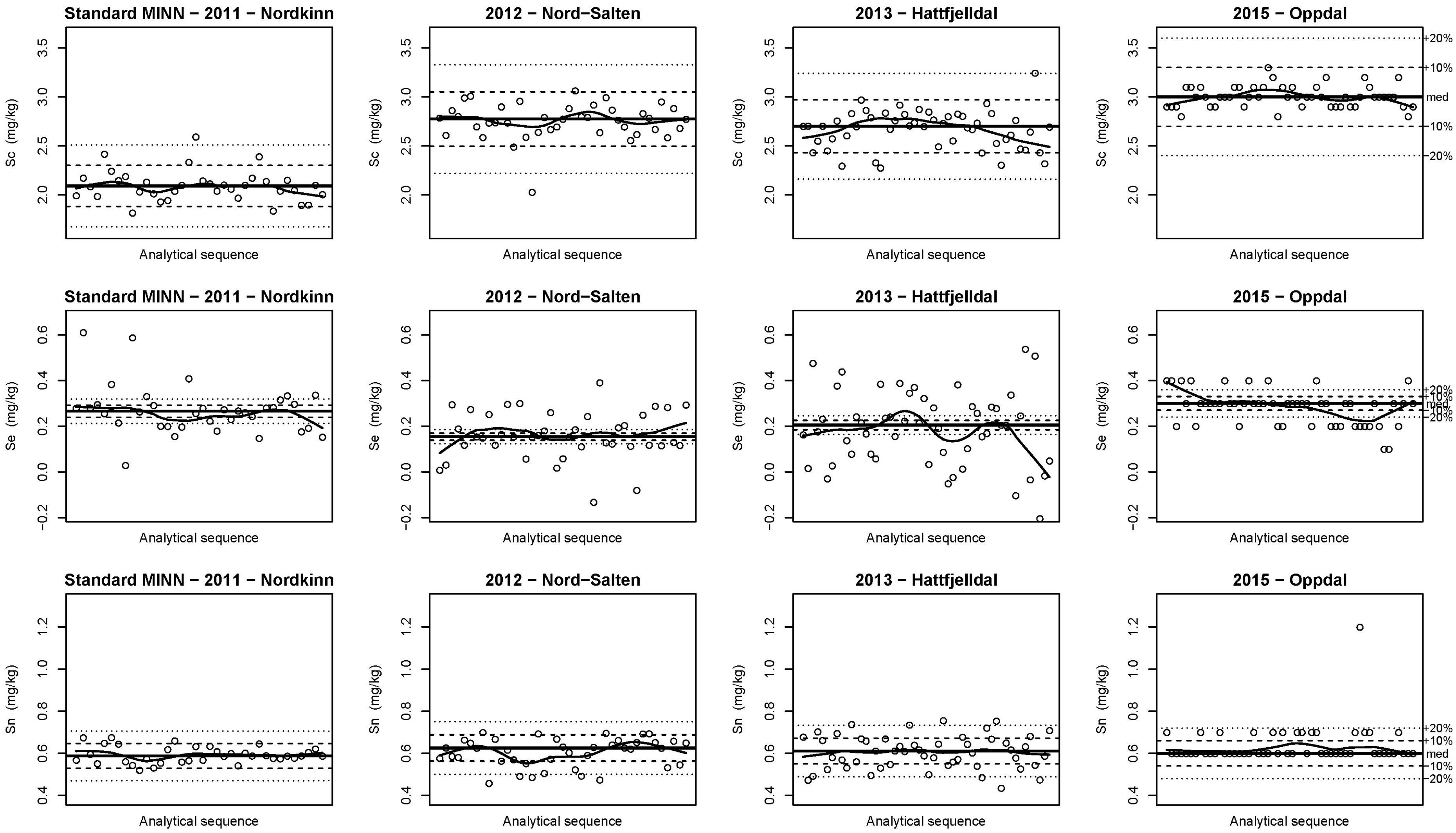

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
K (mg/kg)
La (mg/kg)
Li (mg/kg)
Analytical sequence
5000
5500
6000
6500
12
14
16
18
20
+20%
+10%
med
−10%
−20%

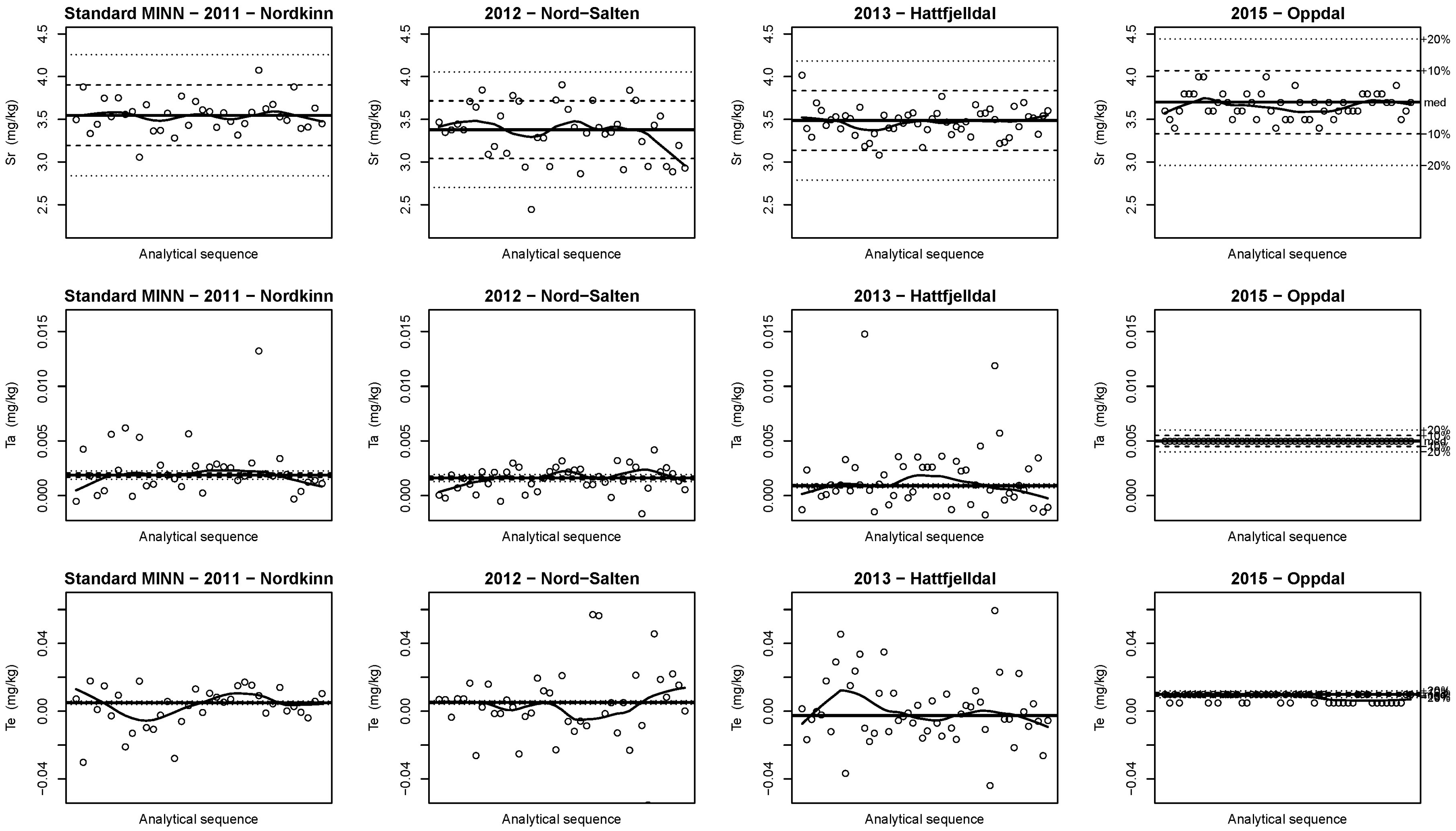

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Mg (mg/kg)
4500
5500
6500
+20%
+10%
med
-10%
-20%
Analytical sequence
Mn (mg/kg)
160
200
240
280
Mo (mg/kg)
1.6
1.8
2.0
2.2
2.4

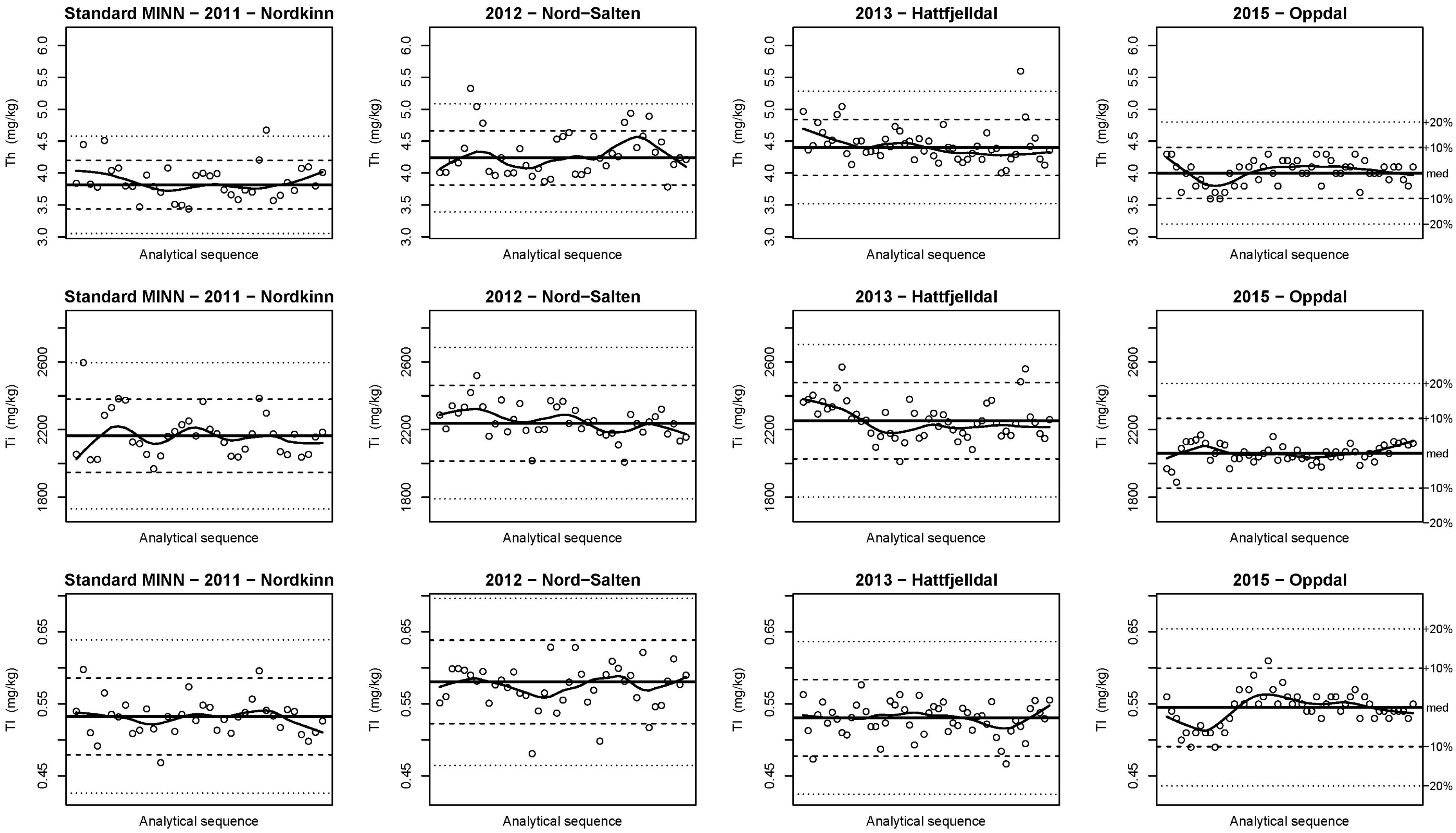

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Na (mg/kg)
Nb (mg/kg)
Ni (mg/kg)
Analytical sequence
0
20
40
60
80
100
1.5
2.0
2.5
15
20
25
30
+20%
+10%
med
-10%
-20%

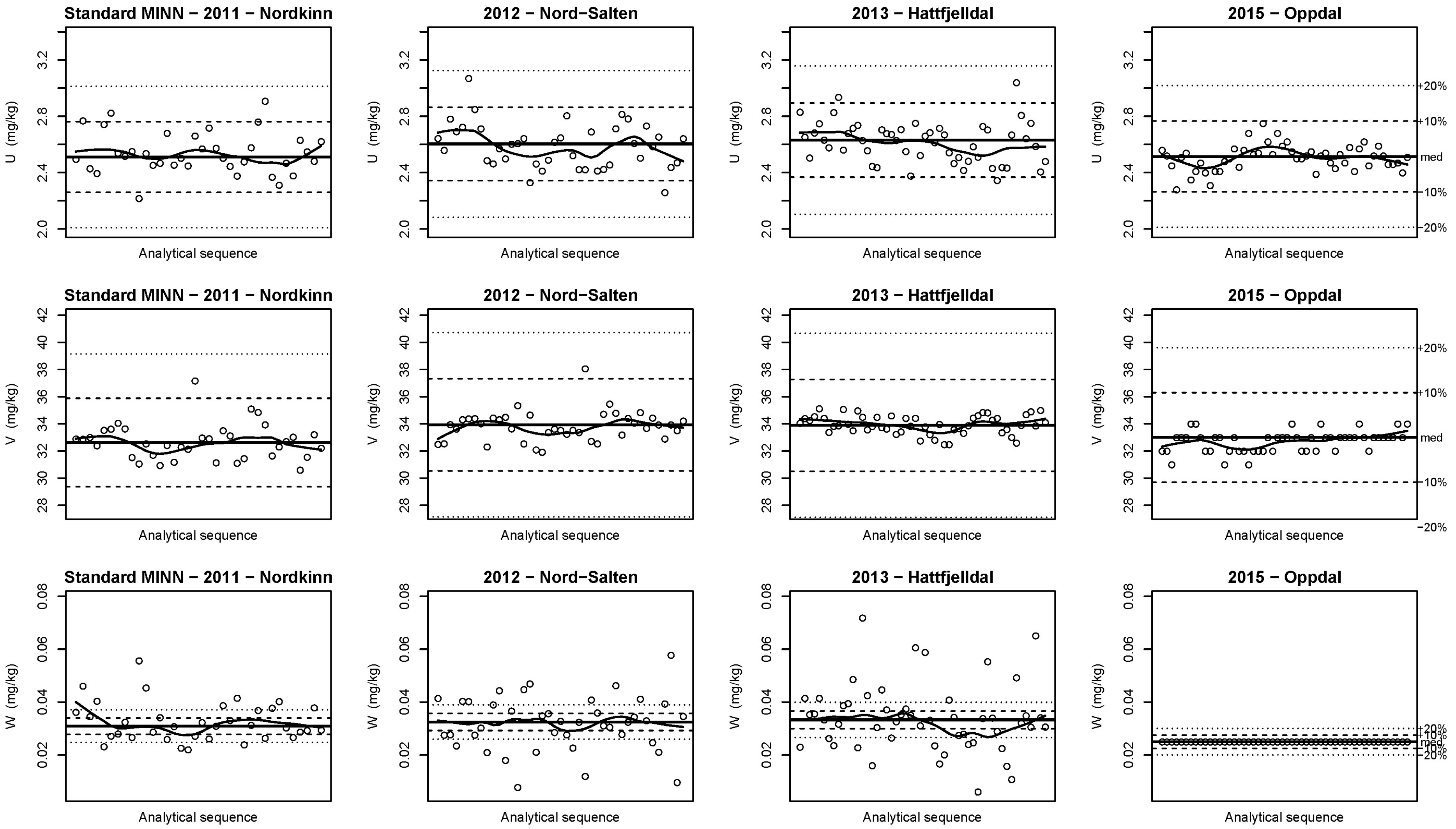

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
P (mg/kg)
Pb (mg/kg)
Rb (mg/kg)
Analytical sequence
300
350
400
450
10
11
12
13
14
15
16
55
60
65
70
75
80
85
90
+20%
+10%
med
-10%
-20%

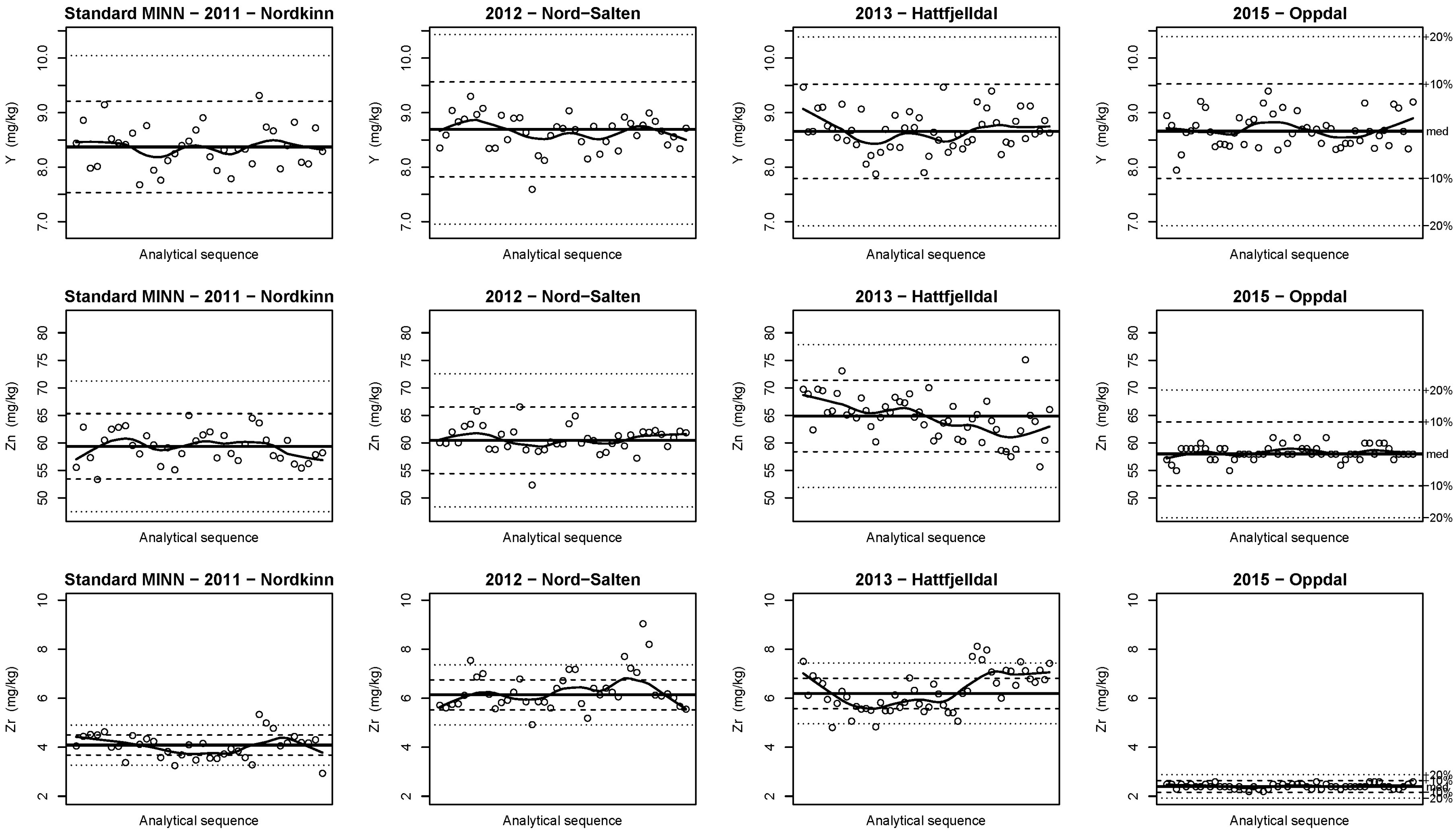

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Re (mg/kg)
−0.003
−0.001
0.001
0.003
Analytical sequence
S (mg/kg)
50
100
150
200
+20%
+10%
med
−10%
−20%
Sb (mg/kg)
0.01
0.03
0.05
0.07


Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Sc (mg/kg)
Se (mg/kg)
Sn (mg/kg)
Analytical sequence
+20%
+10%
med
-10%
-20%


Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Sr (mg/kg)
Ta (mg/kg)
Te (mg/kg)
Analytical sequence
+20%
+10%
med
-10%
-20%
2.5
3.0
3.5
4.0
4.5
0.000
0.005
0.010
0.015
−0.04
0.00
0.04


Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Th (mg/kg)
3.0
3.5
4.0
4.5
5.0
5.5
6.0
Ti (mg/kg)
1800
2200
2600
Tl (mg/kg)
0.45
0.55
0.65
Analytical sequence
+20%
+10%
med
−10%
−20%

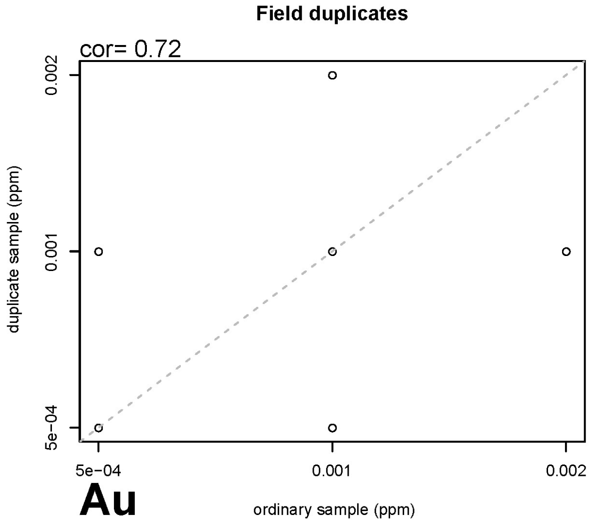

Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
U (mg/kg)
V (mg/kg)
W (mg/kg)
Analytical sequence
+20%
+10%
med
−10%
−20%

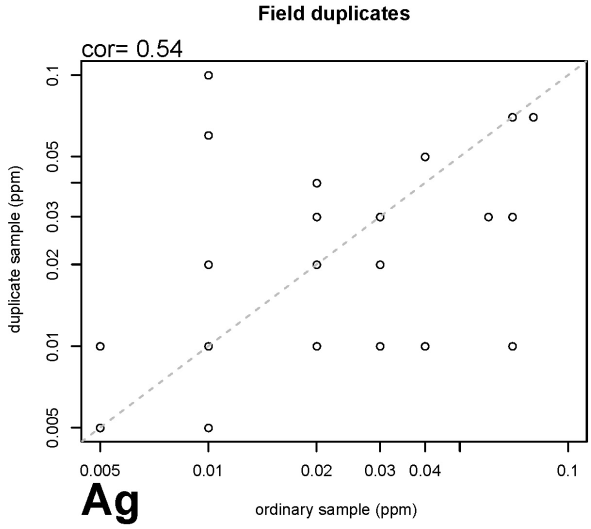


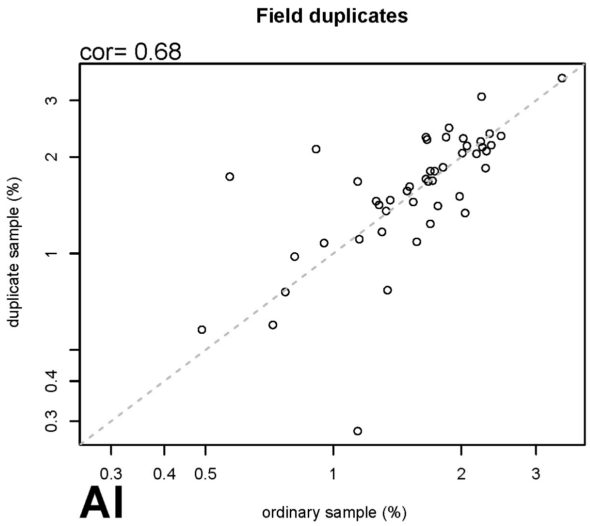
Standard MINN − 2011 − Nordkinn
2012 − Nord−Salten
2013 − Hattfjelldal
2015 − Oppdal
Y (mg/kg)
Zn (mg/kg)
Zr (mg/kg)
Analytical sequence
+20%
+10%
med
-10%
-20%

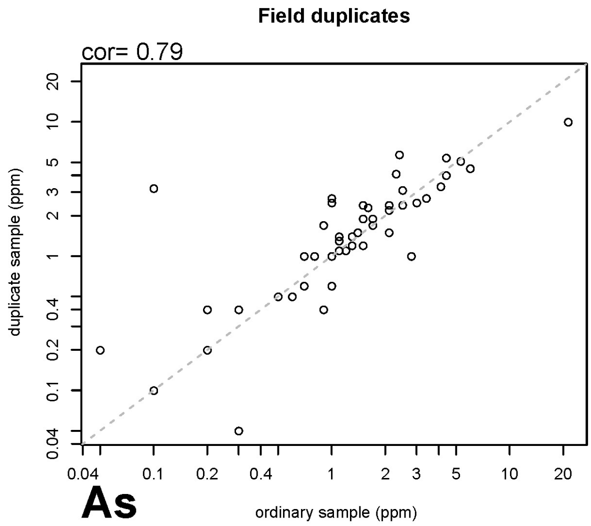
Appendix IV XY plots of duplicate samples

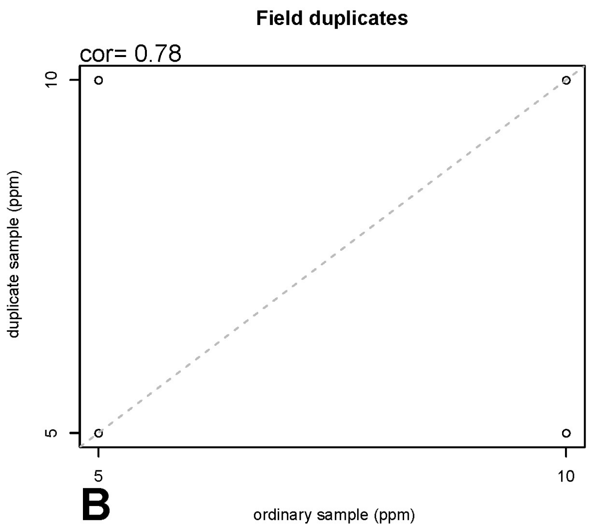
XY plots for field duplicates versus ordinary samples, and analytical duplicates versus ordinary samples. Note logarithmic scale.

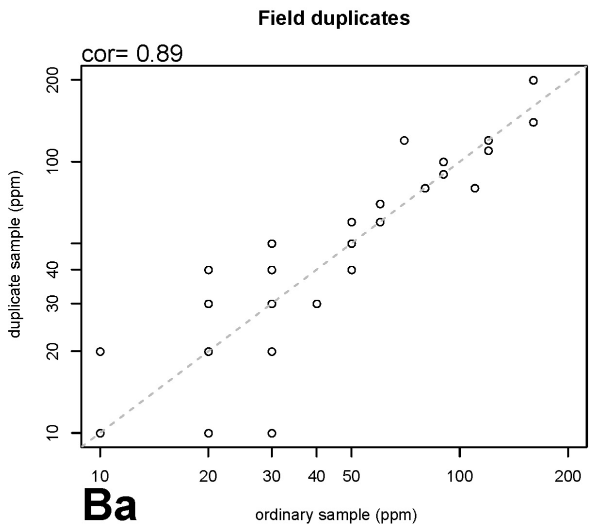

Field duplicates
cor= 0.72
duplicate sample (ppm)
5e−04
0.001
0.002
ordinary sample (ppm)
Au

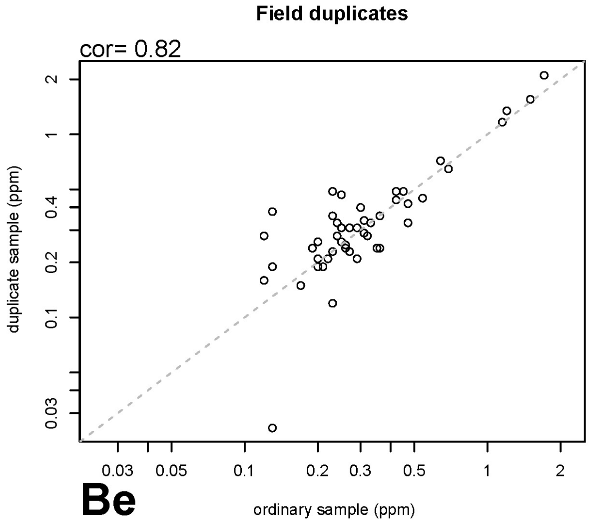

Field duplicates
cor= 0.54
duplicate sample (ppm)
0.005
0.01
0.02
0.03
0.04
0.05
0.1
ordinary sample (ppm)
Ag

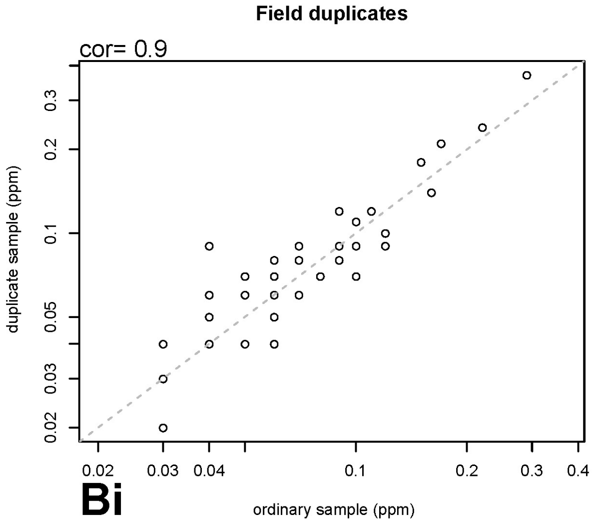

Field duplicates
cor= 0.68
duplicate sample (%)
0.3
0.4
0.5
1
2
3
ordinary sample (%)
Al

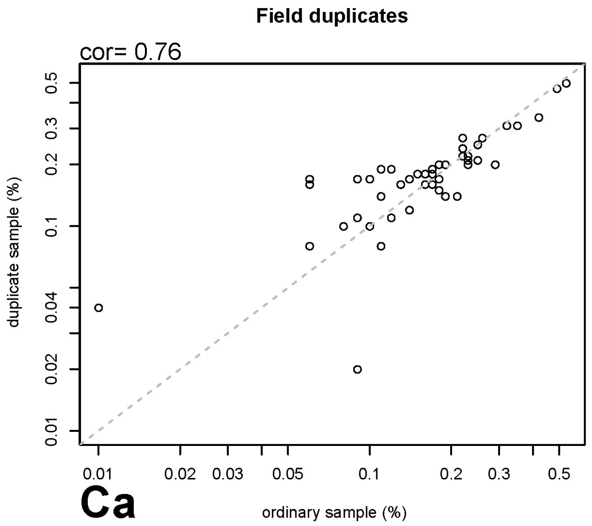

Field duplicates
cor= 0.79
duplicate sample (ppm)
0.04
0.1
0.2
0.4
1
2
3
5
10
20
ordinary sample (ppm)
As

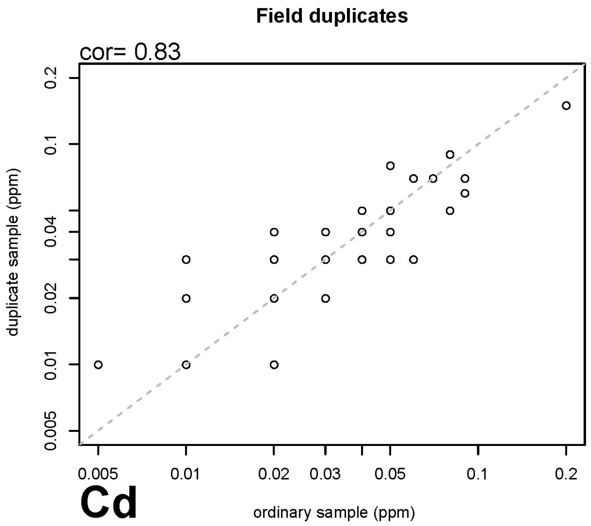

Field duplicates
cor= 0.78
duplicate sample (ppm)
5
10
ordinary sample (ppm)
B

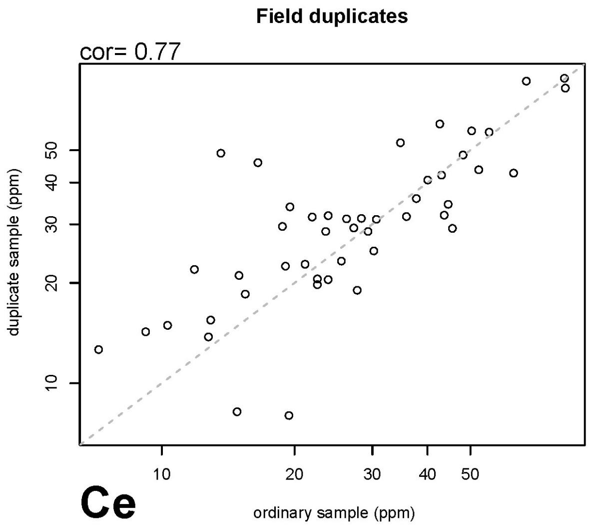

Field duplicates
cor= 0.89
duplicate sample (ppm)
10
20
30
40
50
100
200
ordinary sample (ppm)
Ba

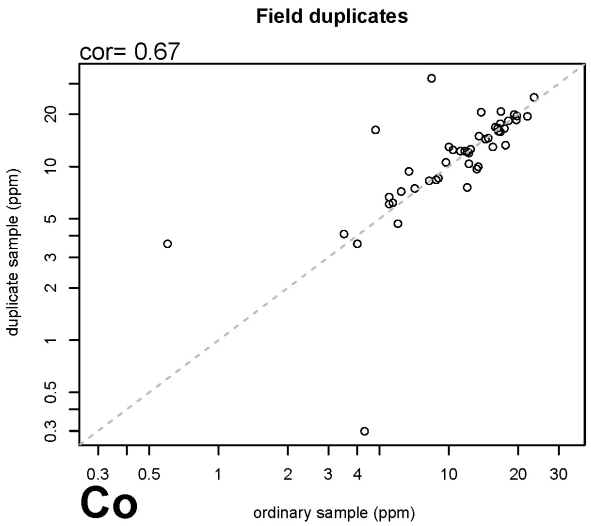

Field duplicates
cor= 0.82
duplicate sample (ppm)
ordinary sample (ppm)
Be

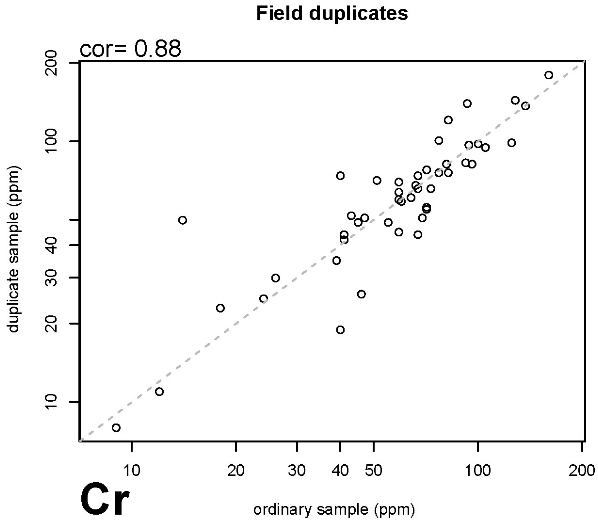

Field duplicates
cor= 0.9
duplicate sample (ppm)
ordinary sample (ppm)
Bi

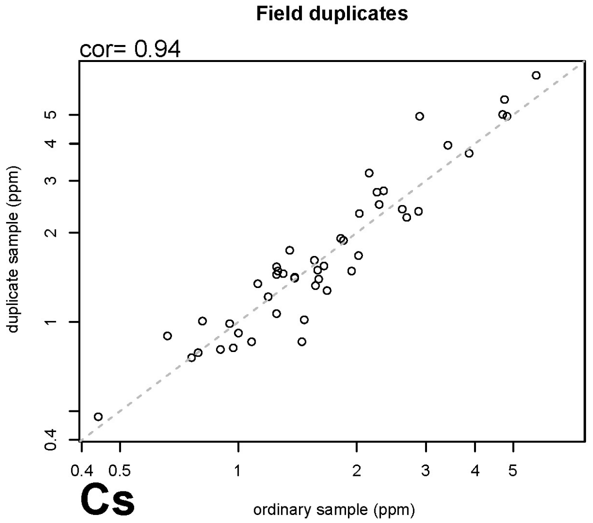

Field duplicates
cor= 0.76
duplicate sample (%)
ordinary sample (%)
Ca

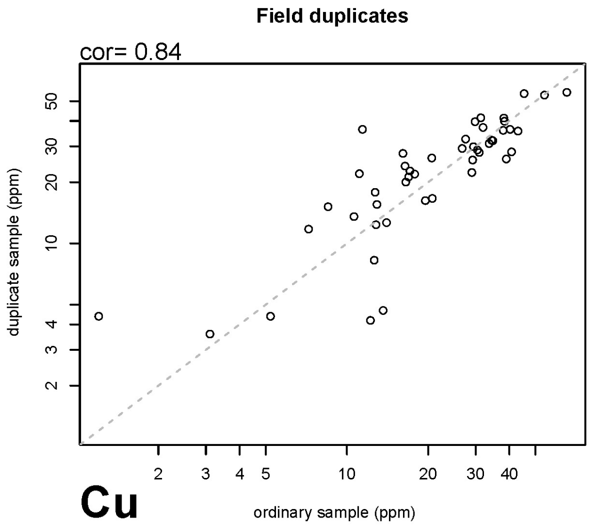

Field duplicates
cor= 0.83
duplicate sample (ppm)
ordinary sample (ppm)
Cd

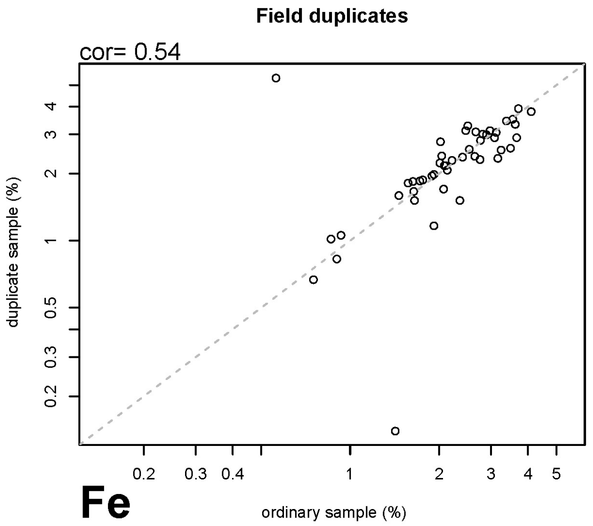

Field duplicates
cor= 0.77
duplicate sample (ppm)
ordinary sample (ppm)
Ce

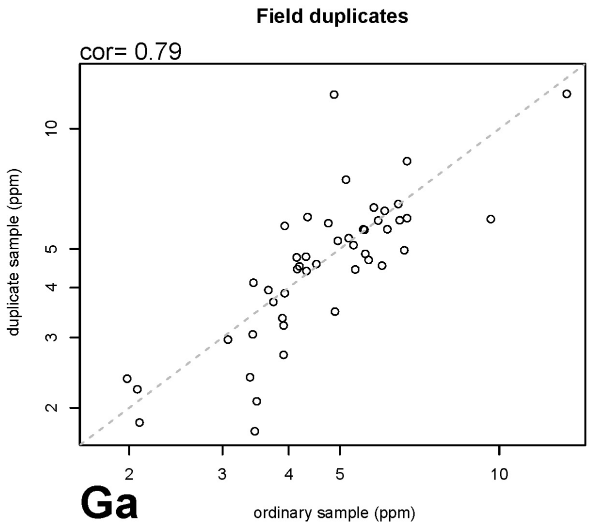

Field duplicates
cor= 0.67
duplicate sample (ppm)
ordinary sample (ppm)
Co

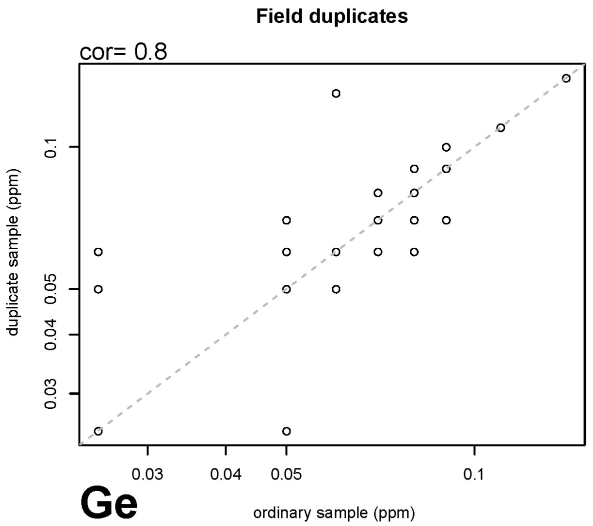

Field duplicates
cor= 0.88
duplicate sample (ppm)
ordinary sample (ppm)
10 20 30 40 50 100 200
Cr

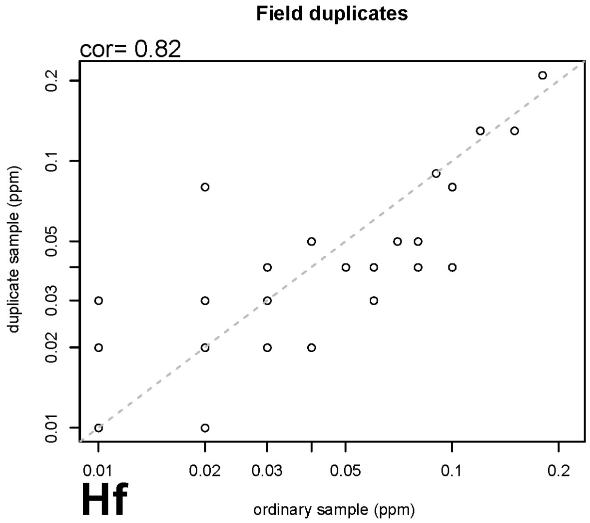

Field duplicates
cor= 0.94
duplicate sample (ppm)
ordinary sample (ppm)
0.4 0.5 1 2 3 4 5
Cs

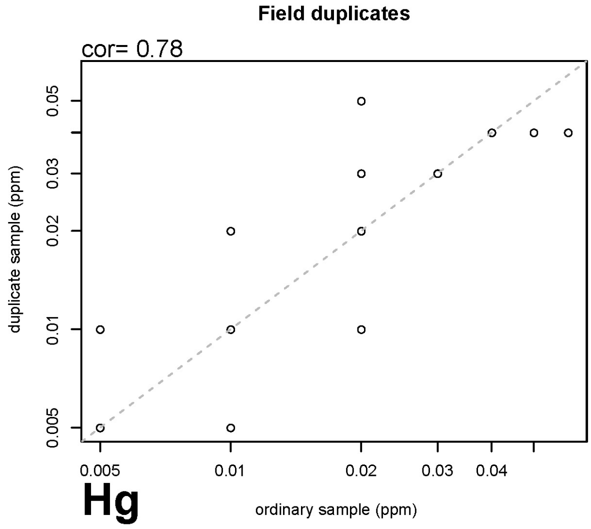

Field duplicates
cor= 0.84
duplicate sample (ppm)
ordinary sample (ppm)
2 3 4 5 10 20 30 40 50
Cu

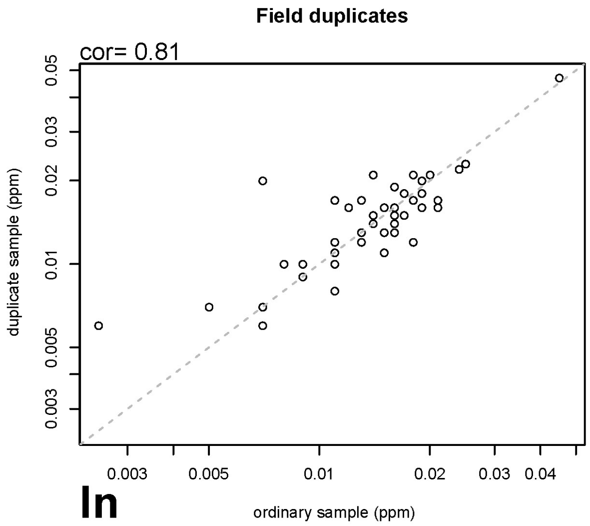

Field duplicates
cor= 0.54
duplicate sample (%)
ordinary sample (%)
0.2 0.3 0.4 0.5 1 2 3 4 5
Fe

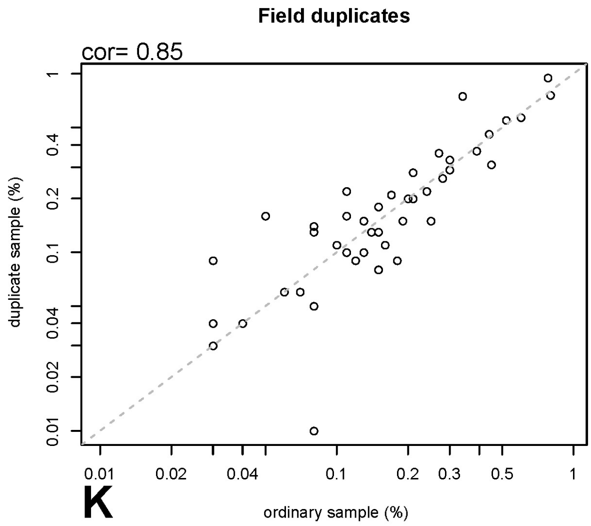

Field duplicates
cor= 0.79
duplicate sample (ppm)
ordinary sample (ppm)
2 3 4 5 10
Ga

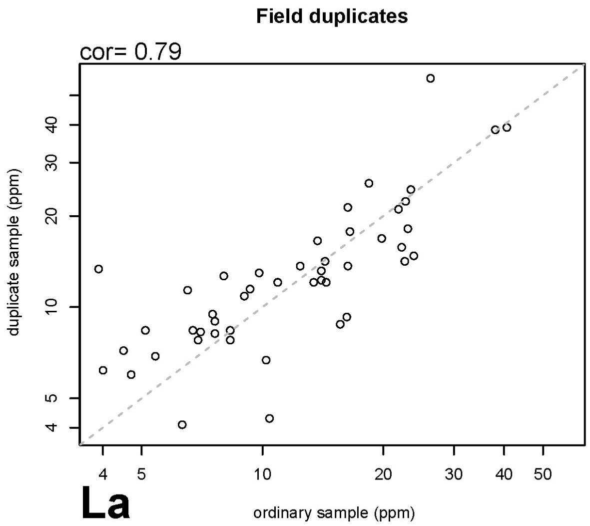

Field duplicates
cor= 0.8
duplicate sample (ppm)
ordinary sample (ppm)
0.03 0.04 0.05 0.1
Ge

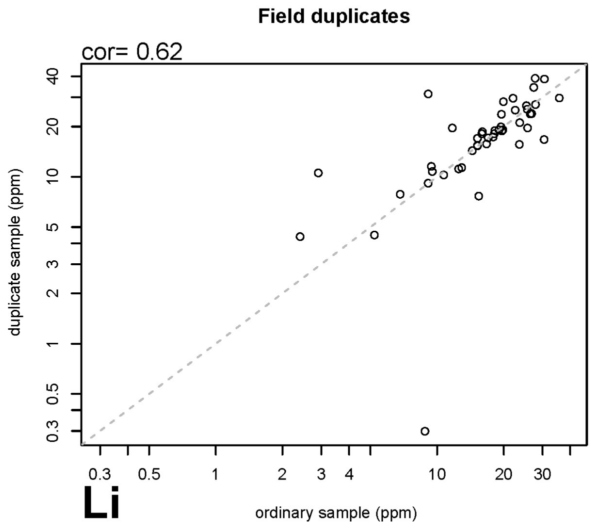

Field duplicates
cor= 0.82
duplicate sample (ppm)
0.01 0.02 0.03 0.05 0.1 0.2
0.01 0.02 0.03 0.05 0.1 0.2
Hf
ordinary sample (ppm)

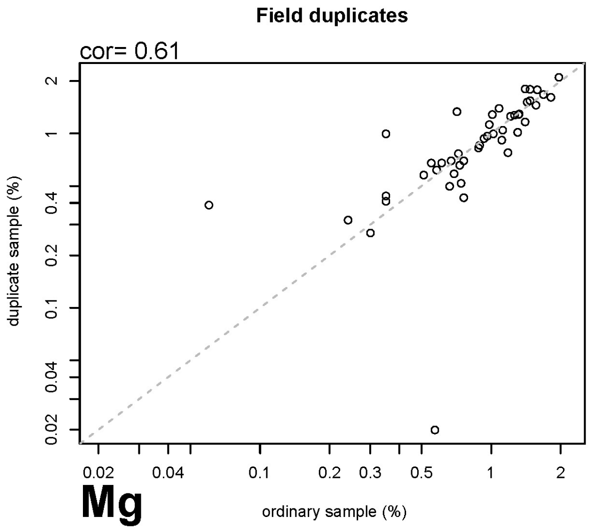

Field duplicates
cor= 0.78
duplicate sample (ppm)
0.005 0.01 0.02 0.03 0.05
0.005 0.01 0.02 0.03 0.04
Hg
ordinary sample (ppm)

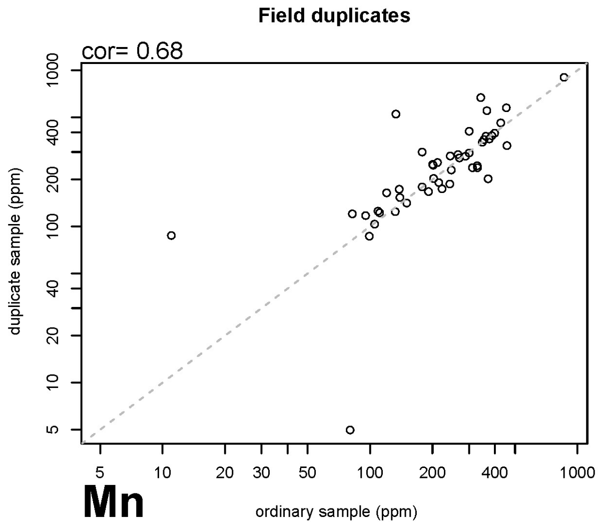

Field duplicates
cor= 0.81
duplicate sample (ppm)
0.003 0.005 0.01 0.02 0.03 0.05
0.003 0.005 0.01 0.02 0.03 0.04
In
ordinary sample (ppm)

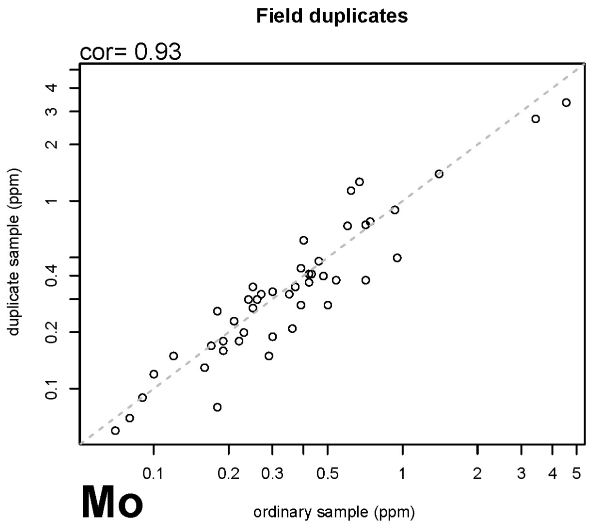

Field duplicates
cor= 0.85
duplicate sample (%)
0.01 0.02 0.04 0.1 0.2 0.4 1
0.01 0.02 0.04 0.1 0.2 0.3 0.5 1
K
ordinary sample (%)

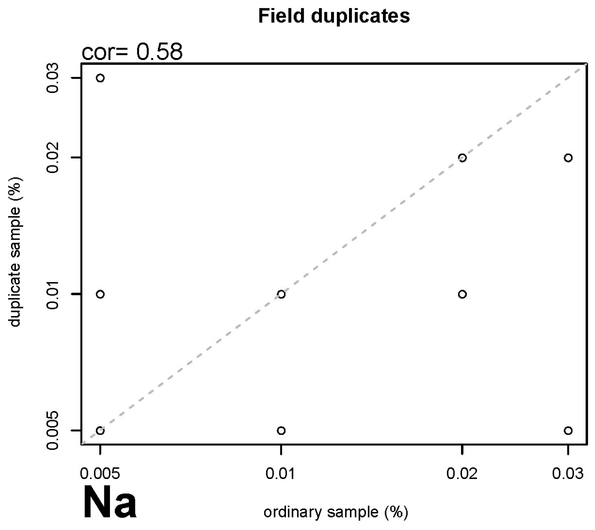

Field duplicates
cor= 0.79
duplicate sample (ppm)
4 5 10 20 30 40
4 5 10 20 30 40 50
La
ordinary sample (ppm)

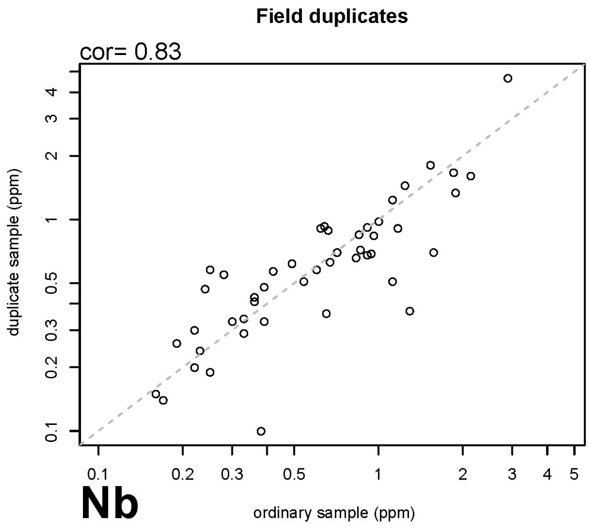

Field duplicates
cor= 0.62
duplicate sample (ppm)
0.3 0.5 1 2 3 5 10 20 40
0.3 0.5 1 2 3 4 10 20 30
Li
ordinary sample (ppm)

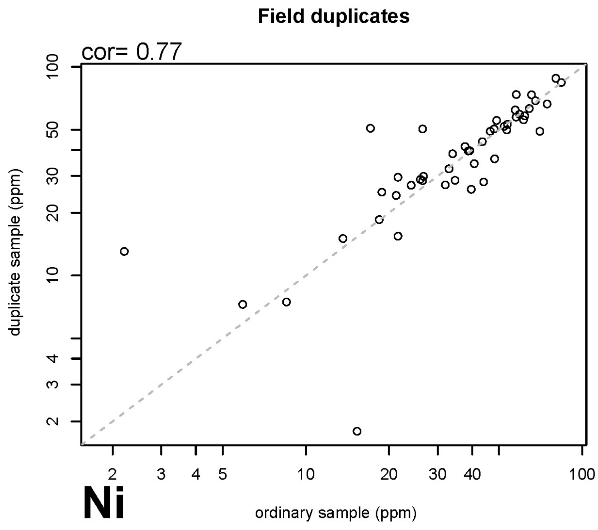

Field duplicates
cor= 0.61
duplicate sample (%)
ordinary sample (%)
Mg

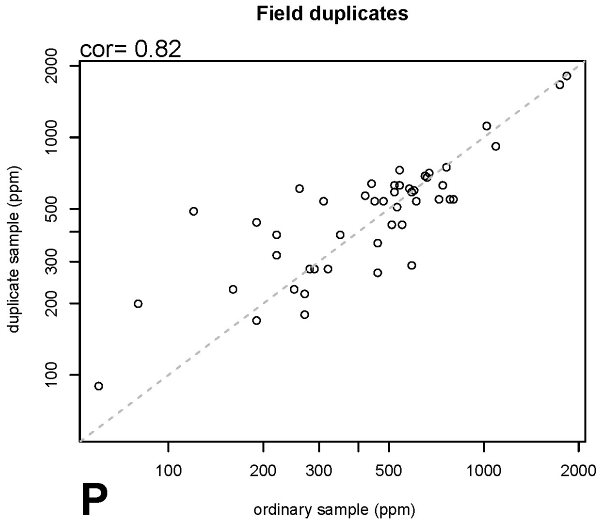

Field duplicates
cor= 0.68
duplicate sample (ppm)
ordinary sample (ppm)
Mn

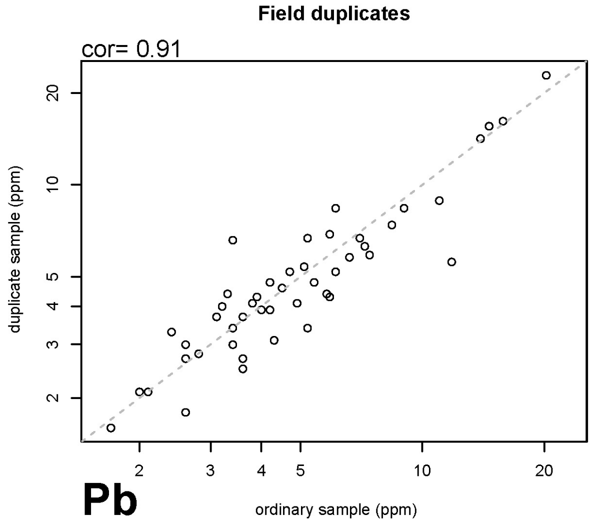

Field duplicates
cor= 0.93
duplicate sample (ppm)
ordinary sample (ppm)
Mo

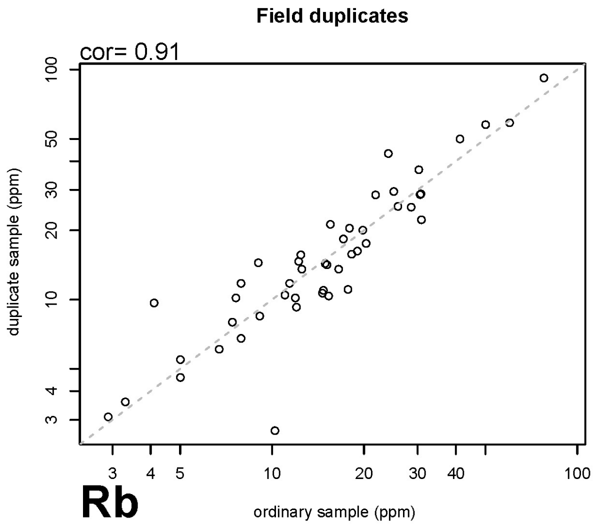

Field duplicates
cor= 0.58
duplicate sample (%)
ordinary sample (%)
Na

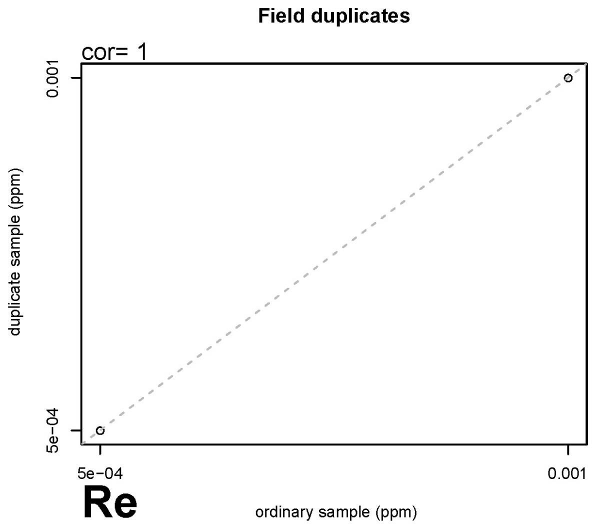

Field duplicates
cor= 0.83
duplicate sample (ppm)
ordinary sample (ppm)
Nb

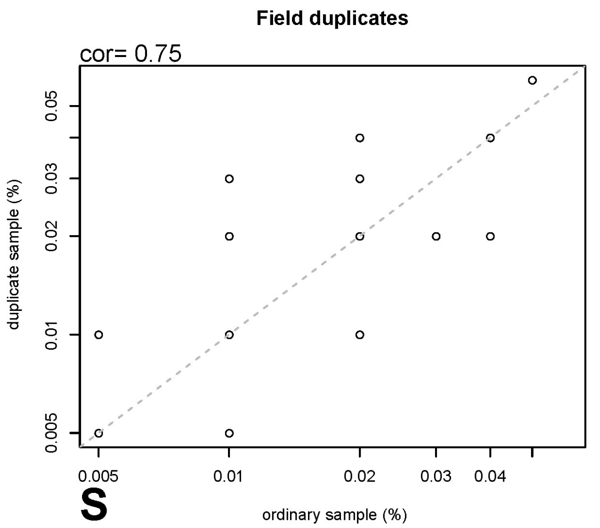

Field duplicates
cor= 0.77
duplicate sample (ppm)
ordinary sample (ppm)
Ni

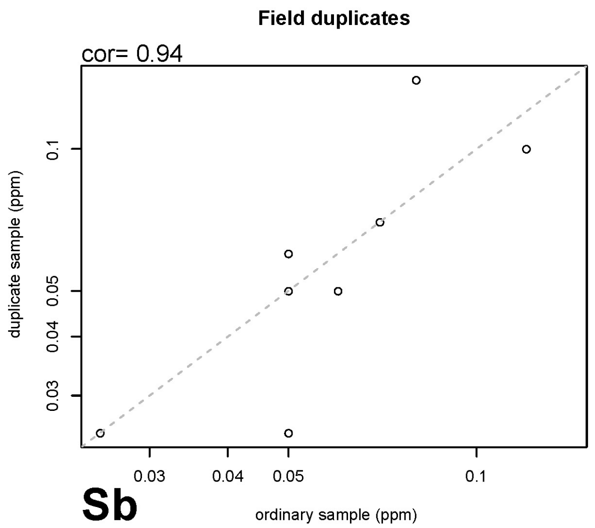

Field duplicates
cor= 0.82
duplicate sample (ppm)
100
200
300
500
1000
2000
100
200
300
500
1000
2000
P
ordinary sample (ppm)

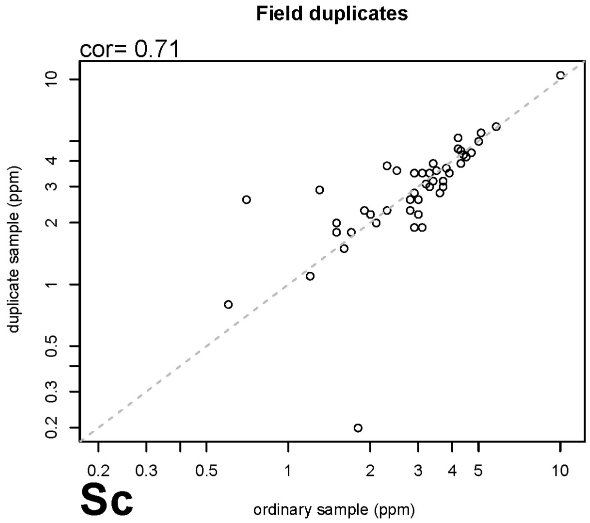

Field duplicates
cor= 0.91
duplicate sample (ppm)
2
3
4
5
10
20
2
3
4
5
10
20
Pb
ordinary sample (ppm)

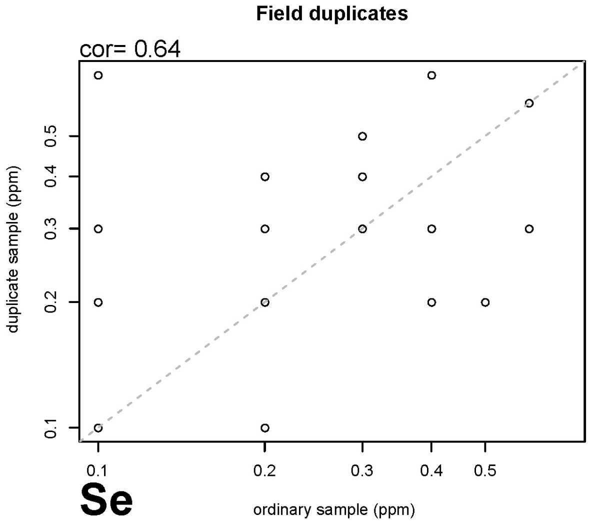

Field duplicates
cor= 0.91
duplicate sample (ppm)
3
4
10
20
30
50
100
3
4
5
10
20
30
40
100
Rb
ordinary sample (ppm)

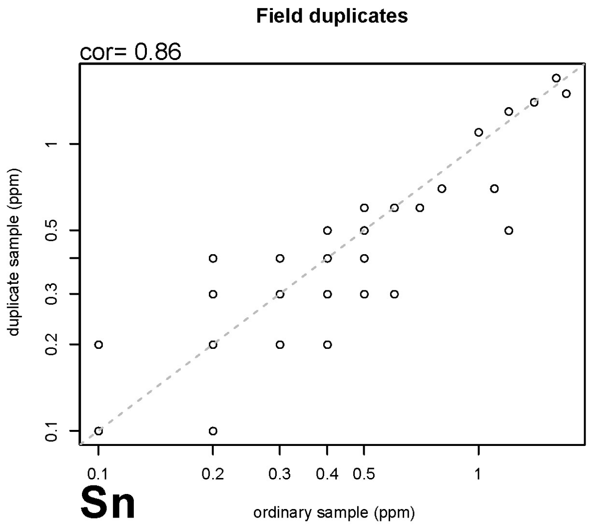

Field duplicates
cor= 1
duplicate sample (ppm)
5e−04
0.001
5e−04
0.001
Re
ordinary sample (ppm)

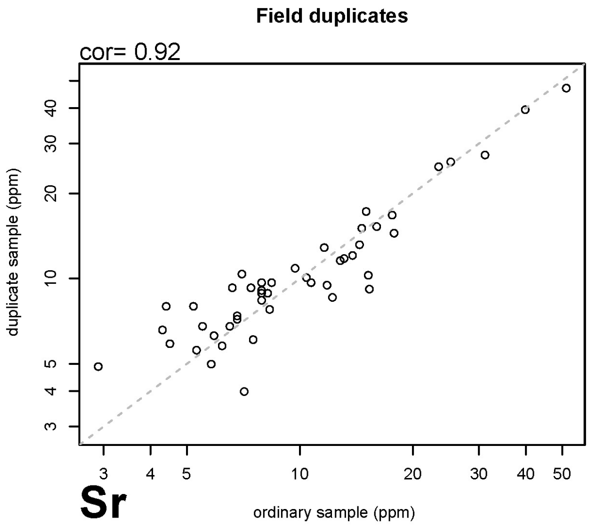

Field duplicates
cor= 0.75
duplicate sample (%)
0.005
0.01
0.02
0.03
0.05
0.005
0.01
0.02
0.03
0.04
S
ordinary sample (%)

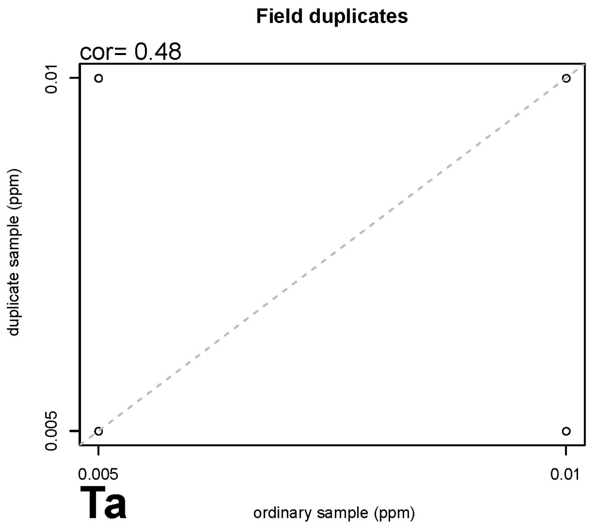

Field duplicates
cor= 0.94
duplicate sample (ppm)
0.03
0.04
0.05
0.1
0.03
0.04
0.05
0.1
Sb
ordinary sample (ppm)

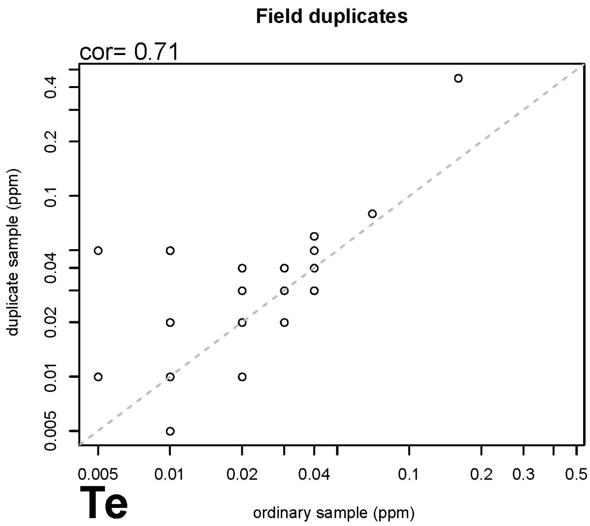

Field duplicates
cor= 0.71
duplicate sample (ppm)
0.2 0.3 0.5 1 2 3 4 10
0.2 0.3 0.5 1 2 3 4 5 10
Sc
ordinary sample (ppm)

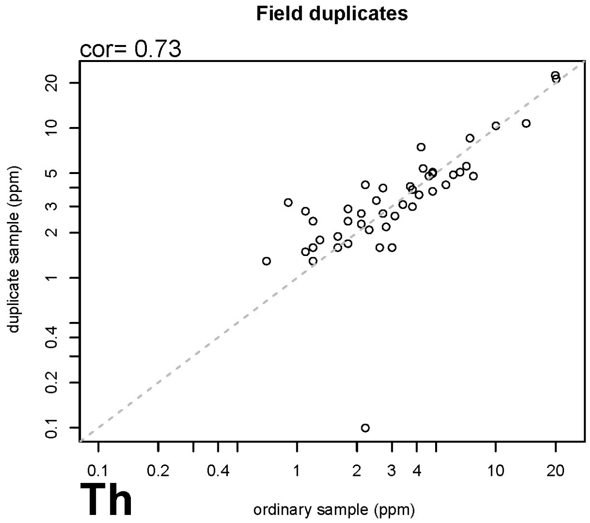

Field duplicates
cor= 0.64
duplicate sample (ppm)
0.1 0.2 0.3 0.4 0.5
0.1 0.2 0.3 0.4 0.5
Se
ordinary sample (ppm)

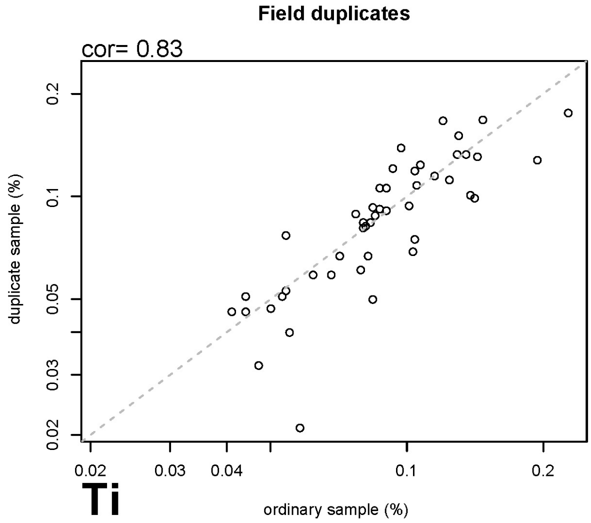

Field duplicates
cor= 0.86
duplicate sample (ppm)
0.1 0.2 0.3 0.5 1
0.1 0.2 0.3 0.4 0.5 1
Sn
ordinary sample (ppm)

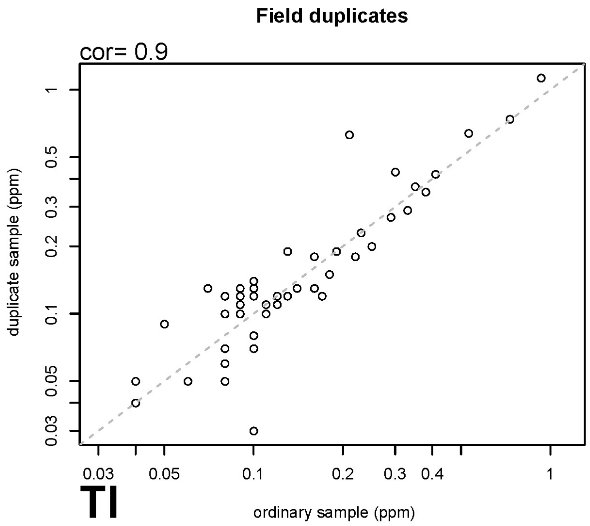

Field duplicates
cor= 0.92
duplicate sample (ppm)
3 4 5 10 20 30 40
3 4 5 10 20 30 40 50
Sr
ordinary sample (ppm)

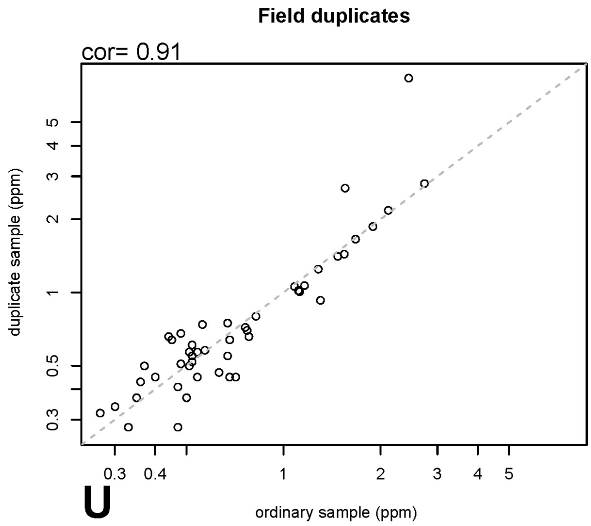

Field duplicates
cor= 0.48
duplicate sample (ppm)
0.005 0.01
0.005 0.01
Ta
ordinary sample (ppm)

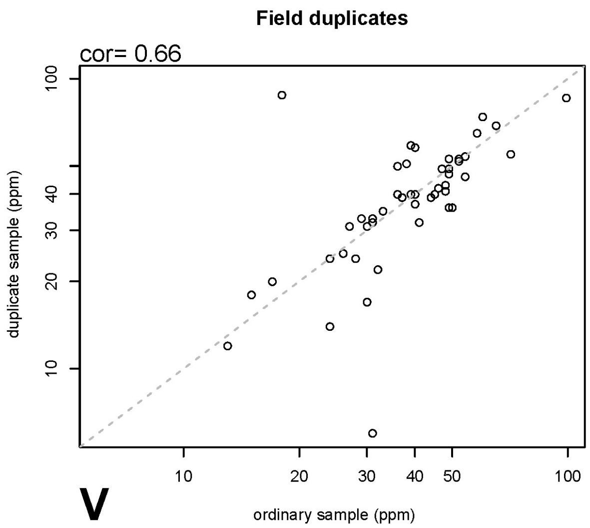

Field duplicates
cor= 0.71
duplicate sample (ppm)
0.005 0.01 0.02 0.04 0.1 0.2 0.4
0.005 0.01 0.02 0.04 0.1 0.2 0.3 0.5
Te
ordinary sample (ppm)

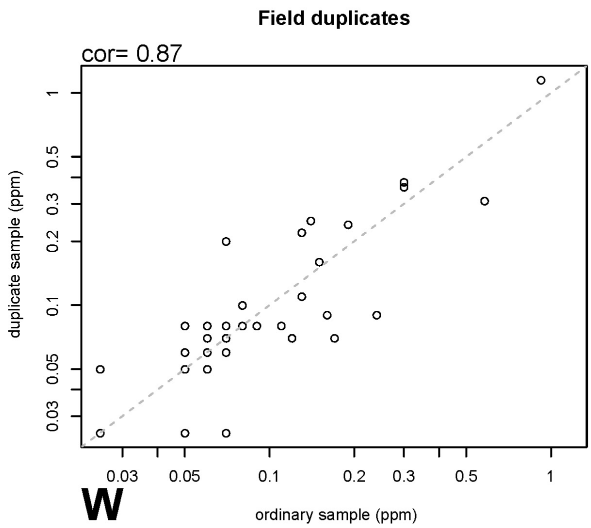

Field duplicates
cor= 0.73
duplicate sample (ppm)
0.1 0.2 0.4 1 2 3 5 10 20
0.1 0.2 0.4 1 2 3 4 10 20
Th
ordinary sample (ppm)

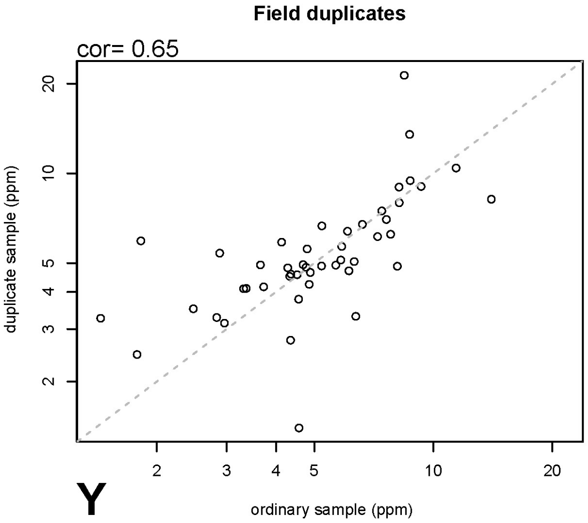

Field duplicates
cor= 0.83
duplicate sample (%)
0.02 0.03 0.05 0.1 0.2
0.02 0.03 0.04 0.1 0.2
Ti
ordinary sample (%)

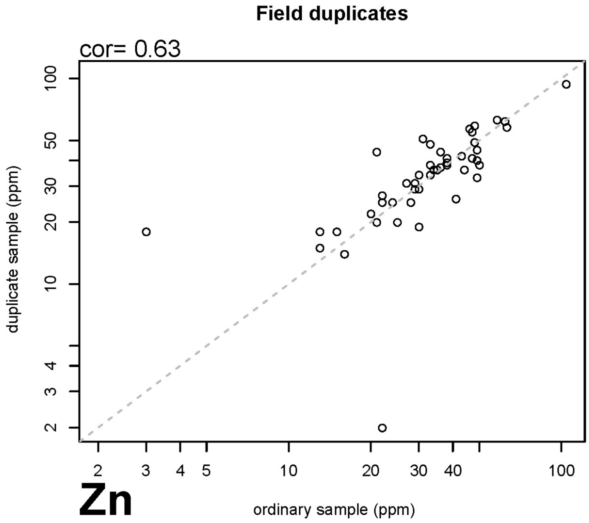

Field duplicates
cor= 0.9
duplicate sample (ppm)
0.03 0.05 0.1 0.2 0.3 0.5 1
0.03 0.05 0.1 0.2 0.3 0.4 1
Tl
ordinary sample (ppm)

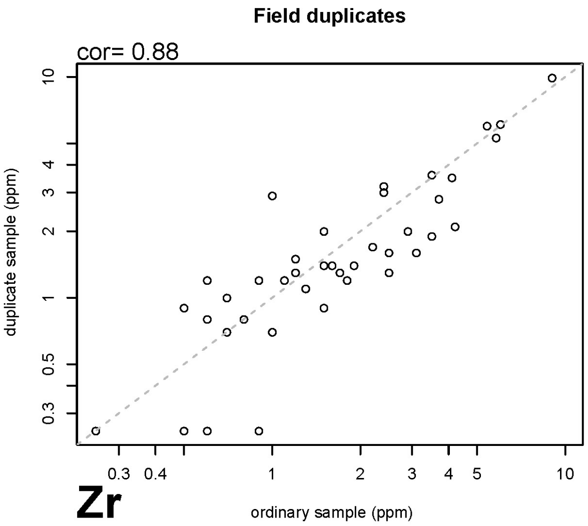

Field duplicates
cor= 0.91
duplicate sample (ppm)
0.3 0.5 1 2 3 4 5
0.3 0.4 1 2 3 4 5
U
ordinary sample (ppm)

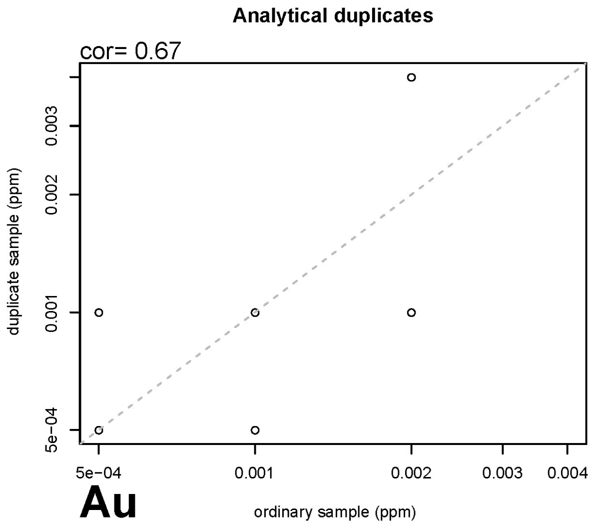

Field duplicates
cor= 0.66
duplicate sample (ppm)
10 20 30 40 100
10 20 30 40 50 100
V
ordinary sample (ppm)

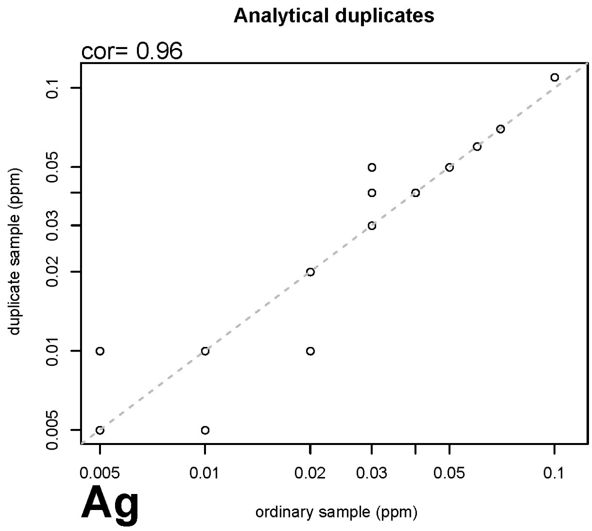

Field duplicates
cor= 0.87
duplicate sample (ppm)
0.03 0.05 0.1 0.2 0.3 0.5 1
0.03 0.05 0.1 0.2 0.3 0.5 1
W
ordinary sample (ppm)

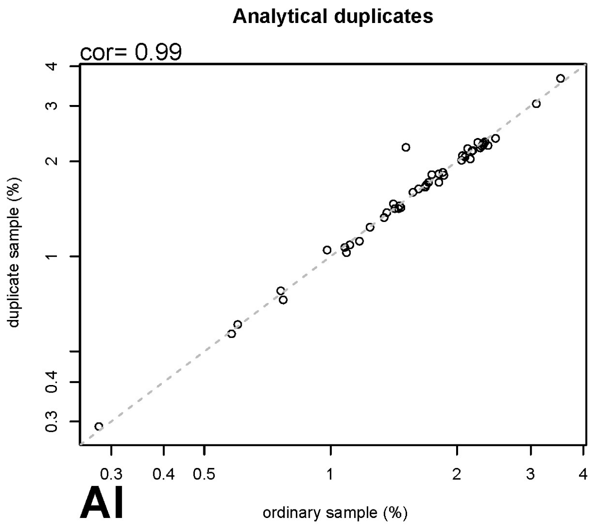

Field duplicates
cor= 0.65
duplicate sample (ppm)
ordinary sample (ppm)
Y

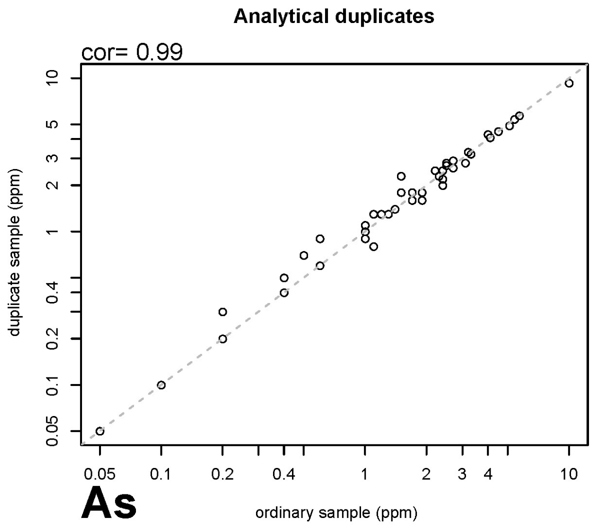

Field duplicates
cor= 0.63
duplicate sample (ppm)
ordinary sample (ppm)
Zn

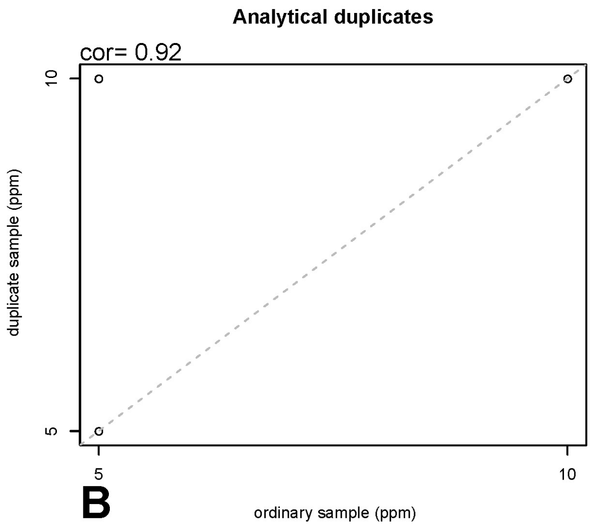

Field duplicates
cor= 0.88
duplicate sample (ppm)
ordinary sample (ppm)
Zr

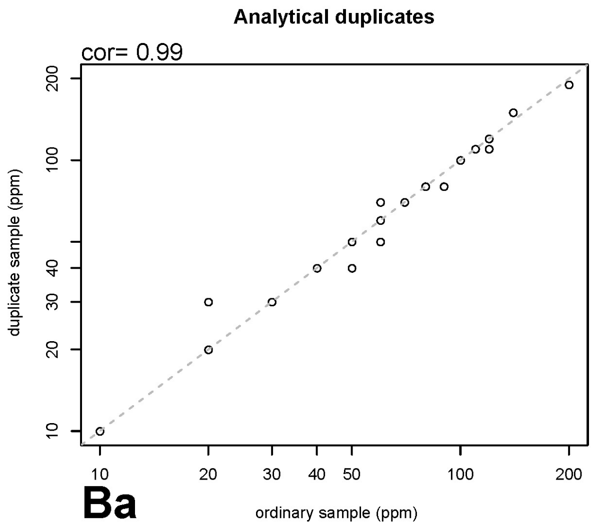

Analytical duplicates
cor= 0.67
duplicate sample (ppm)
ordinary sample (ppm)
5e−04
0.001
0.002
0.003
0.004
Au

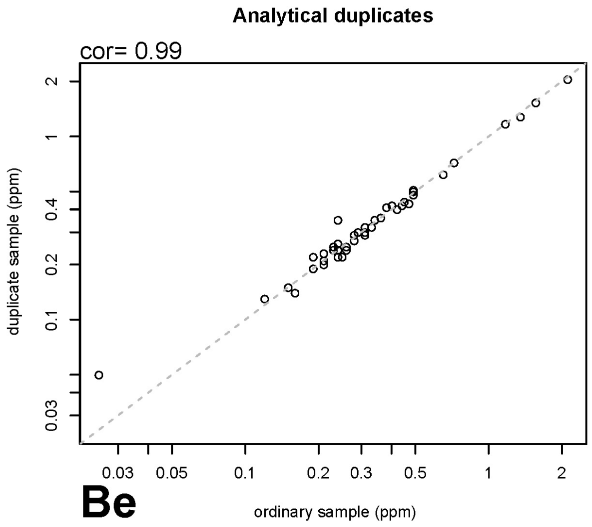

Analytical duplicates
cor= 0.96
duplicate sample (ppm)
ordinary sample (ppm)
0.005
0.01
0.02
0.03
0.05
0.1
Ag

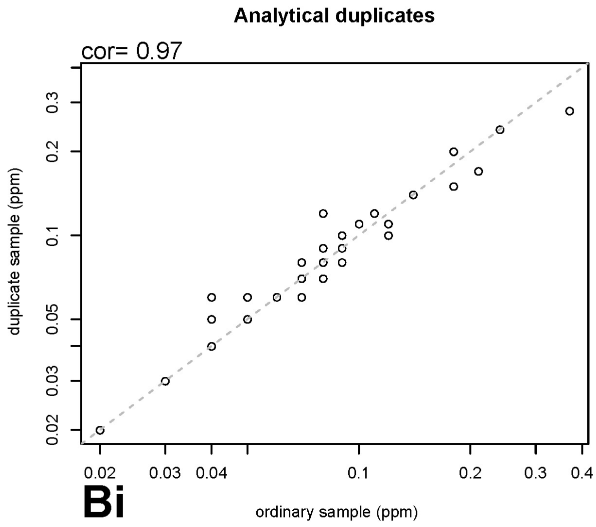

Analytical duplicates
cor= 0.99
duplicate sample (%)
ordinary sample (%)
0.3
0.4
0.5
1
2
3
4
Al

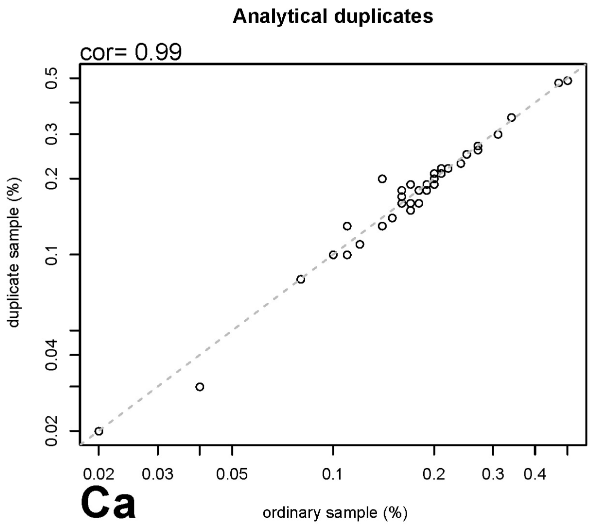

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
ordinary sample (ppm)
0.05
0.1
0.2
0.4
1
2
3
4
5
10
As

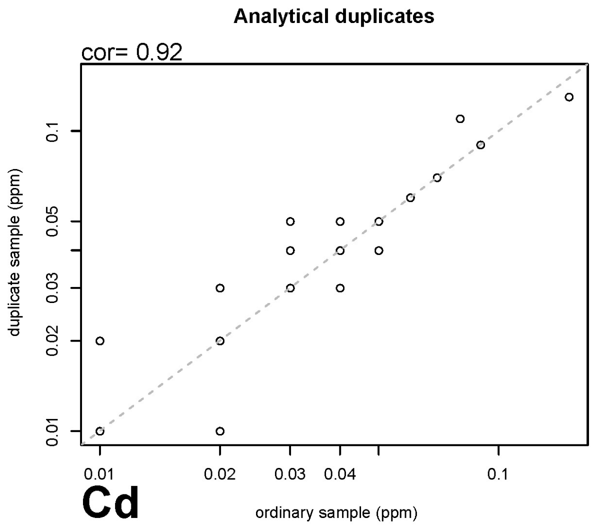

Analytical duplicates
cor= 0.92
duplicate sample (ppm)
ordinary sample (ppm)
5
10
B

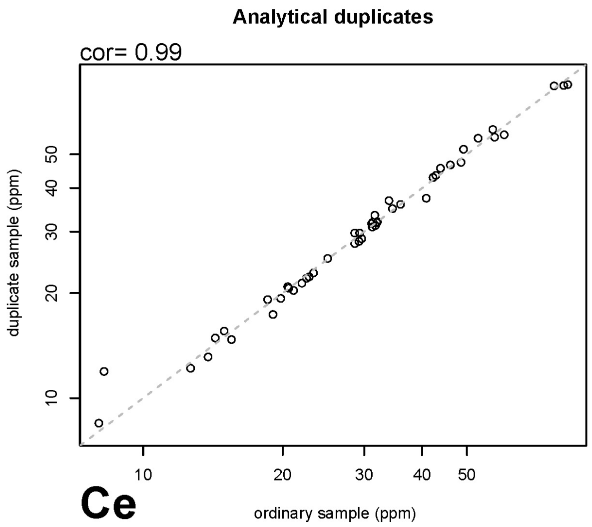

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
ordinary sample (ppm)
10
20
30
40
50
100
200
Ba

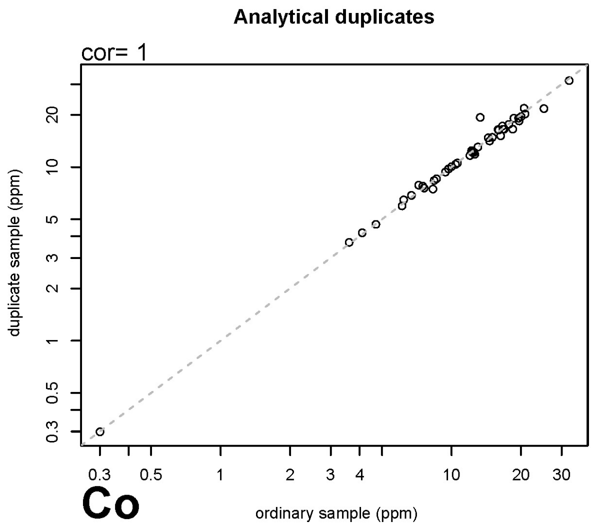

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
0.03 0.1 0.2 0.4 1 2
0.03 0.05 0.1 0.2 0.3 0.5 1 2
ordinary sample (ppm)
Be

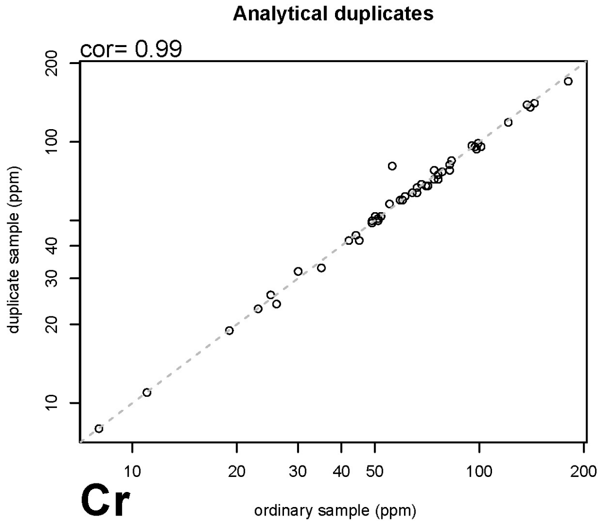

Analytical duplicates
cor= 0.97
duplicate sample (ppm)
0.02 0.03 0.05 0.1 0.2 0.3
0.02 0.03 0.04 0.1 0.2 0.3 0.4
ordinary sample (ppm)
Bi

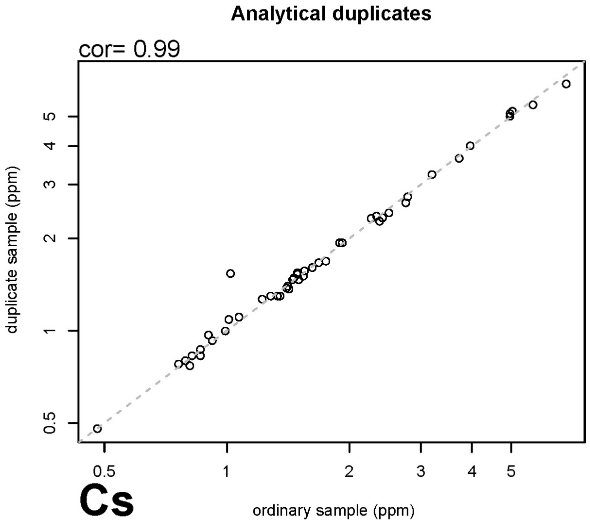

Analytical duplicates
cor= 0.99
duplicate sample (%)
0.02 0.04 0.1 0.2 0.3 0.5
0.02 0.03 0.05 0.1 0.2 0.3 0.4
ordinary sample (%)
Ca

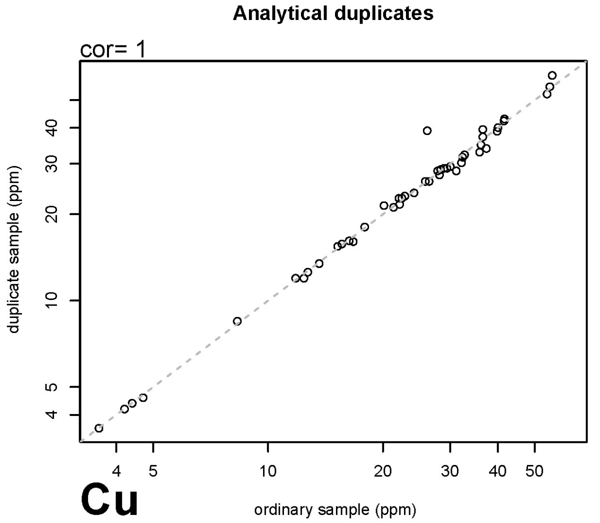

Analytical duplicates
cor= 0.92
duplicate sample (ppm)
0.01 0.02 0.03 0.05 0.1
0.01 0.02 0.03 0.04 0.1
ordinary sample (ppm)
Cd

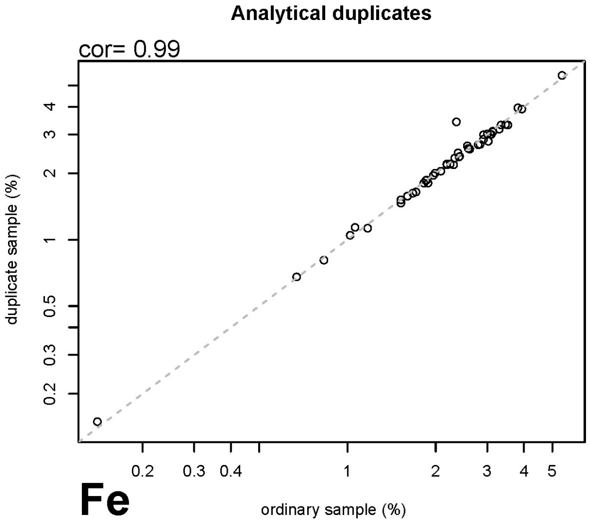

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
10 20 30 40 50
10 20 30 40 50
ordinary sample (ppm)
Ce

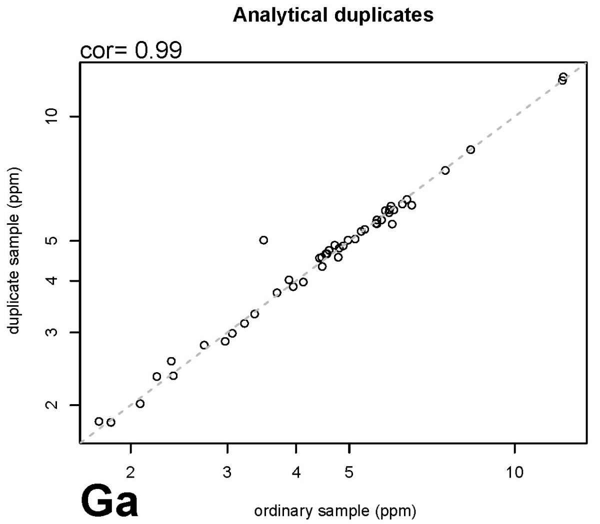

Analytical duplicates
cor= 1
duplicate sample (ppm)
0.3 0.5 1 2 3 5 10 20
0.3 0.5 1 2 3 4 10 20 30
ordinary sample (ppm)
Co

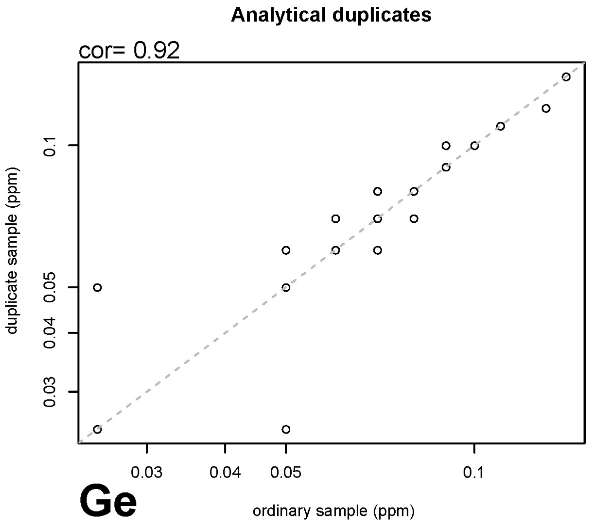

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
10 20 30 40 100 200
10 20 30 40 50 100 200
Cr
ordinary sample (ppm)

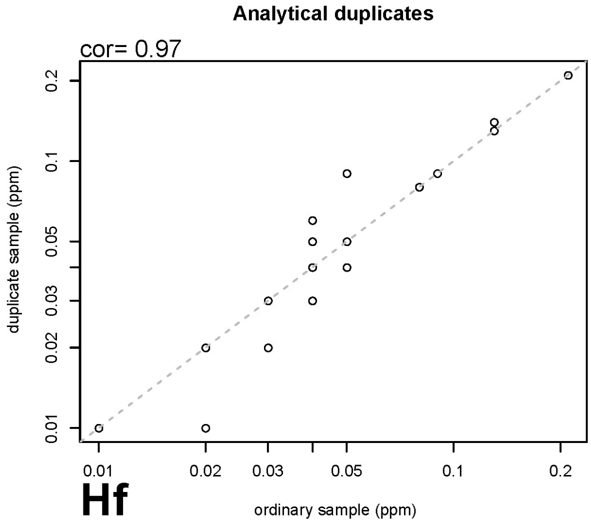

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
0.5 1 2 3 4 5
0.5 1 2 3 4 5
Cs
ordinary sample (ppm)

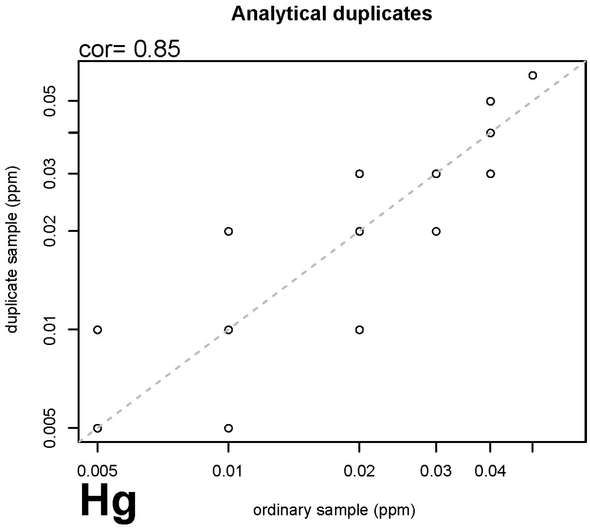

Analytical duplicates
cor= 1
duplicate sample (ppm)
4 5 10 20 30 40
4 5 10 20 30 40 50
Cu
ordinary sample (ppm)

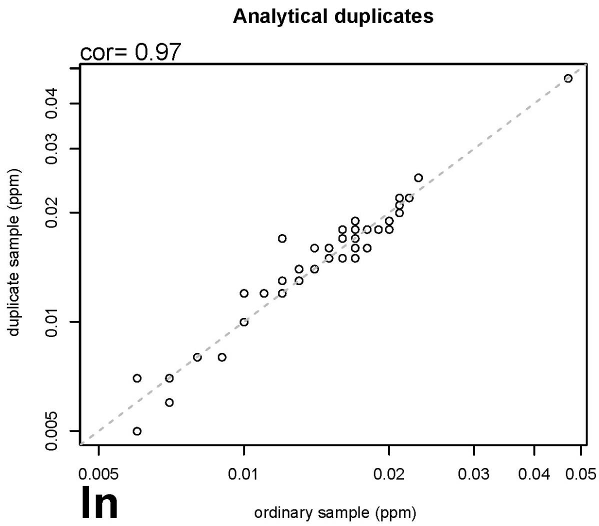

Analytical duplicates
cor= 0.99
duplicate sample (%)
0.2 0.3 0.5 1 2 3 4
0.2 0.3 0.4 1 2 3 4 5
Fe
ordinary sample (%)

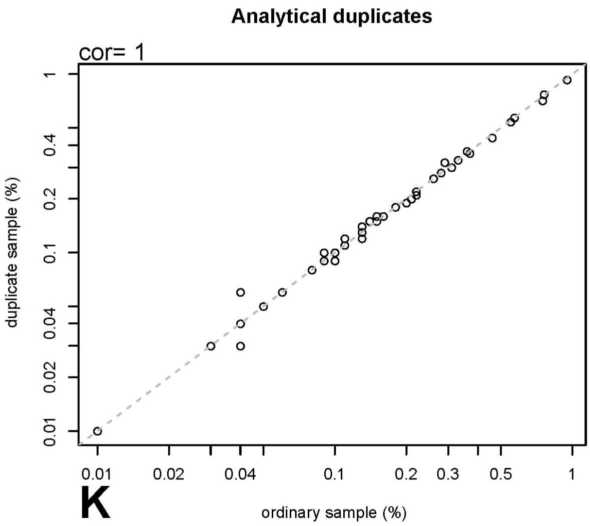

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
2 3 4 5 10
2 3 4 5 10
Ga
ordinary sample (ppm)

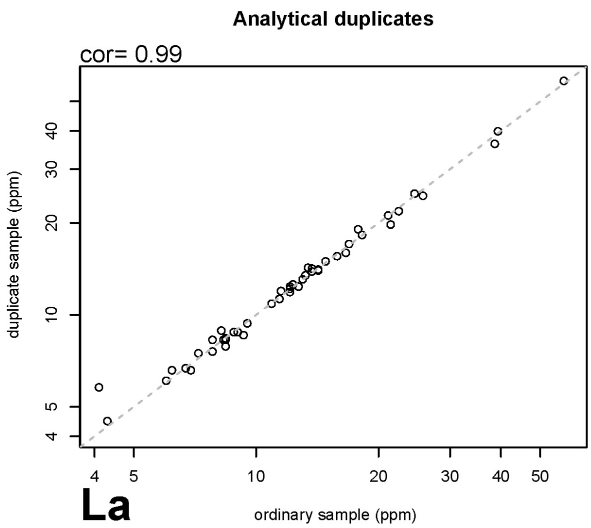

Analytical duplicates
cor= 0.92
duplicate sample (ppm)
0.03 0.04 0.05 0.1
0.03 0.04 0.05 0.1
Ge
ordinary sample (ppm)

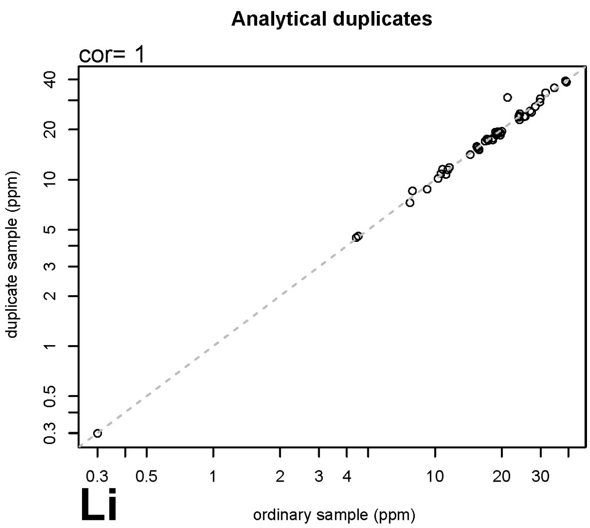

Analytical duplicates
cor= 0.97
duplicate sample (ppm)
0.01
0.02
0.03
0.05
0.1
0.2
0.01
0.02
0.03
0.05
0.1
0.2
Hf
ordinary sample (ppm)

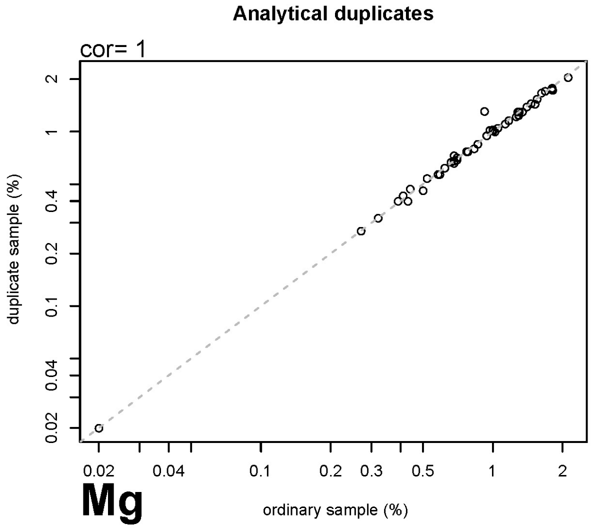

Analytical duplicates
cor= 0.85
duplicate sample (ppm)
0.005
0.01
0.02
0.03
0.05
0.005
0.01
0.02
0.03
0.04
Hg
ordinary sample (ppm)

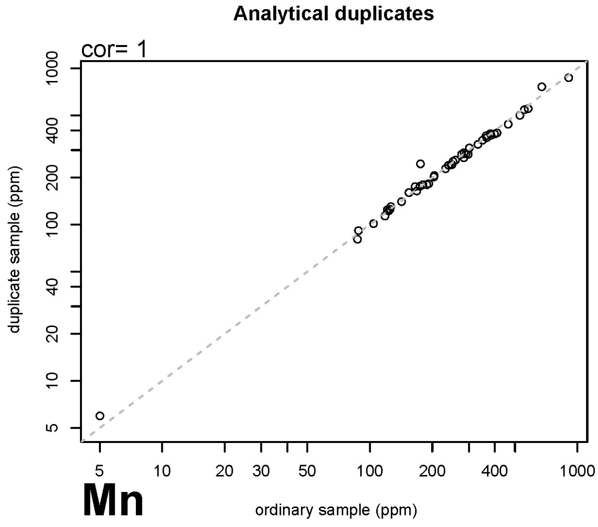

Analytical duplicates
cor= 0.97
duplicate sample (ppm)
0.005
0.01
0.02
0.03
0.04
0.005
0.01
0.02
0.03
0.04
0.05
In
ordinary sample (ppm)

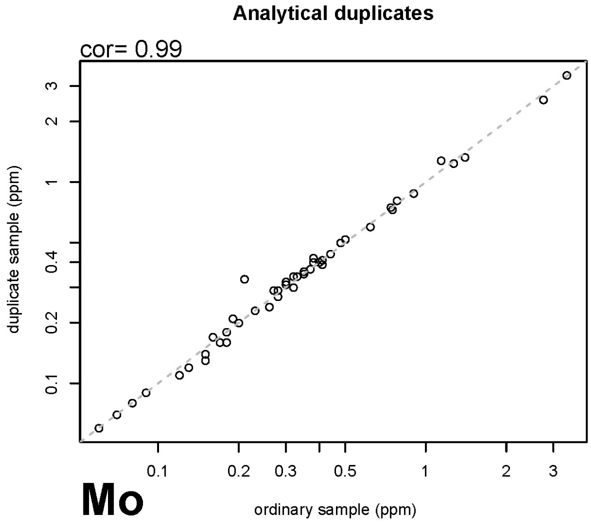

Analytical duplicates
cor= 1
duplicate sample (%)
0.01
0.02
0.04
0.1
0.2
0.4
1
0.01
0.02
0.04
0.1
0.2
0.3
0.5
1
K
ordinary sample (%)

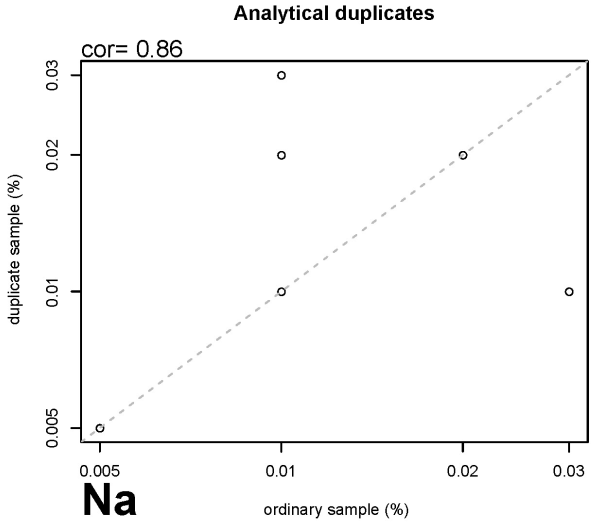

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
4
5
10
20
30
40
4
5
10
20
30
40
50
La
ordinary sample (ppm)

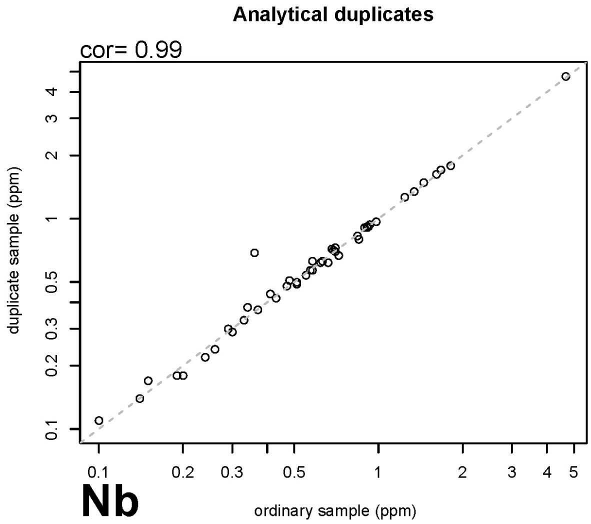

Analytical duplicates
cor= 1
duplicate sample (ppm)
0.3
0.5
1
2
3
5
10
20
40
0.3
0.5
1
2
3
4
10
20
30
Li
ordinary sample (ppm)

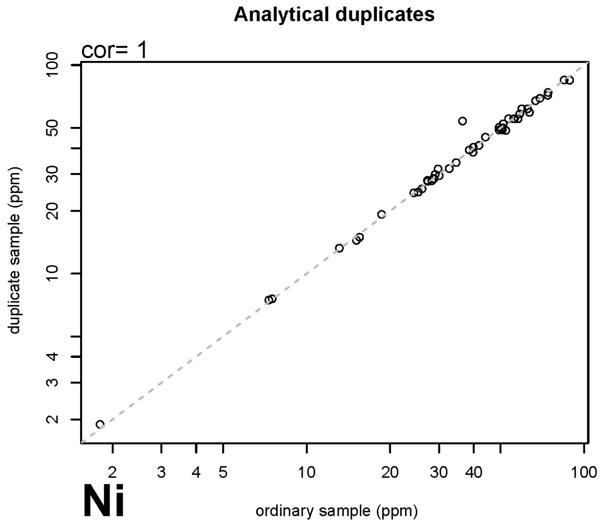

Analytical duplicates
cor= 1
duplicate sample (%)
ordinary sample (%)
Mg

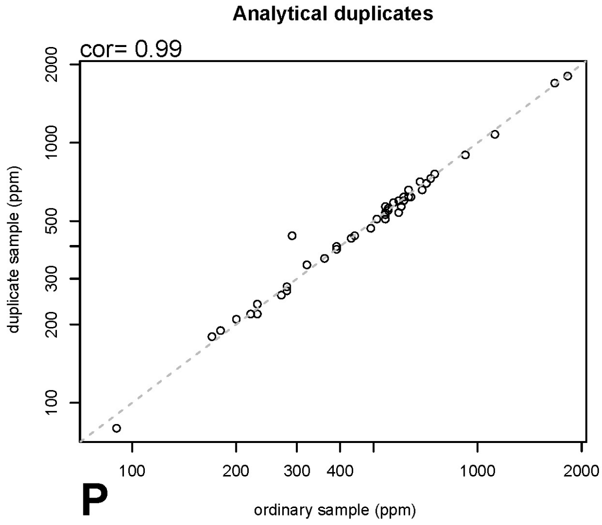

Analytical duplicates
cor= 1
duplicate sample (ppm)
ordinary sample (ppm)
Mn

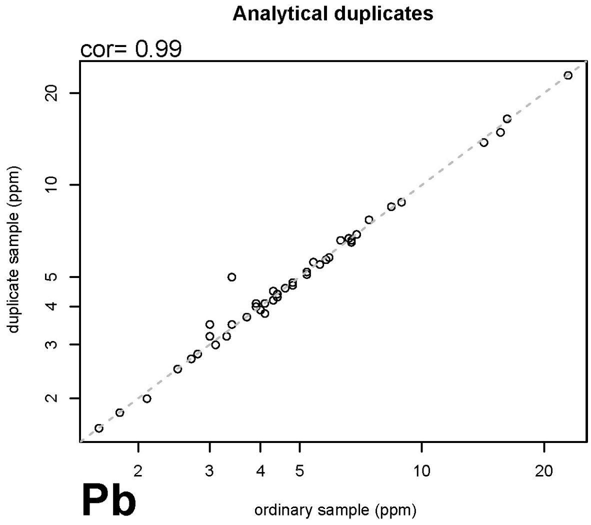

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
ordinary sample (ppm)
Mo

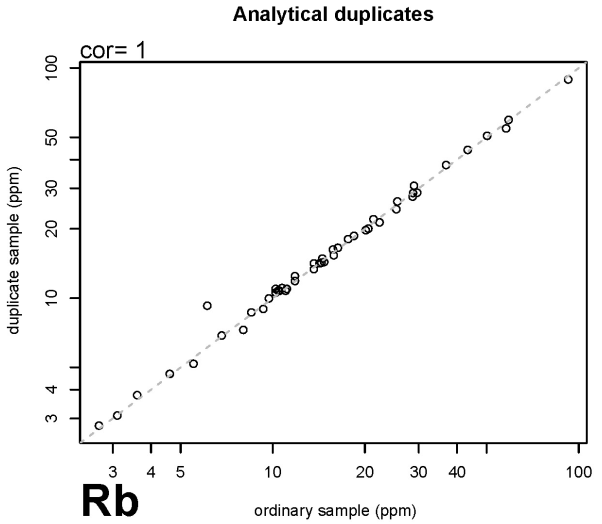

Analytical duplicates
cor= 0.86
duplicate sample (%)
ordinary sample (%)
Na

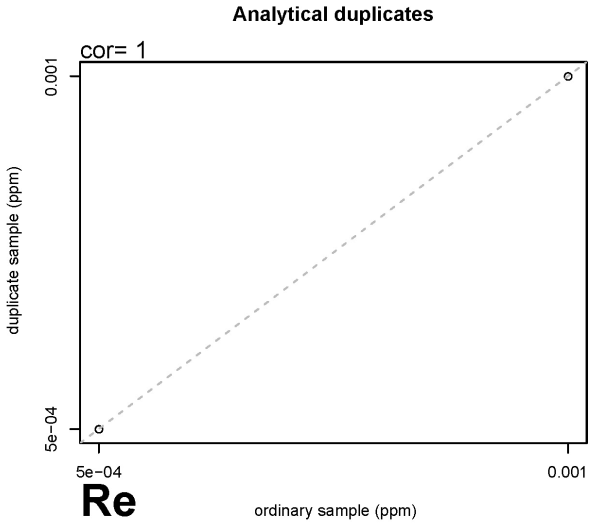

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
ordinary sample (ppm)
Nb

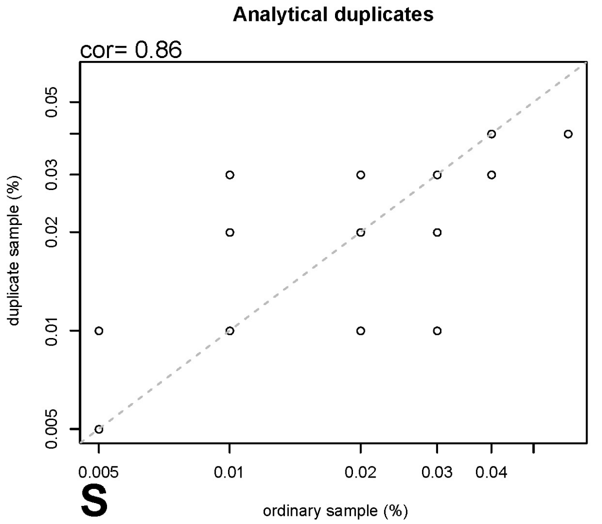

Analytical duplicates
cor= 1
duplicate sample (ppm)
ordinary sample (ppm)
Ni

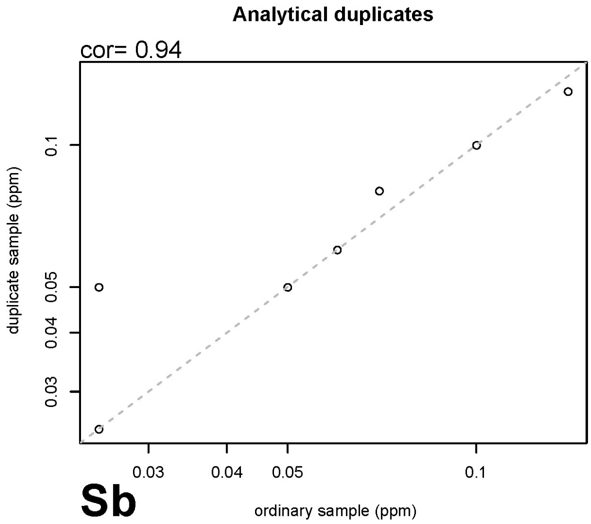

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
100
200
300
500
1000
2000
ordinary sample (ppm)
100
200
300
400
1000
2000
P

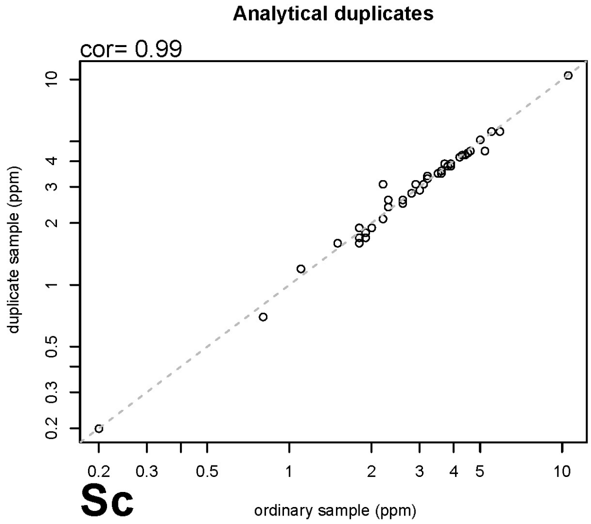

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
2
3
4
5
10
20
ordinary sample (ppm)
2
3
4
5
10
20
Pb

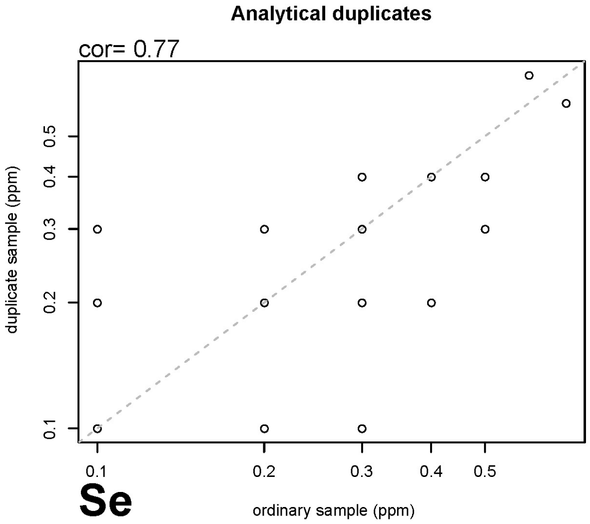

Analytical duplicates
cor= 1
duplicate sample (ppm)
3
4
10
20
30
50
100
ordinary sample (ppm)
3
4
5
10
20
30
40
100
Rb

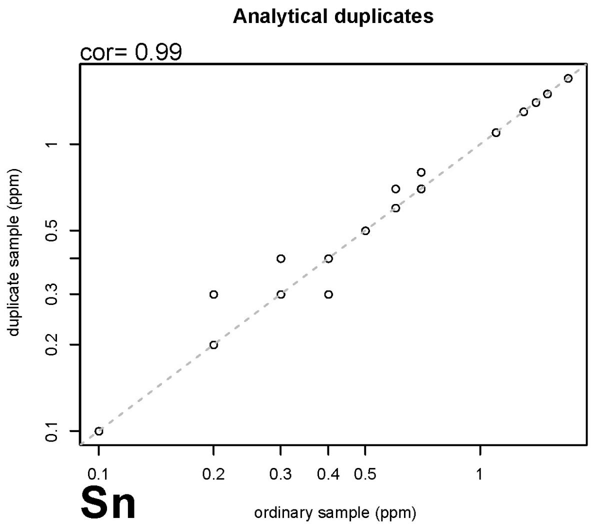

Analytical duplicates
cor= 1
duplicate sample (ppm)
5e−04
0.001
ordinary sample (ppm)
5e−04
0.001
Re

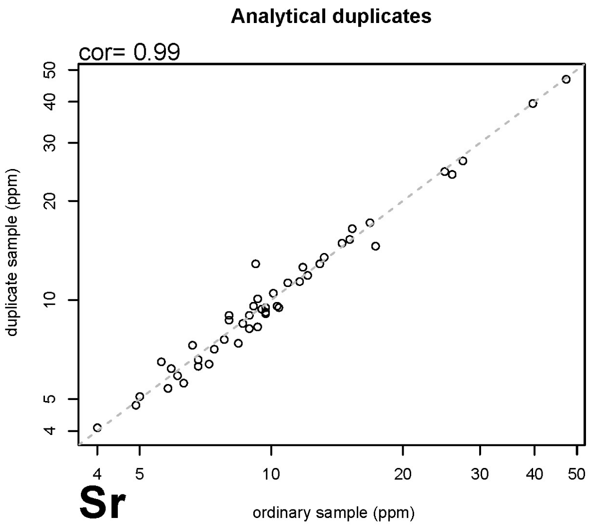

Analytical duplicates
cor= 0.86
duplicate sample (%)
0.005
0.01
0.02
0.03
0.05
ordinary sample (%)
0.005
0.01
0.02
0.03
0.04
S

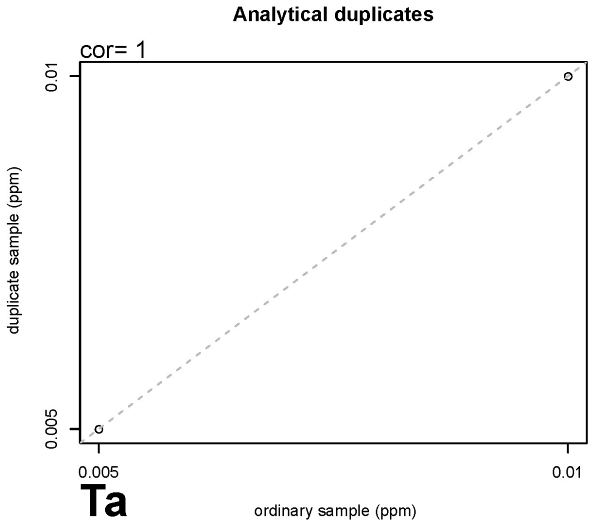

Analytical duplicates
cor= 0.94
duplicate sample (ppm)
0.03
0.04
0.05
0.1
ordinary sample (ppm)
0.03
0.04
0.05
0.1
Sb

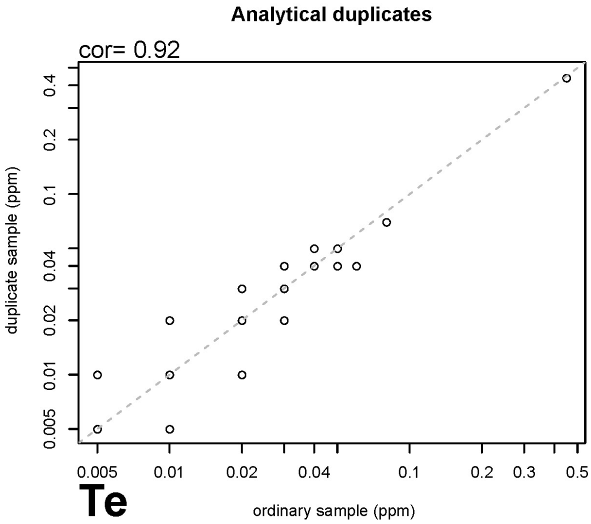

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
0.2
0.3
0.5
1
2
3
4
10
0.2
0.3
0.5
1
2
3
4
5
10
Sc
ordinary sample (ppm)

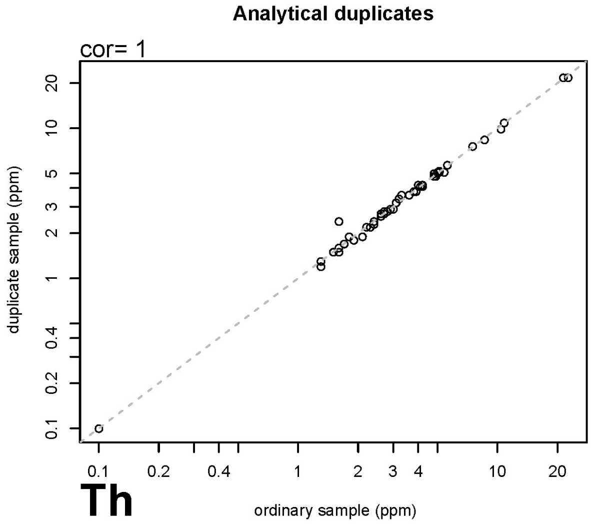

Analytical duplicates
cor= 0.77
duplicate sample (ppm)
0.1
0.2
0.3
0.4
0.5
0.1
0.2
0.3
0.4
0.5
Se
ordinary sample (ppm)

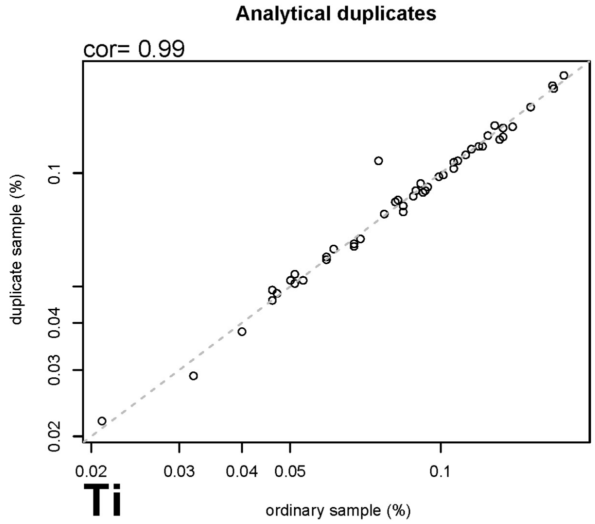

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
0.1
0.2
0.3
0.5
1
0.1
0.2
0.3
0.4
0.5
1
Sn
ordinary sample (ppm)

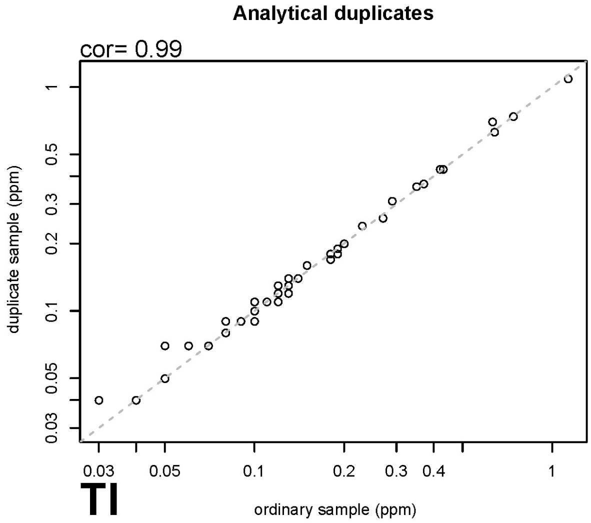

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
4
5
10
20
30
40
50
4
5
10
20
30
40
50
Sr
ordinary sample (ppm)

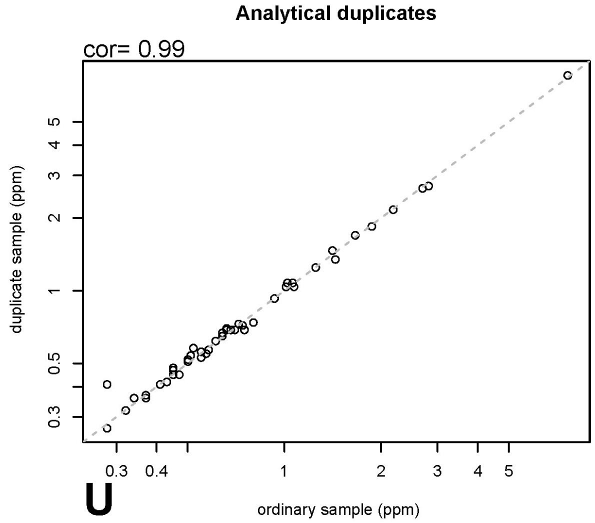

Analytical duplicates
cor= 1
duplicate sample (ppm)
0.005
0.01
0.005
0.01
Ta
ordinary sample (ppm)

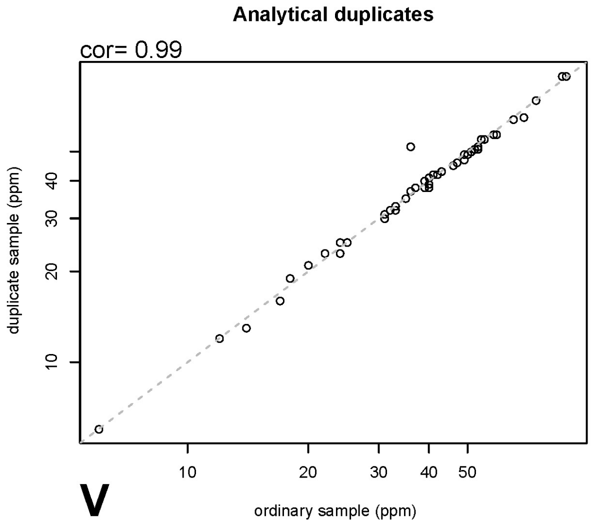

Analytical duplicates
cor= 0.92
duplicate sample (ppm)
0.005
0.01
0.02
0.04
0.1
0.2
0.4
0.005
0.01
0.02
0.04
0.1
0.2
0.3
0.5
Te
ordinary sample (ppm)

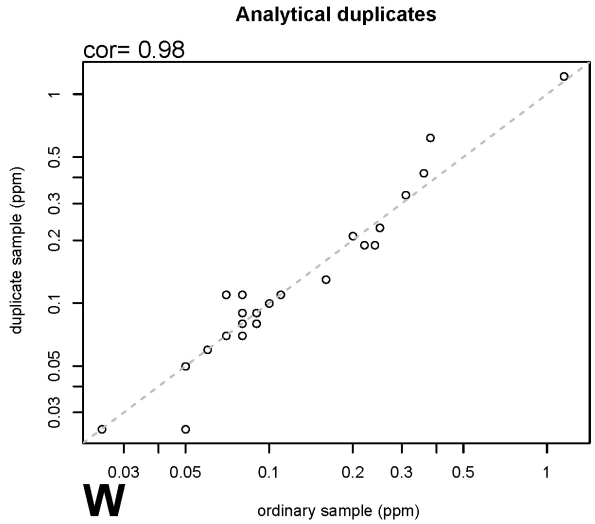

Analytical duplicates
cor= 1
duplicate sample (ppm)
ordinary sample (ppm)
Th

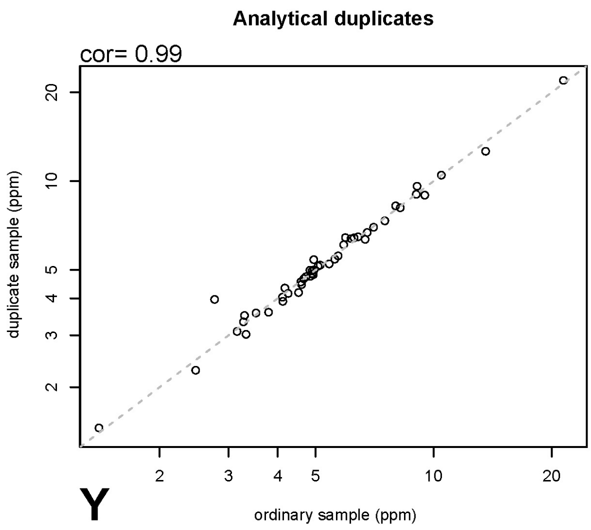

Analytical duplicates
cor= 0.99
duplicate sample (%)
ordinary sample (%)
Ti

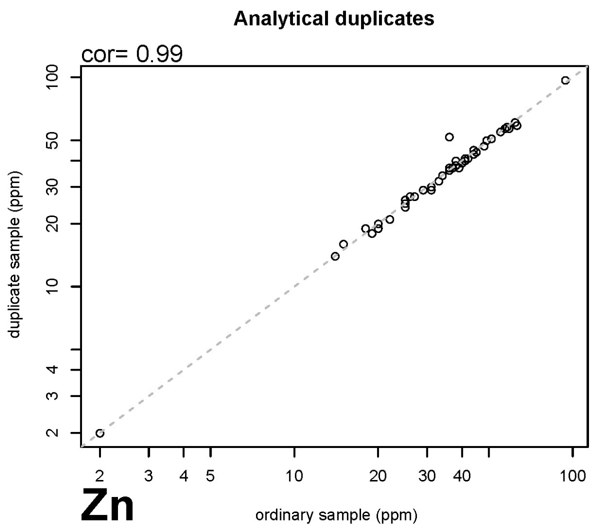

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
ordinary sample (ppm)
Tl

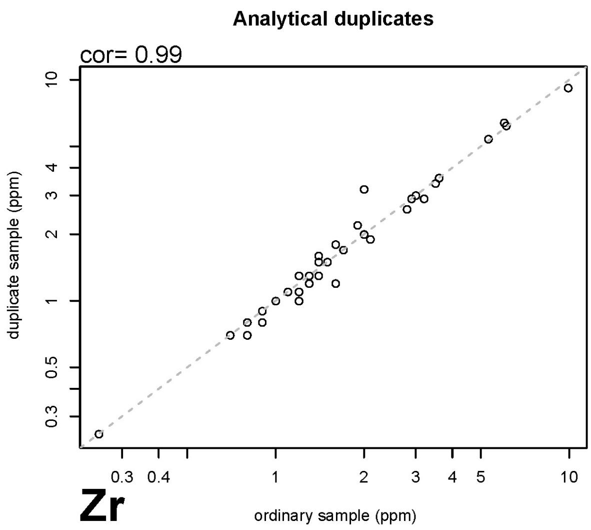

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
ordinary sample (ppm)
U


Analytical duplicates
cor= 0.99
duplicate sample (ppm)
ordinary sample (ppm)
V


Analytical duplicates
cor= 0.98
duplicate sample (ppm)
ordinary sample (ppm)
W

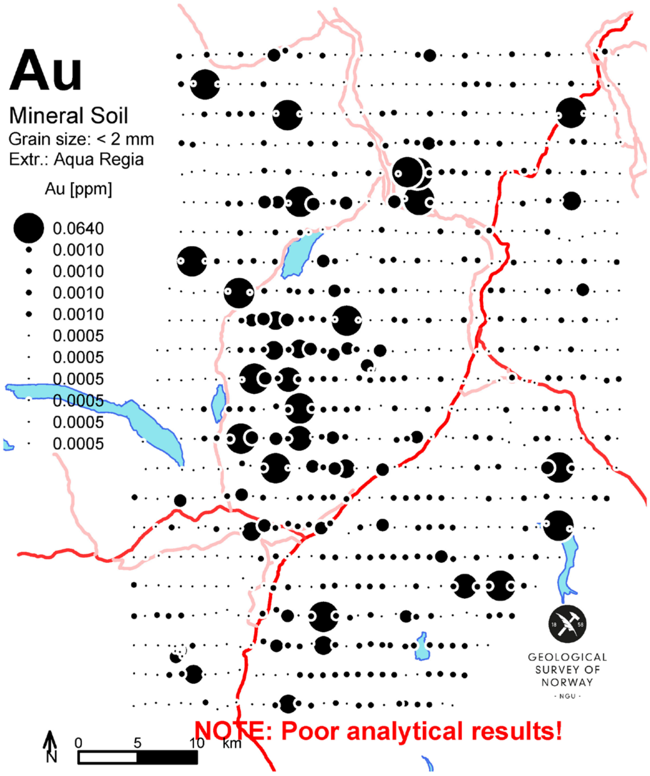

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
2
3
4
5
10
20
2
3
4
5
10
20
ordinary sample (ppm)
Y

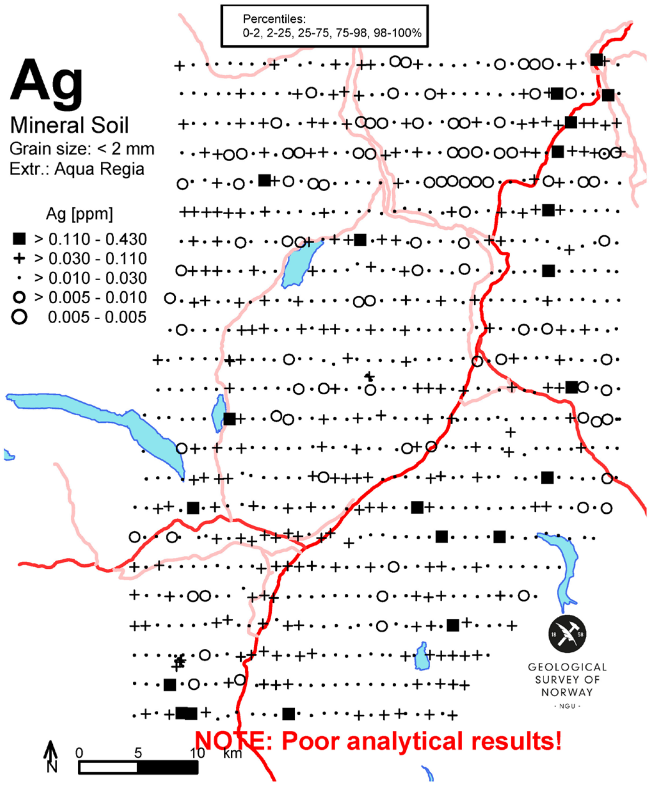

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
2
3
4
10
20
30
50
100
2
3
4
5
10
20
30
40
100
ordinary sample (ppm)
Zn

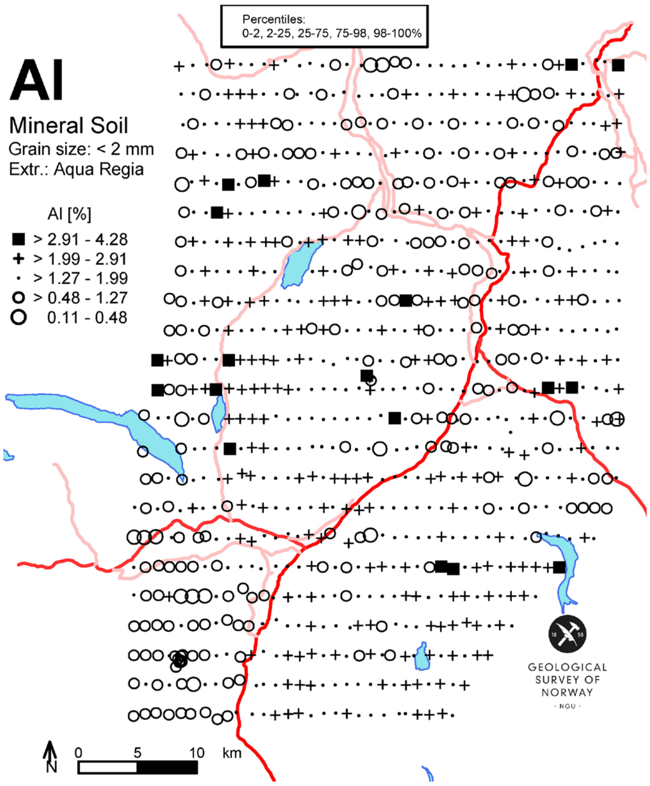

Analytical duplicates
cor= 0.99
duplicate sample (ppm)
0.3
0.5
1
2
3
4
10
0.3
0.4
1
2
3
4
5
10
ordinary sample (ppm)
Zr

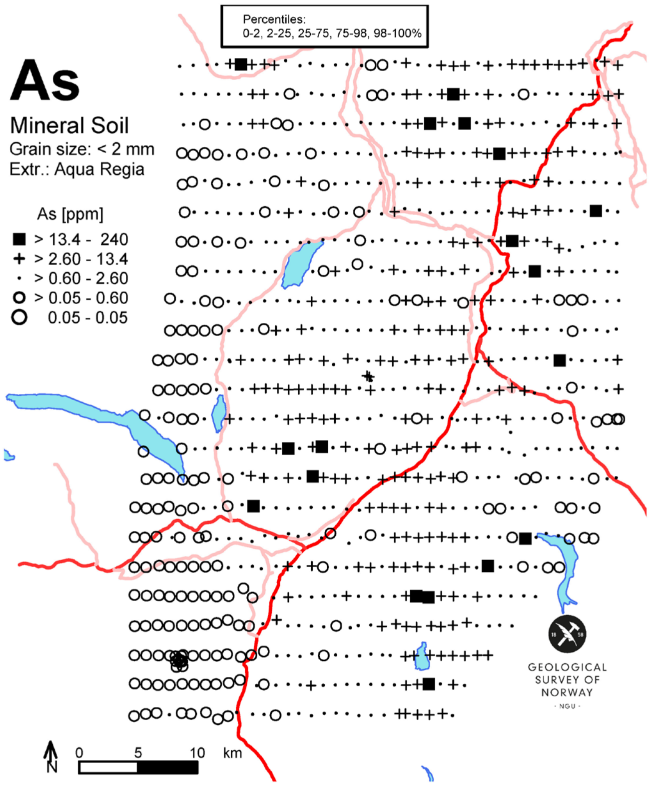
Appendix V Geochemical maps from the Oppdal area.

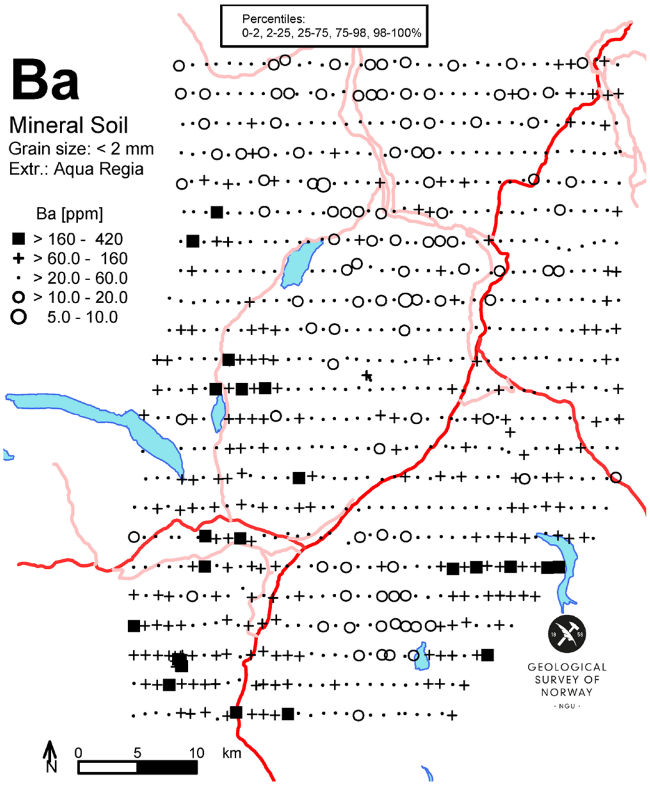
Note that these maps should be studied keeping the results of quality control in mind.
Samples showing strong deviation on duplicate results are not showed on the maps.
B, Na and S are not provided maps for due to poor data quality.
EDA map interval: 0-2%, 2-25%, 25-75%, 75-98%, 98-100%.

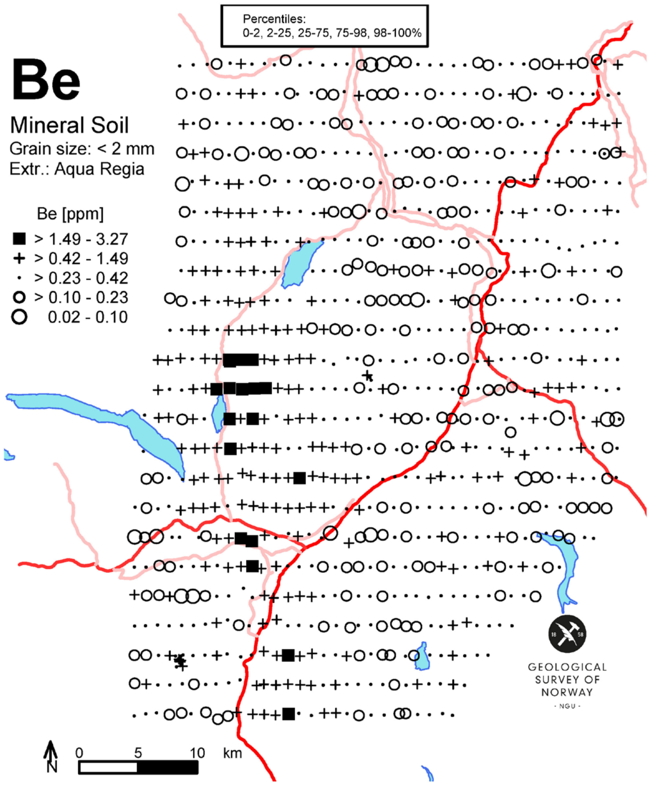

Au
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Au [ppm]
0.0640
0.0010
0.0010
0.0010
0.0010
0.0005
0.0005
0.0005
0.0005
0.0005
0.0005
NOTE: Poor analytical results!
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY

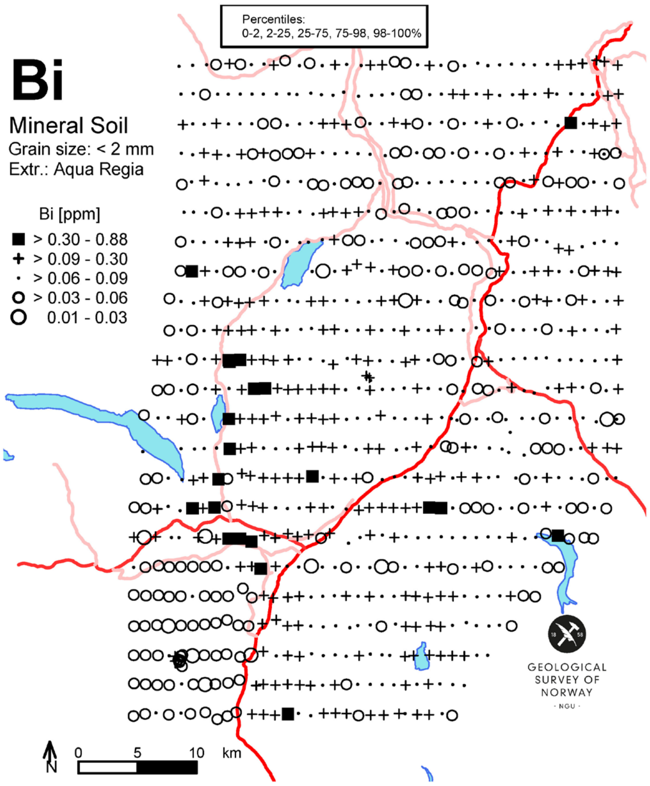

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Ag
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Ag [ppm]
> 0.110 - 0.430
> 0.030 - 0.110
> 0.010 - 0.030
> 0.005 - 0.010
0.005 - 0.005
NOTE: Poor analytical results!
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY

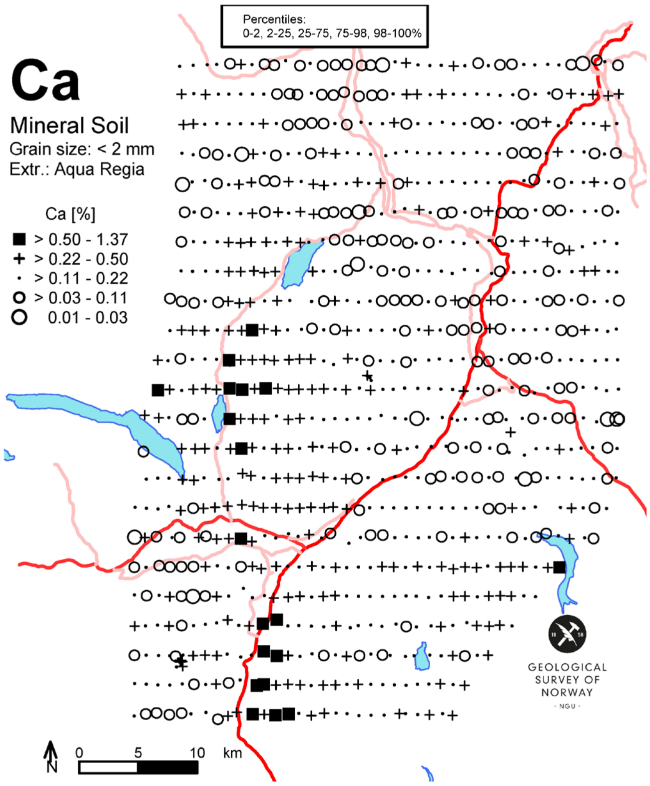

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Al
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Al [%]
> 2.91 - 4.28
> 1.99 - 2.91
> 1.27 - 1.99
> 0.48 - 1.27
0.11 - 0.48
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY

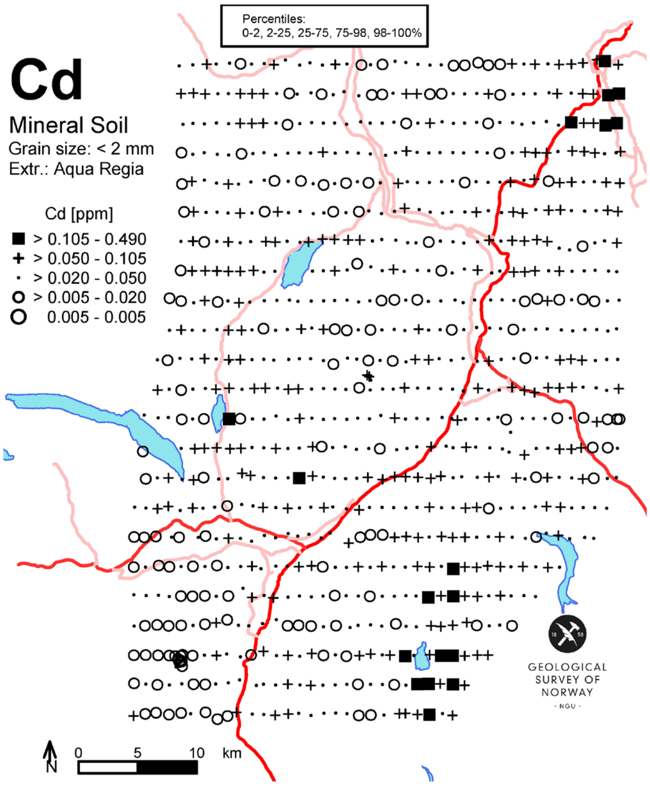

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
As
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
As [ppm]
> 13.4 - 240
> 2.60 - 13.4
> 0.60 - 2.60
> 0.05 - 0.60
0.05 - 0.05
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY

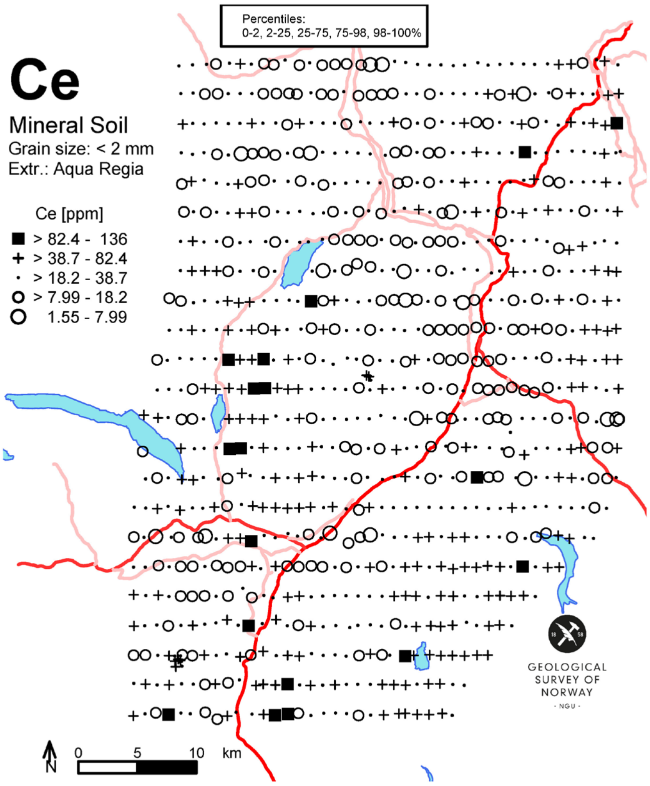

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Ba
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Ba [ppm]
> 160 - 420
> 60.0 - 160
> 20.0 - 60.0
> 10.0 - 20.0
5.0 - 10.0
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY
- NGU -

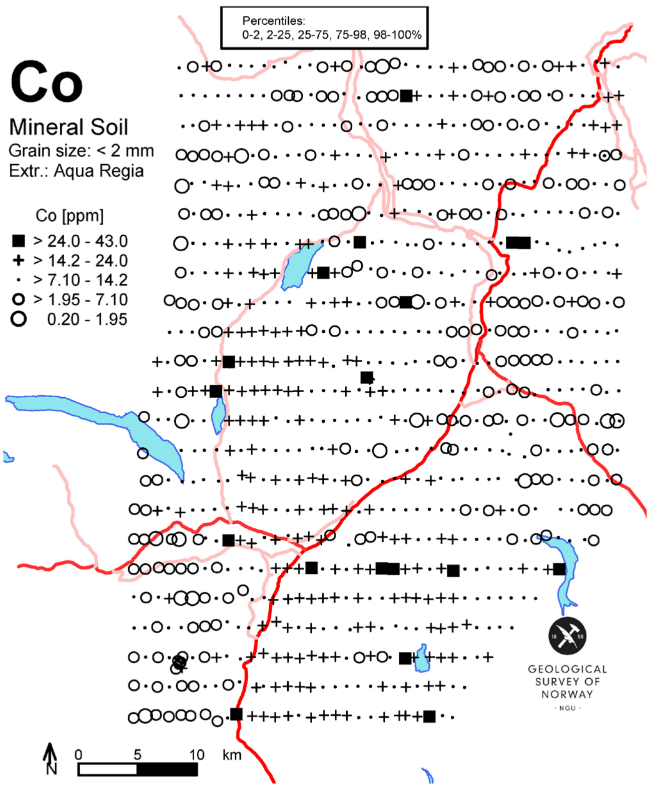

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Be
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Be [ppm]
> 1.49 - 3.27
> 0.42 - 1.49
> 0.23 - 0.42
> 0.10 - 0.23
0.02 - 0.10
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY
- NGU -

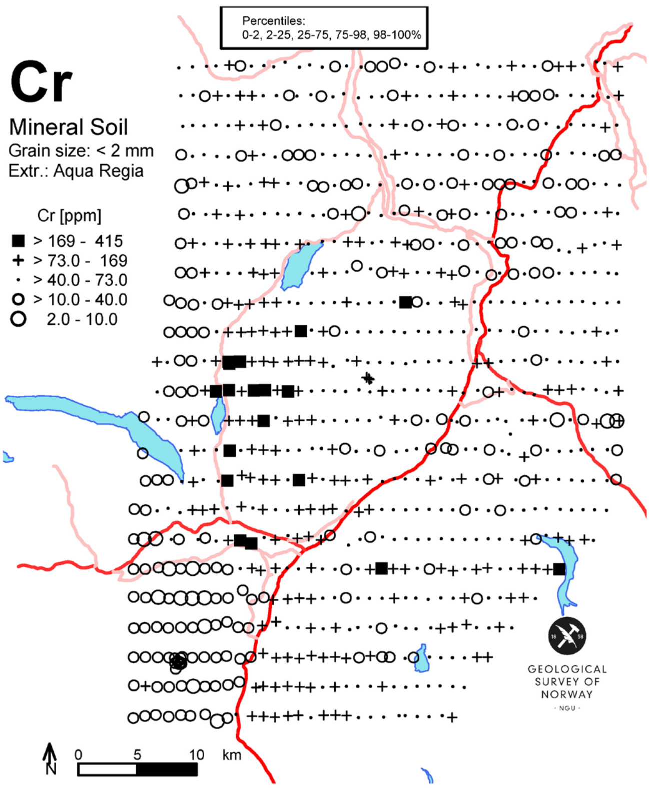

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Bi
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Bi [ppm]
> 0.30 - 0.88
> 0.09 - 0.30
> 0.06 - 0.09
> 0.03 - 0.06
0.01 - 0.03
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY
- NGU -

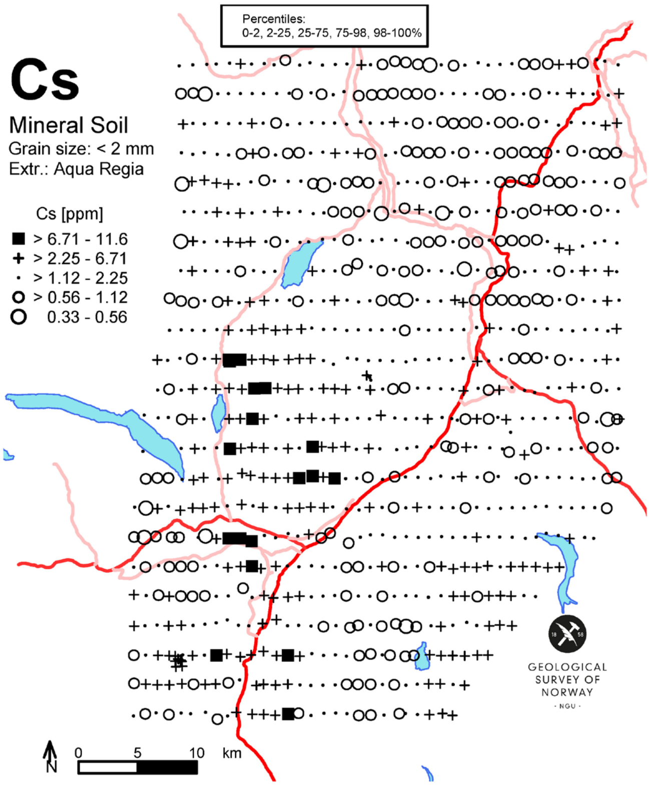

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Ca
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Ca [%]
> 0.50 - 1.37
> 0.22 - 0.50
> 0.11 - 0.22
> 0.03 - 0.11
0.01 - 0.03
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY
- NGU -

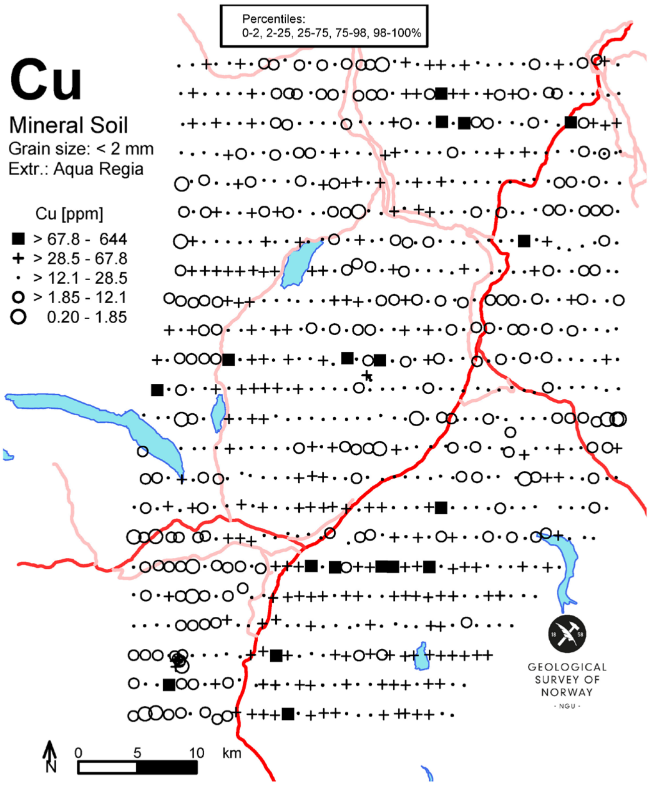

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Cd
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Cd [ppm]
> 0.105 - 0.490
> 0.050 - 0.105
> 0.020 - 0.050
> 0.005 - 0.020
0.005 - 0.005
GEOLOGICAL SURVEY OF NORWAY
N
0 5 10 km

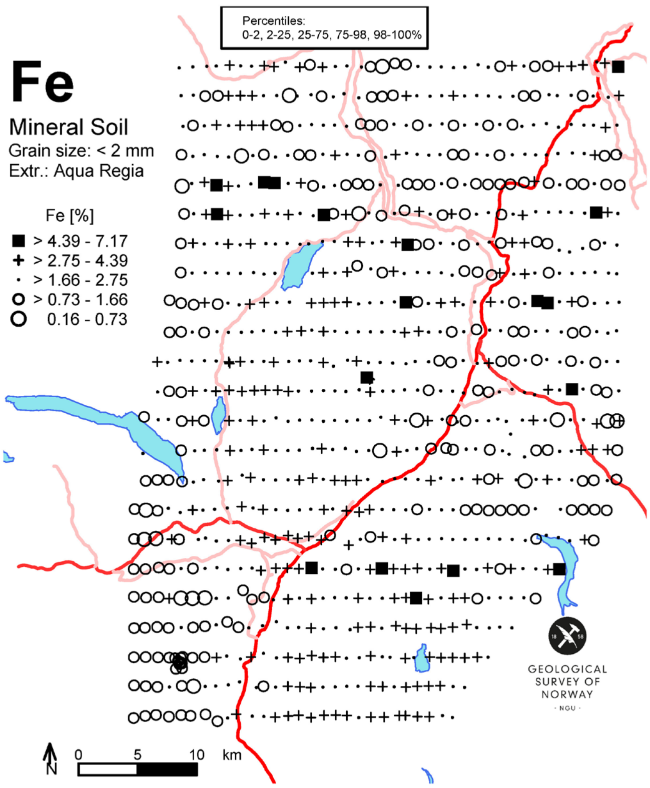

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Ce
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Ce [ppm]
> 82.4 - 136
> 38.7 - 82.4
> 18.2 - 38.7
> 7.99 - 18.2
1.55 - 7.99
GEOLOGICAL SURVEY OF NORWAY
N
0 5 10 km

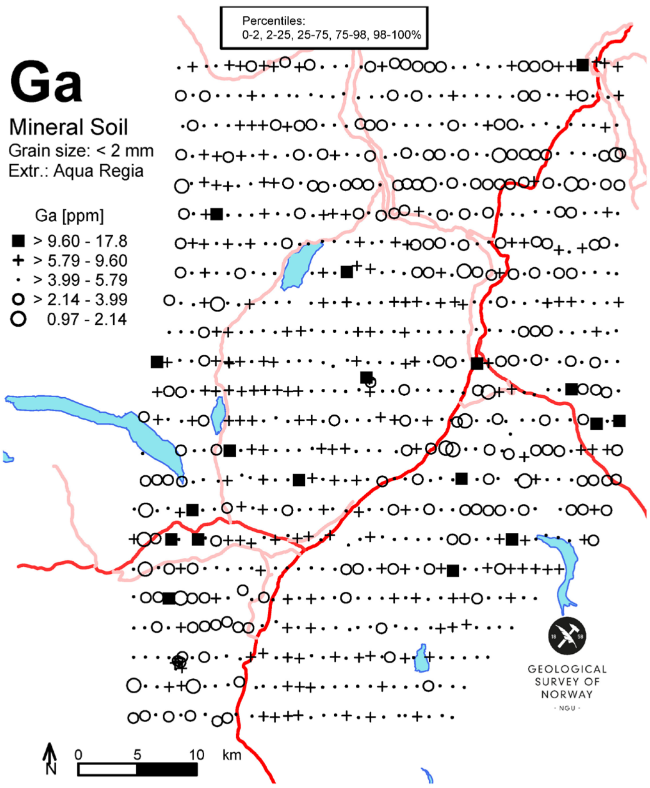

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Co
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Co [ppm]
> 24.0 - 43.0
> 14.2 - 24.0
> 7.10 - 14.2
> 1.95 - 7.10
0.20 - 1.95
GEOLOGICAL SURVEY OF NORWAY
N
0 5 10 km

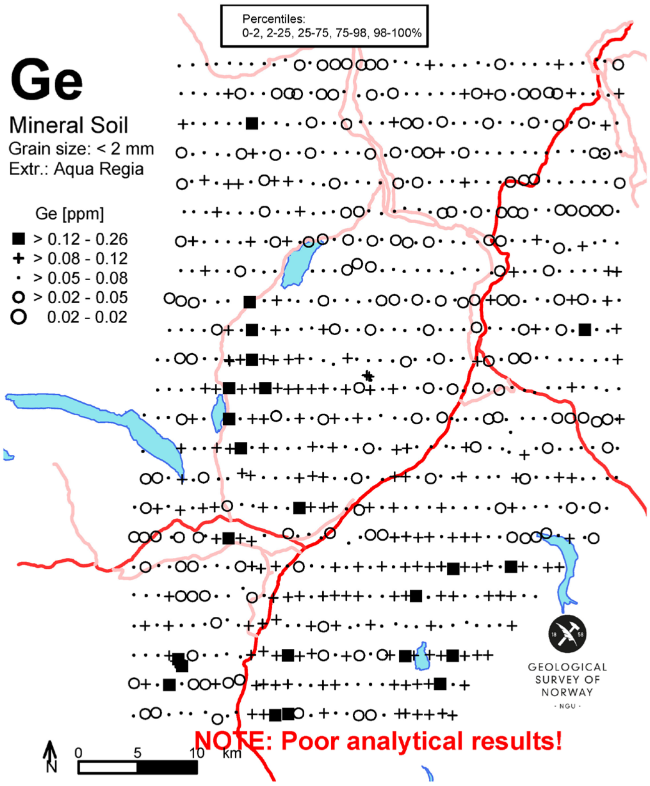

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Cr
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Cr [ppm]
> 169 - 415
> 73.0 - 169
> 40.0 - 73.0
> 10.0 - 40.0
2.0 - 10.0
GEOLOGICAL SURVEY OF NORWAY
N
0 5 10 km

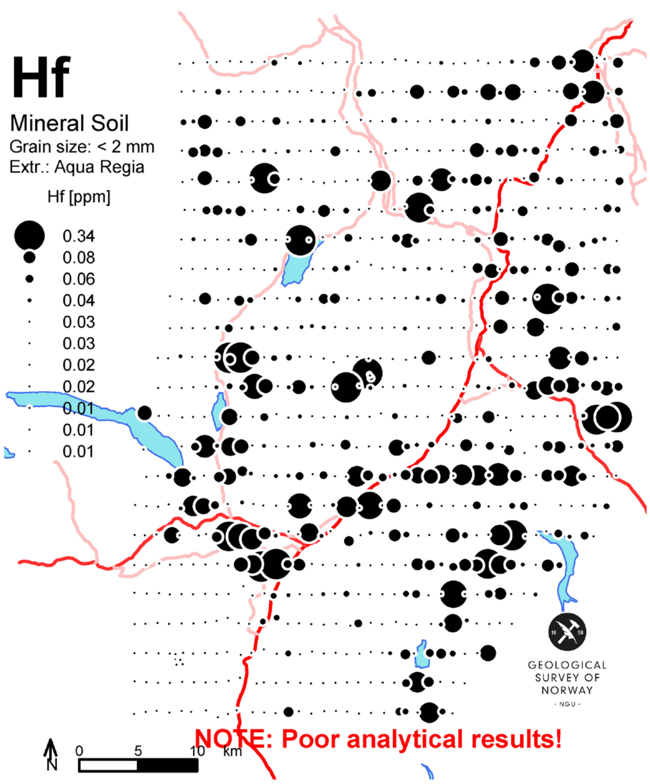

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Cs
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Cs [ppm]
> 6.71 - 11.6
> 2.25 - 6.71
> 1.12 - 2.25
> 0.56 - 1.12
0.33 - 0.56
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY

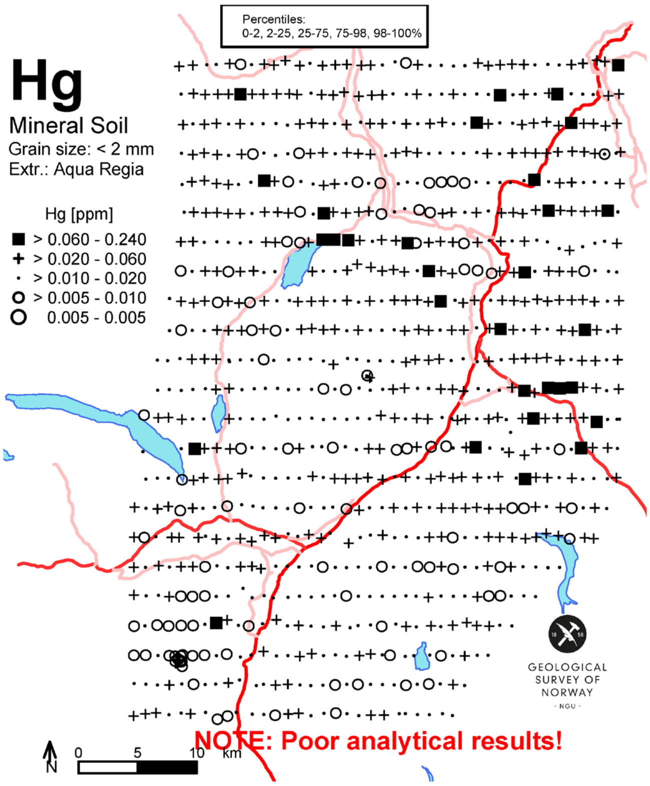

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Cu
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Cu [ppm]
> 67.8 - 644
> 28.5 - 67.8
> 12.1 - 28.5
> 1.85 - 12.1
0.20 - 1.85
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY

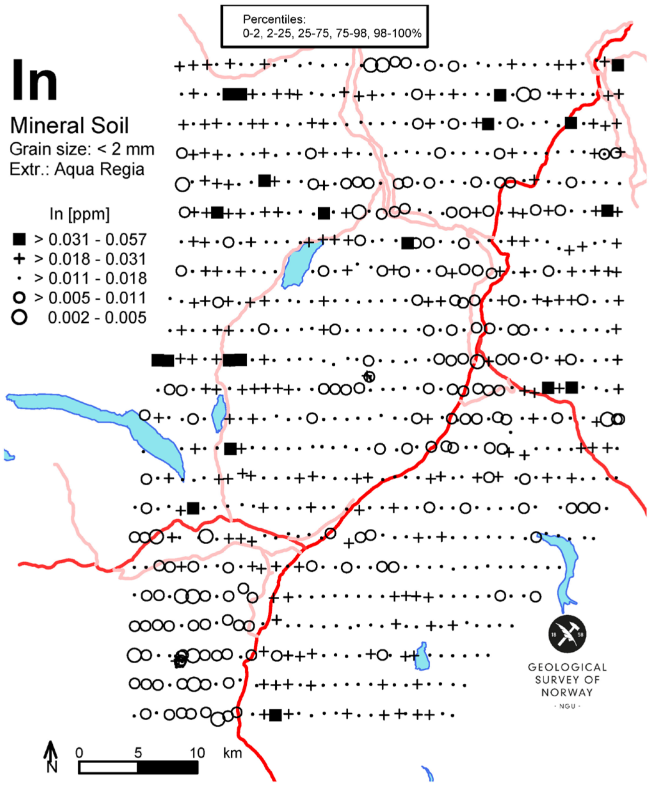

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Fe
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Fe [%]
> 4.39 - 7.17
> 2.75 - 4.39
> 1.66 - 2.75
> 0.73 - 1.66
0.16 - 0.73
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY

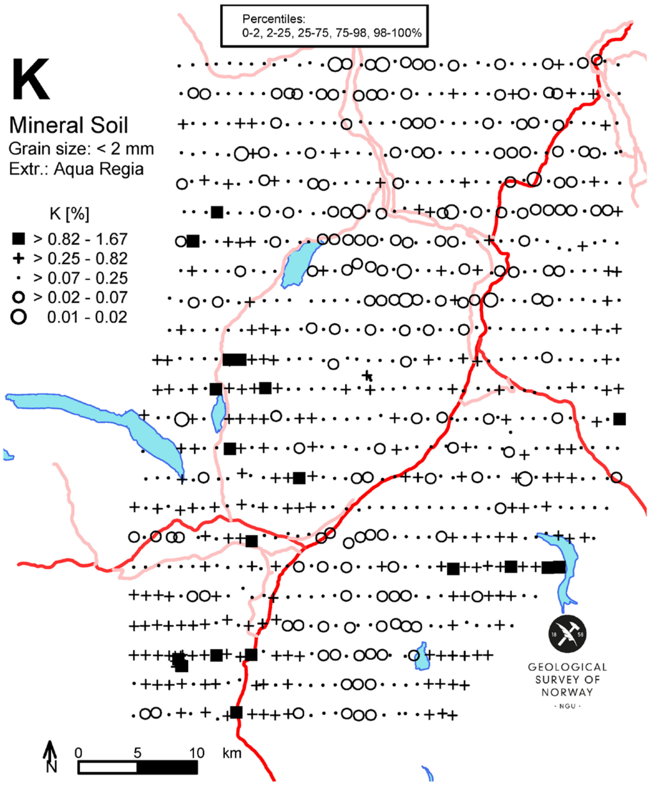

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Ga
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Ga [ppm]
> 9.60 - 17.8
> 5.79 - 9.60
> 3.99 - 5.79
> 2.14 - 3.99
0.97 - 2.14
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY

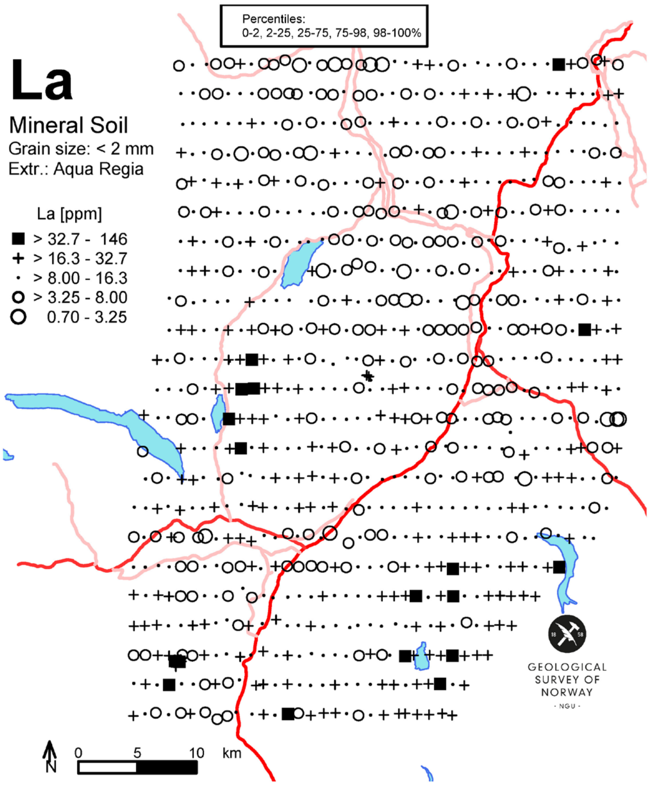

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Ge
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Ge [ppm]
> 0.12 - 0.26
> 0.08 - 0.12
> 0.05 - 0.08
> 0.02 - 0.05
0.02 - 0.02
GEOLOGICAL SURVEY OF NORWAY
NGU
N
0 5 10 km
NOTE: Poor analytical results!

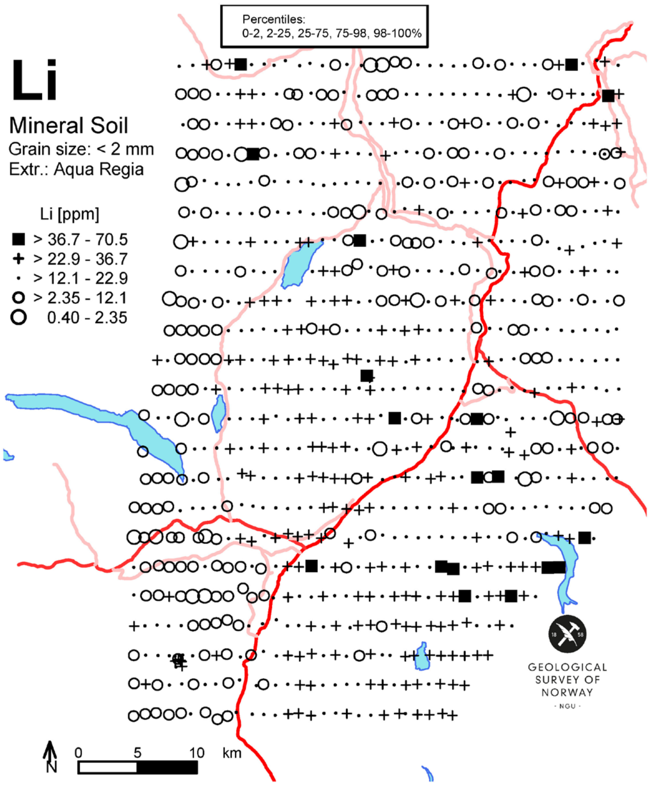

Hf
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Hf [ppm]
0.34
0.08
0.06
0.04
0.03
0.03
0.02
0.02
0.01
0.01
0.01
GEOLOGICAL SURVEY OF NORWAY
NGU
N
0 5 10 km
NOTE: Poor analytical results!

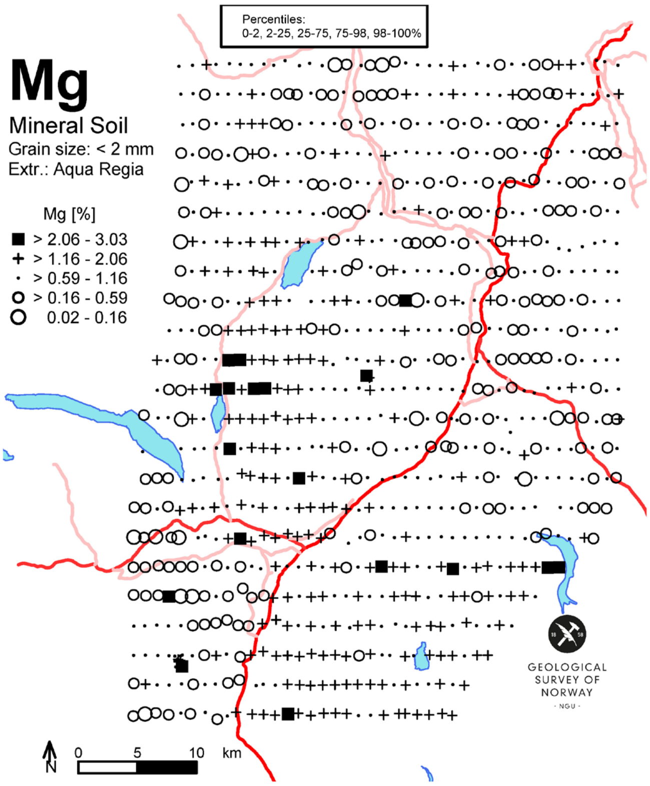

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Hg
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Hg [ppm]
> 0.060 - 0.240
> 0.020 - 0.060
> 0.010 - 0.020
> 0.005 - 0.010
0.005 - 0.005
GEOLOGICAL SURVEY OF NORWAY
NGU
N
0 5 10 km
NOTE: Poor analytical results!

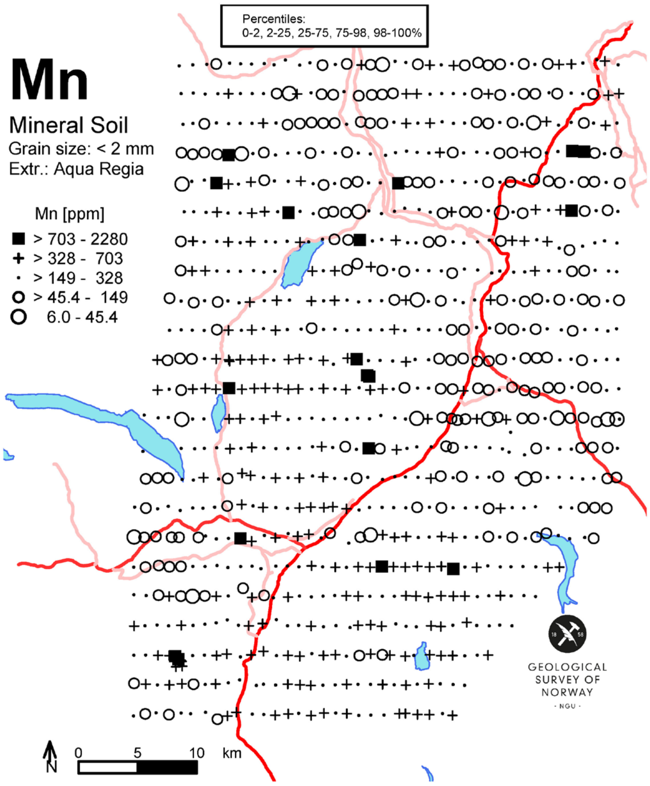

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
In
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
In [ppm]
> 0.031 - 0.057
> 0.018 - 0.031
> 0.011 - 0.018
> 0.005 - 0.011
0.002 - 0.005
GEOLOGICAL SURVEY OF NORWAY
NGU
N
0 5 10 km


Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
K
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
K [%]
> 0.82 - 1.67
> 0.25 - 0.82
> 0.07 - 0.25
> 0.02 - 0.07
0.01 - 0.02
N
0
5
10
km
GEOLOGICAL
SURVEY OF
NORWAY

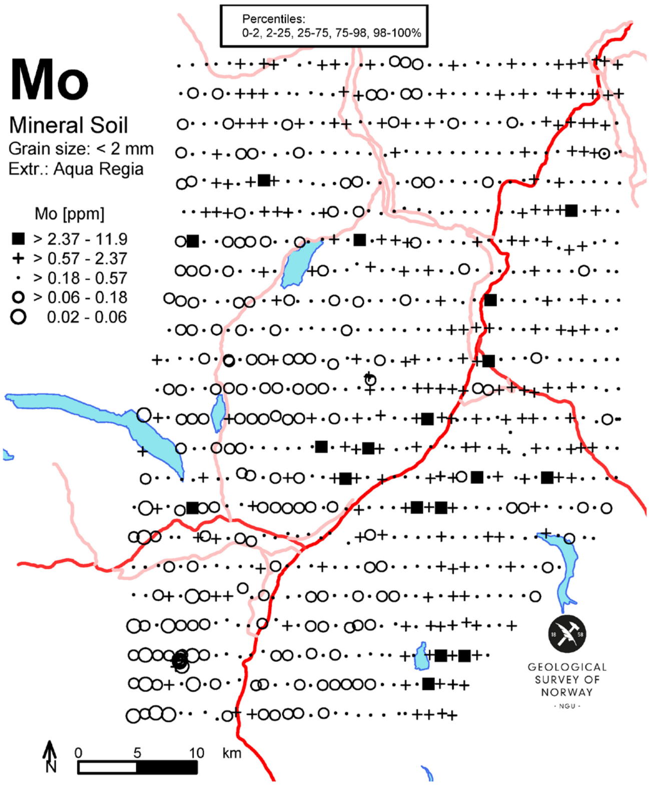

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
La
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
La [ppm]
> 32.7 - 146
> 16.3 - 32.7
> 8.00 - 16.3
> 3.25 - 8.00
0.70 - 3.25
N
0
5
10
km
GEOLOGICAL
SURVEY OF
NORWAY


Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Li
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Li [ppm]
> 36.7 - 70.5
> 22.9 - 36.7
> 12.1 - 22.9
> 2.35 - 12.1
0.40 - 2.35
N
0
5
10
km
GEOLOGICAL
SURVEY OF
NORWAY

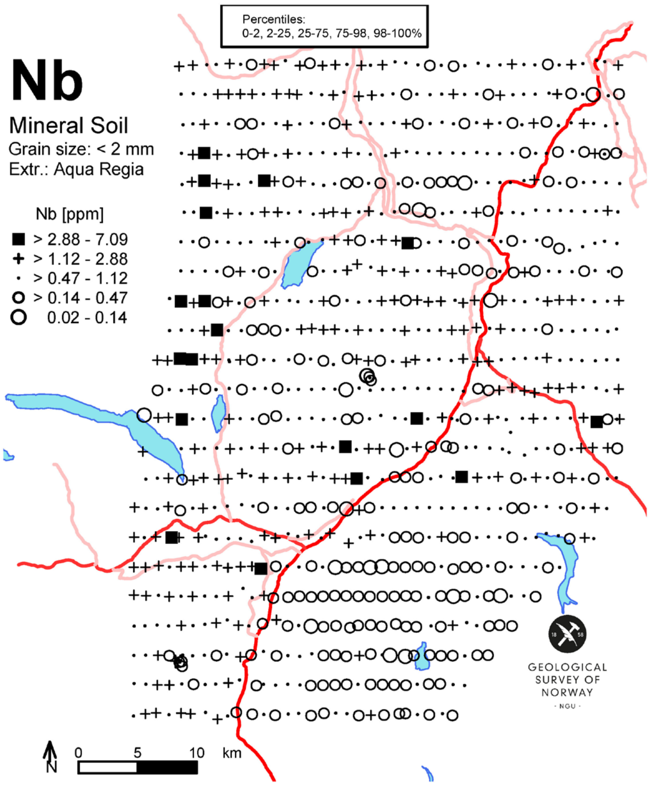

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Mg
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Mg [%]
> 2.06 - 3.03
> 1.16 - 2.06
> 0.59 - 1.16
> 0.16 - 0.59
0.02 - 0.16
N
0
5
10
km
GEOLOGICAL
SURVEY OF
NORWAY



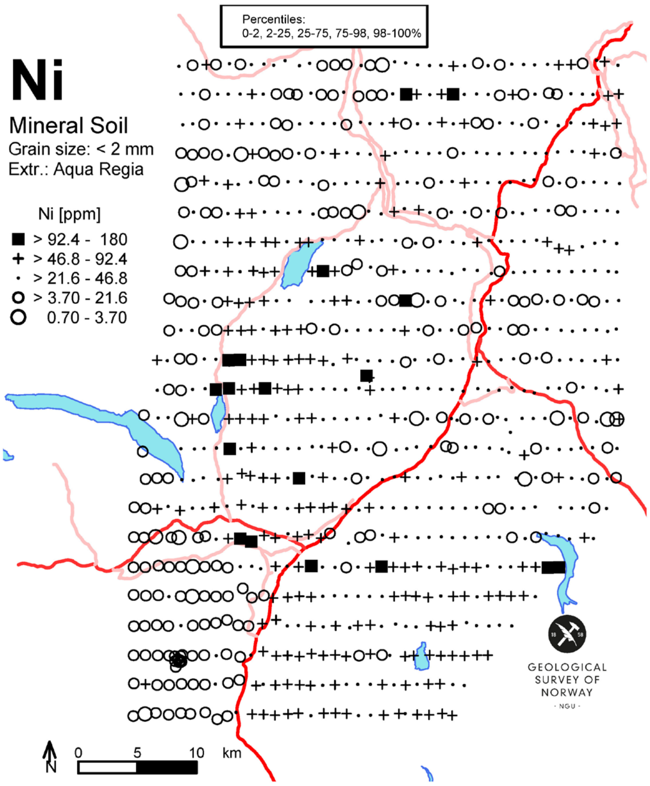
Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Mn
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Mn [ppm]
> 703 - 2280
> 328 - 703
> 149 - 328
> 45.4 - 149
6.0 - 45.4
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY



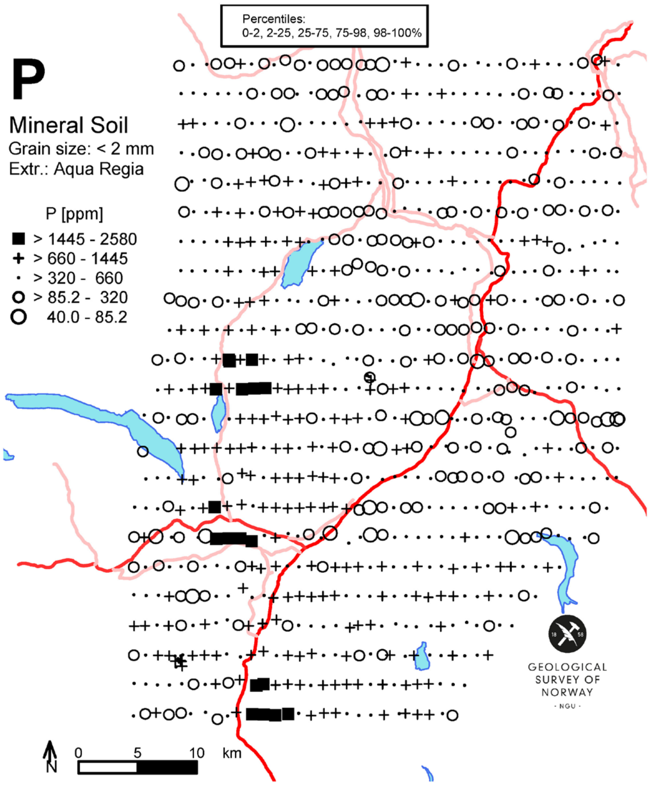
Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Mo
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Mo [ppm]
> 2.37 - 11.9
> 0.57 - 2.37
> 0.18 - 0.57
> 0.06 - 0.18
0.02 - 0.06
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY

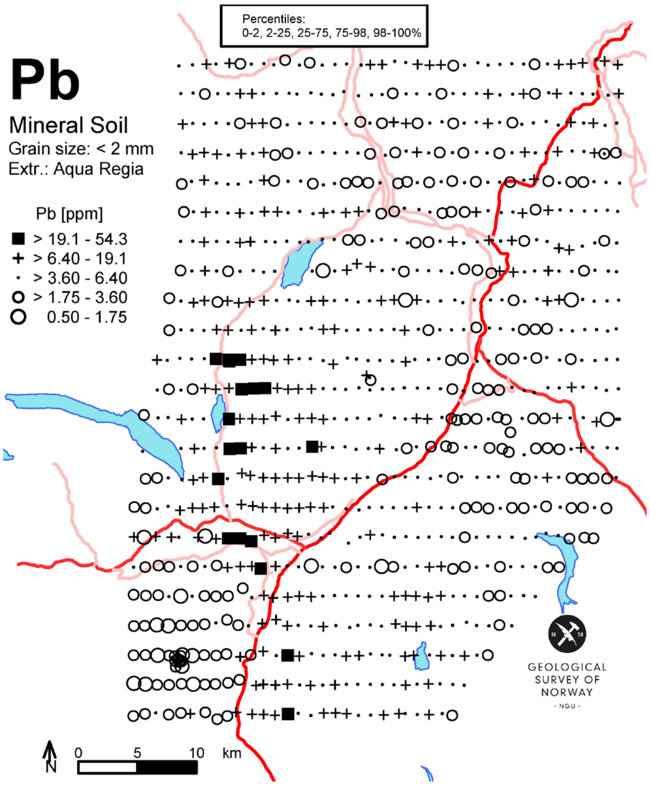


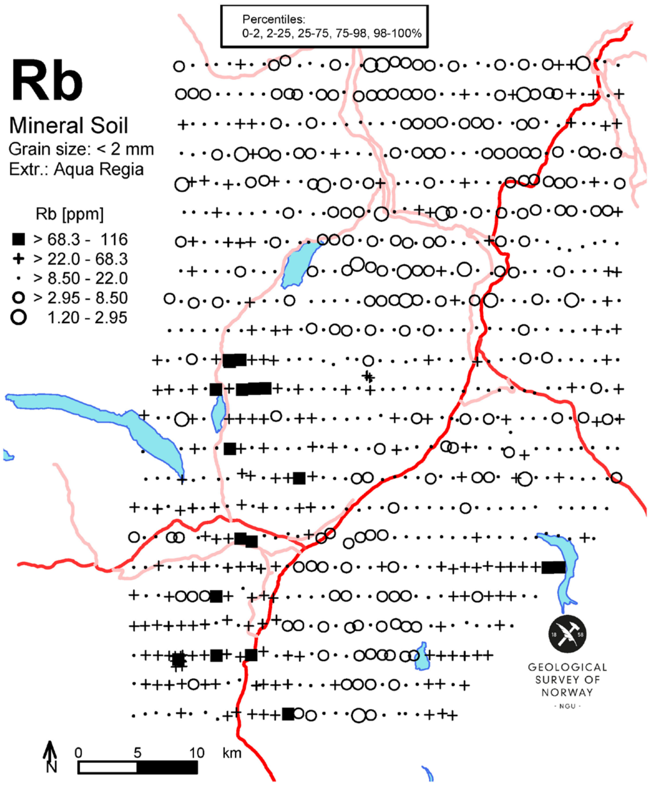
Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Nb
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Nb [ppm]
> 2.88 - 7.09
> 1.12 - 2.88
> 0.47 - 1.12
> 0.14 - 0.47
0.02 - 0.14
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY

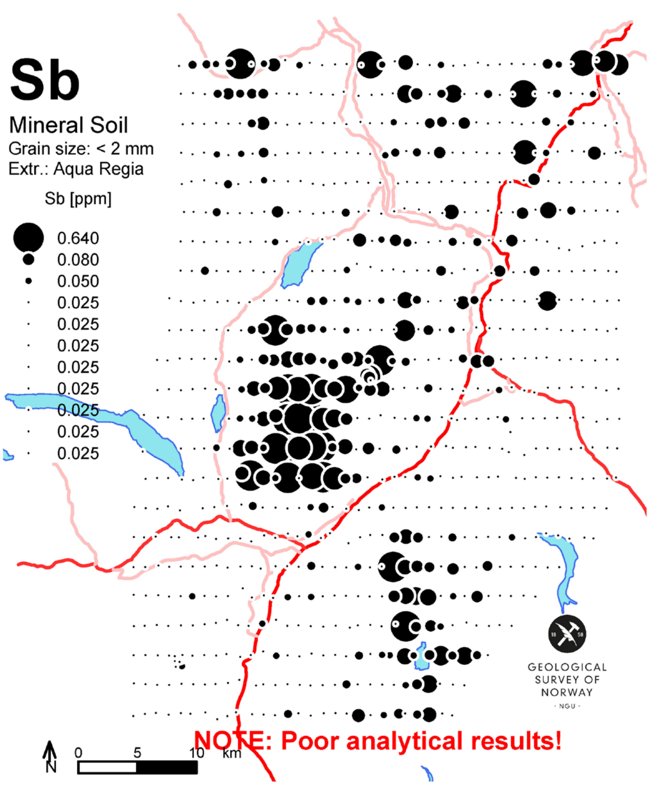


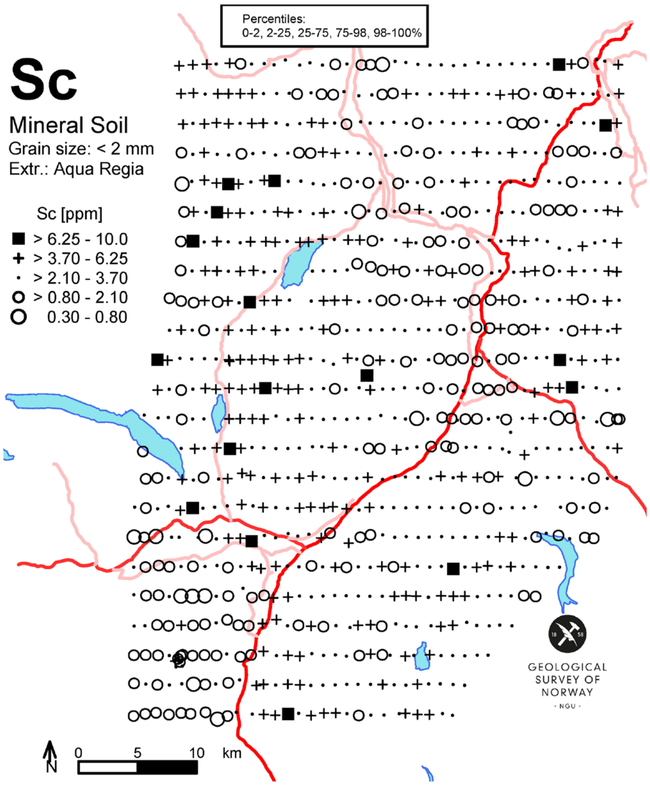
Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Ni
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Ni [ppm]
> 92.4 - 180
> 46.8 - 92.4
> 21.6 - 46.8
> 3.70 - 21.6
0.70 - 3.70
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY

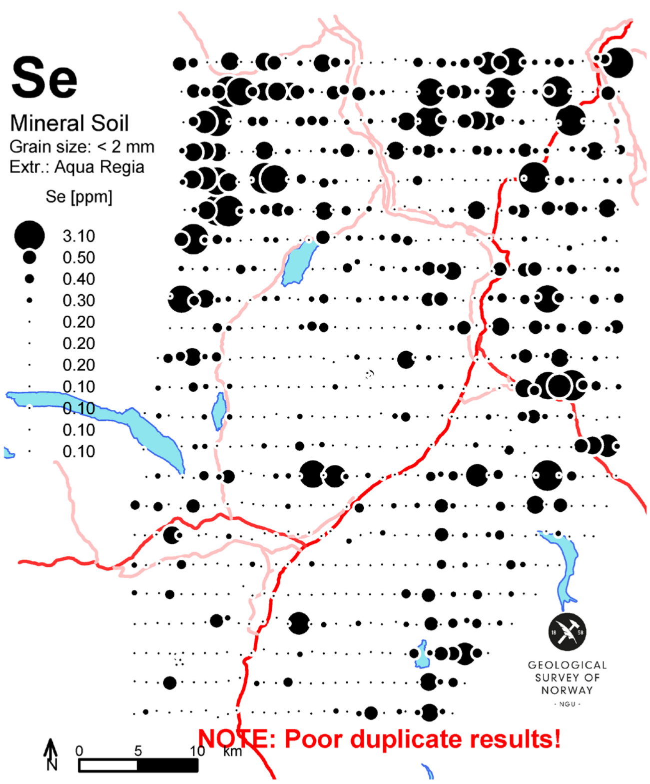

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
P
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
P [ppm]
> 1445 - 2580
> 660 - 1445
> 320 - 660
> 85.2 - 320
40.0 - 85.2
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY
- NGU -

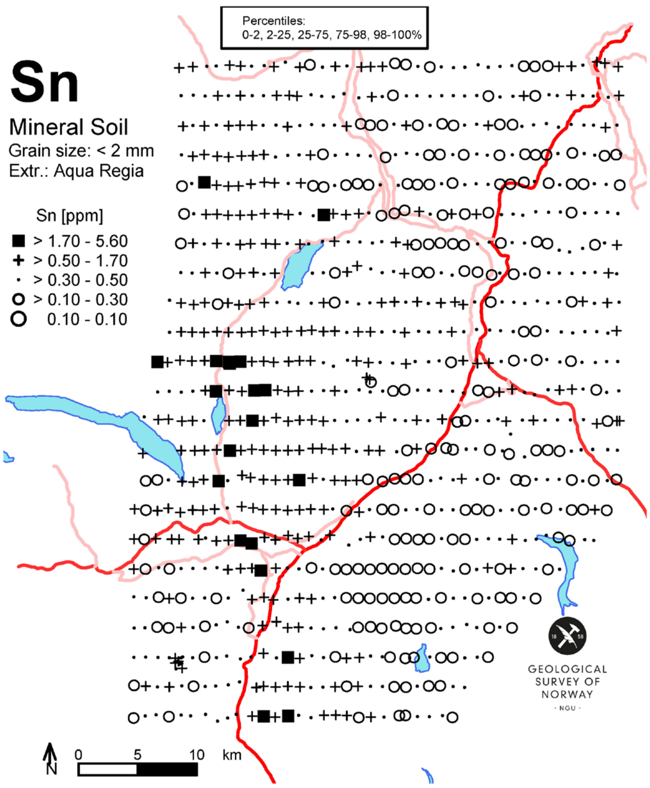

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Pb
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Pb [ppm]
> 19.1 - 54.3
> 6.40 - 19.1
> 3.60 - 6.40
> 1.75 - 3.60
0.50 - 1.75
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY
- NGU -

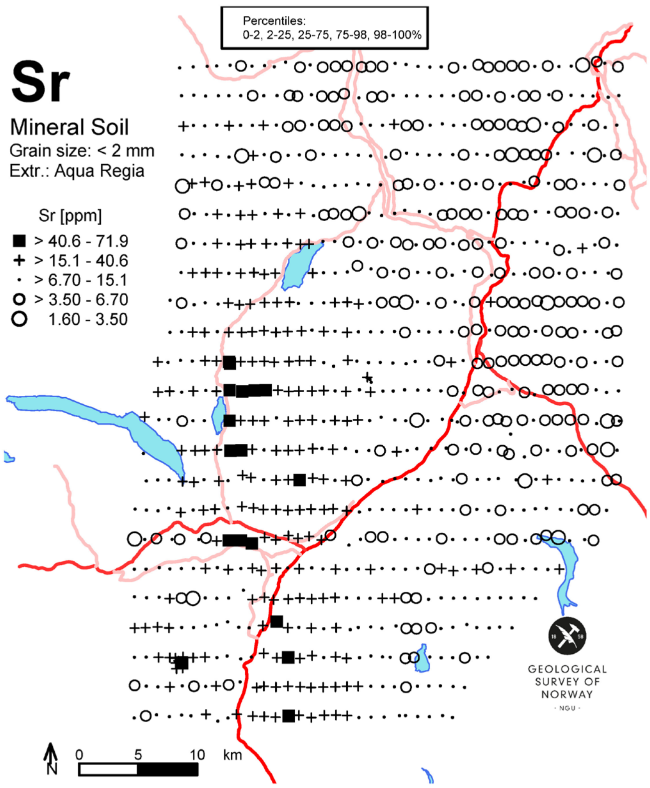

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Rb
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Rb [ppm]
> 68.3 - 116
> 22.0 - 68.3
> 8.50 - 22.0
> 2.95 - 8.50
1.20 - 2.95
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY
- NGU -

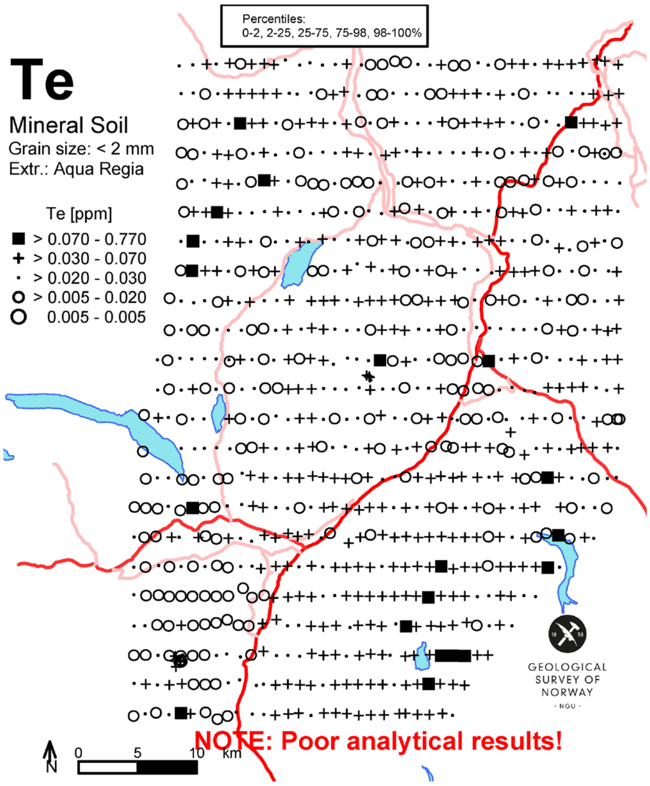

Sb
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Sb [ppm]
0.640
0.080
0.050
0.025
0.025
0.025
0.025
0.025
0.025
0.025
0.025
NOTE: Poor analytical results!
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY
- NGU -

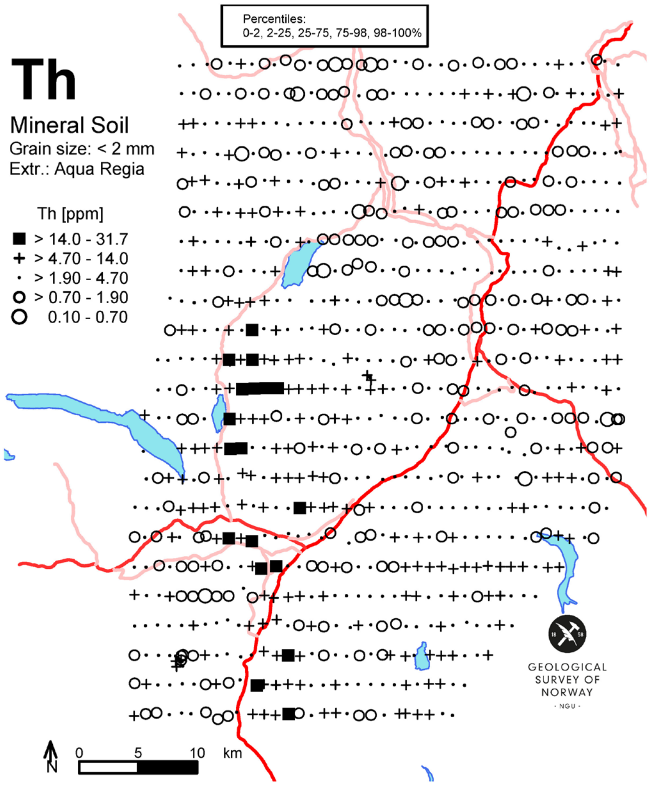

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Sc
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Sc [ppm]
> 6.25 - 10.0
> 3.70 - 6.25
> 2.10 - 3.70
> 0.80 - 2.10
0.30 - 0.80
GEOLOGICAL SURVEY OF NORWAY
0 5 10 km
N

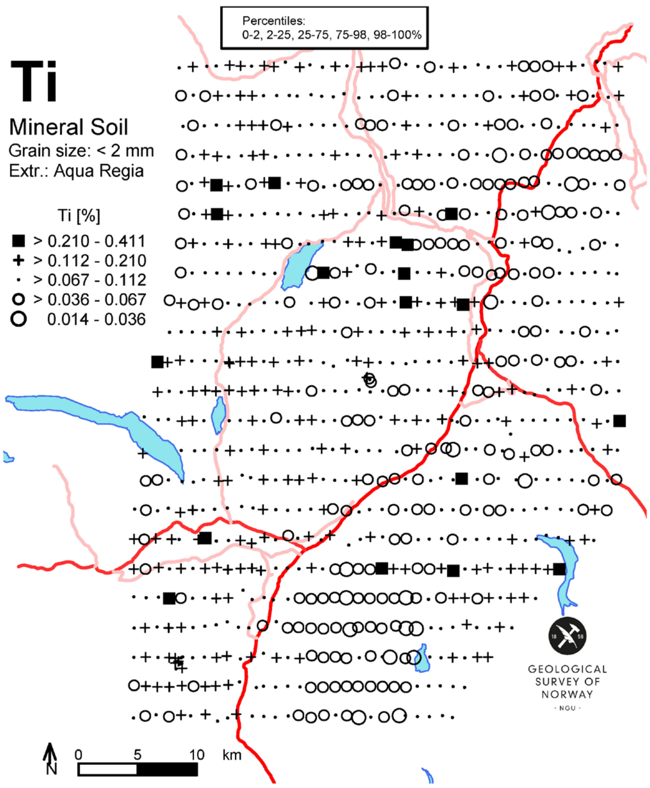

Se
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Se [ppm]
3.10
0.50
0.40
0.30
0.20
0.20
0.20
0.10
0.10
0.10
0.10
GEOLOGICAL SURVEY OF NORWAY
0 5 10 km
N
NOTE: Poor duplicate results!

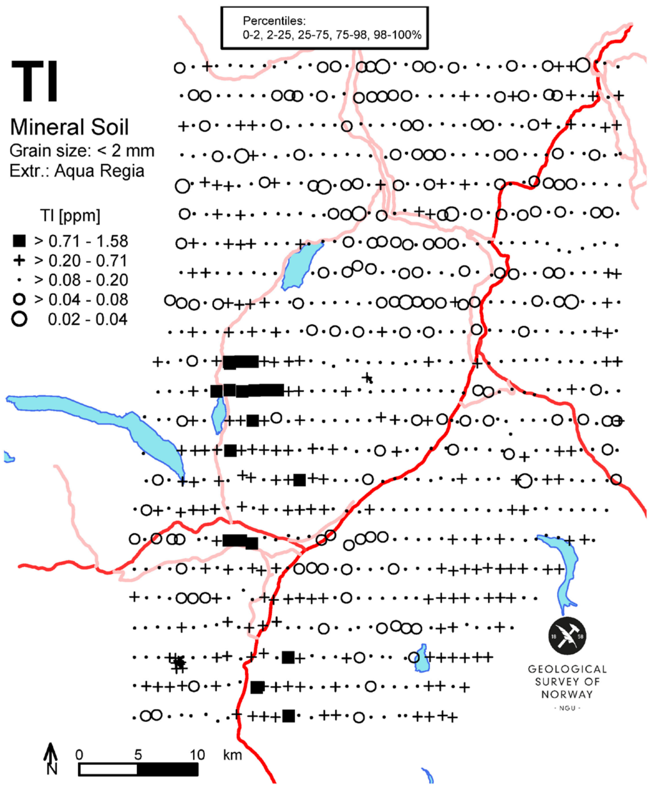

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Sn
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Sn [ppm]
> 1.70 - 5.60
> 0.50 - 1.70
> 0.30 - 0.50
> 0.10 - 0.30
0.10 - 0.10
GEOLOGICAL SURVEY OF NORWAY
0 5 10 km
N

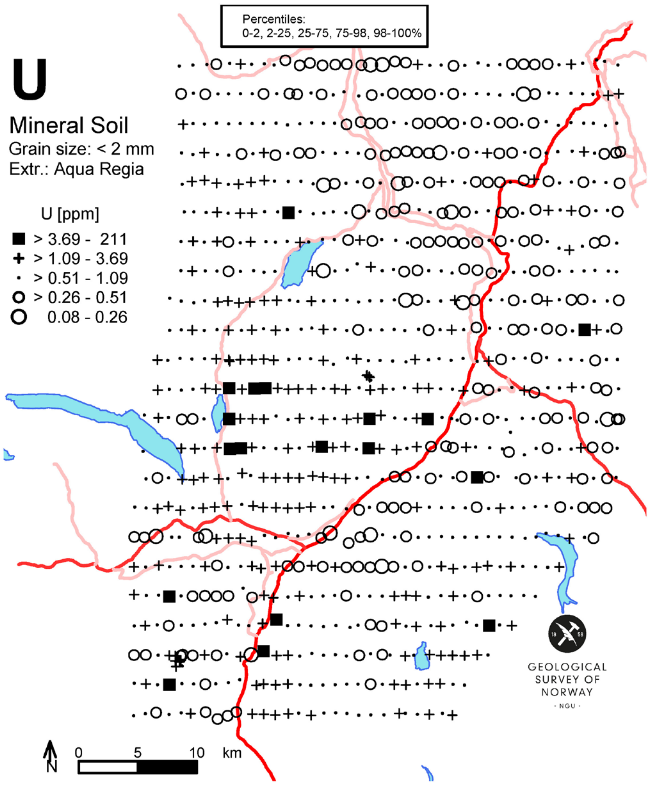

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Sr
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Sr [ppm]
> 40.6 - 71.9
> 15.1 - 40.6
> 6.70 - 15.1
> 3.50 - 6.70
1.60 - 3.50
GEOLOGICAL SURVEY OF NORWAY
0 5 10 km
N

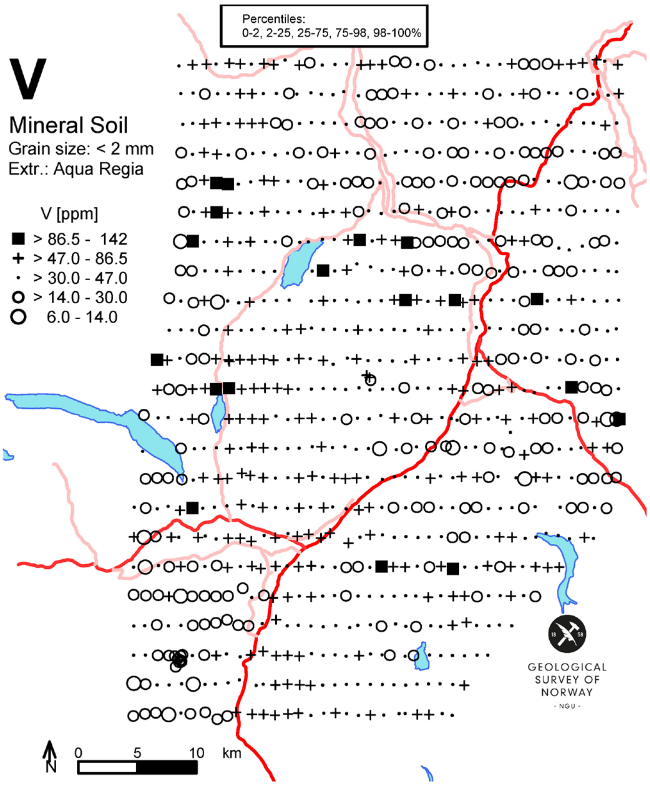

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Te
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Te [ppm]
> 0.070 - 0.770
> 0.030 - 0.070
> 0.020 - 0.030
> 0.005 - 0.020
0.005 - 0.005
NOTE: Poor analytical results!
N
0
5
10
km
GEOLOGICAL SURVEY OF NORWAY
- NGU -

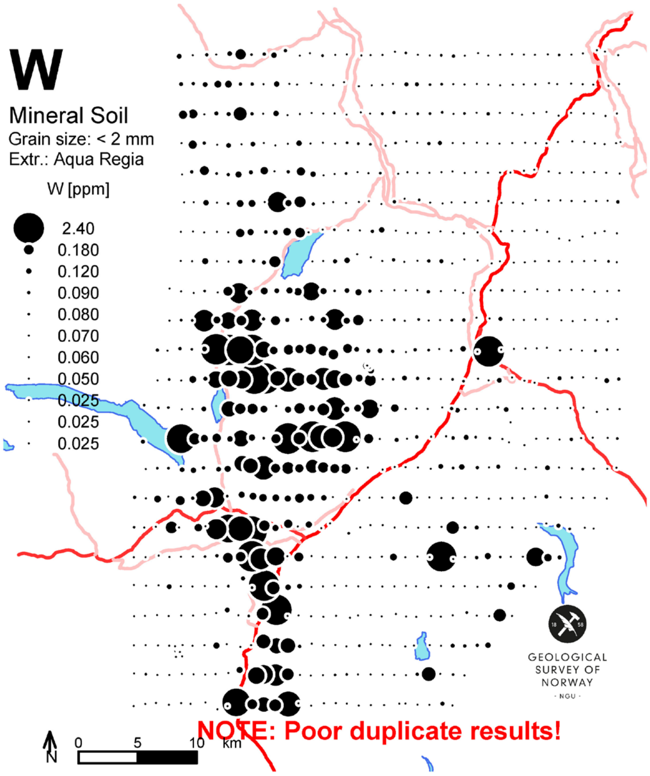

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Th
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Th [ppm]
> 14.0 - 31.7
> 4.70 - 14.0
> 1.90 - 4.70
> 0.70 - 1.90
0.10 - 0.70
N
0
5
10
km
GEOLOGICAL SURVEY OF NORWAY
- NGU -

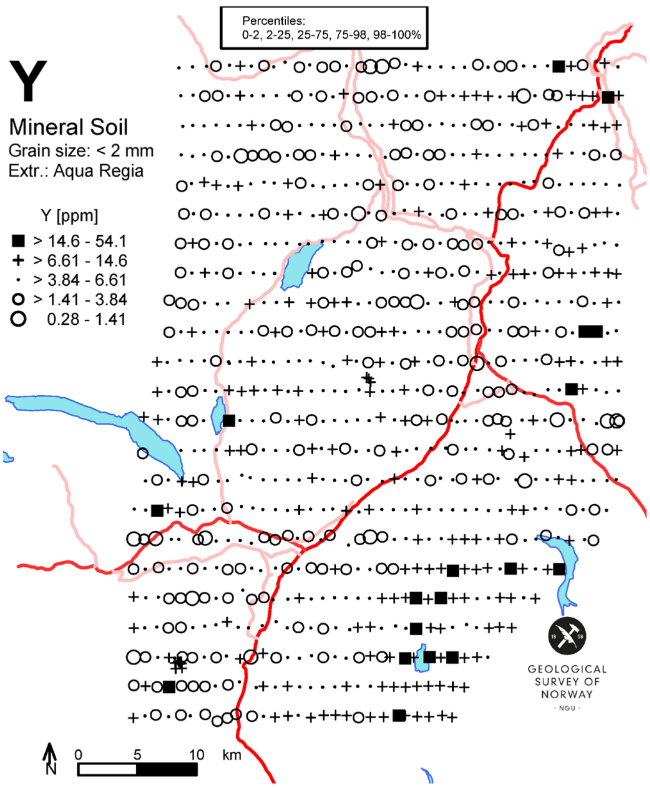

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Ti
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Ti [%]
> 0.210 - 0.411
> 0.112 - 0.210
> 0.067 - 0.112
> 0.036 - 0.067
0.014 - 0.036
N
0
5
10
km
GEOLOGICAL SURVEY OF NORWAY
- NGU -

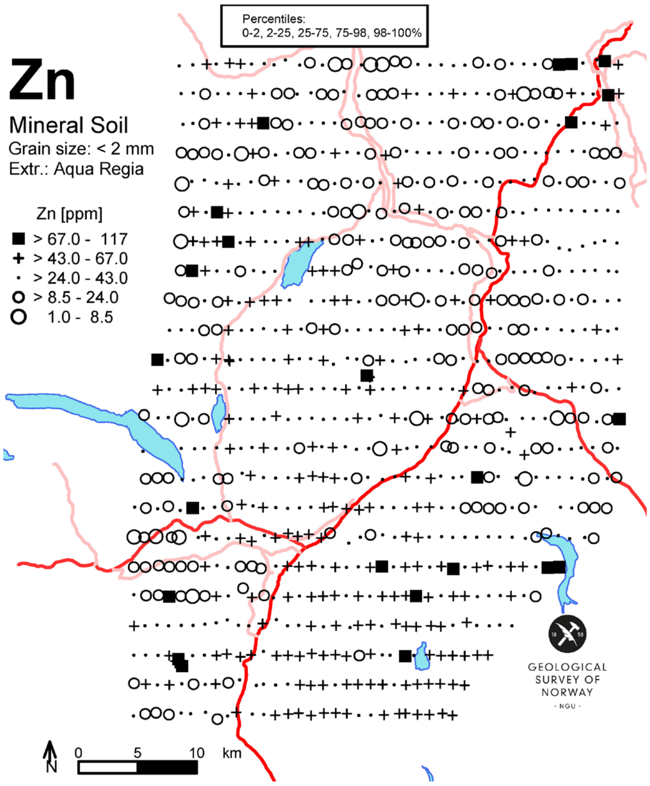

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Tl
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Tl [ppm]
> 0.71 - 1.58
> 0.20 - 0.71
> 0.08 - 0.20
> 0.04 - 0.08
0.02 - 0.04
N
0
5
10
km
GEOLOGICAL SURVEY OF NORWAY
- NGU -

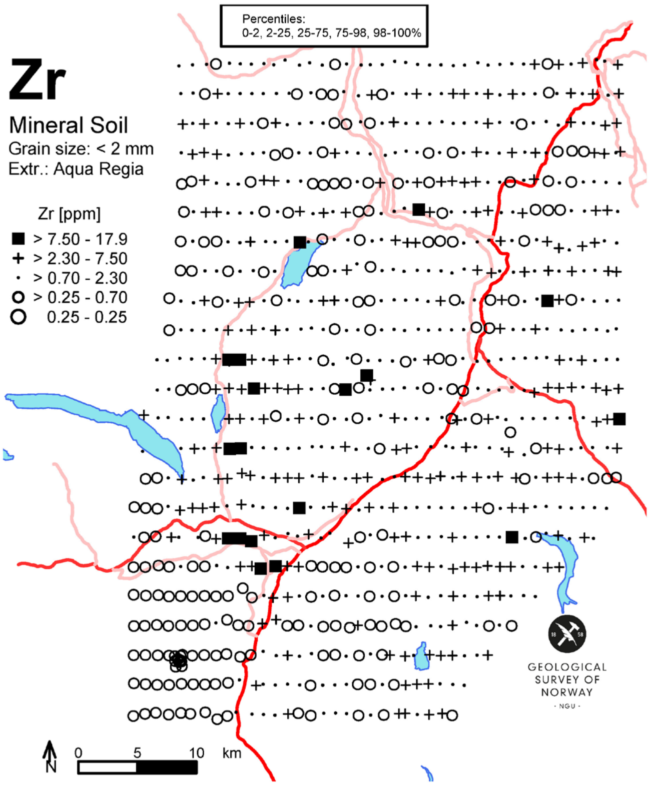

Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
U
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
U [ppm]
> 3.69 - 211
> 1.09 - 3.69
> 0.51 - 1.09
> 0.26 - 0.51
0.08 - 0.26
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY
- NGU -


Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
V
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
V [ppm]
> 86.5 - 142
> 47.0 - 86.5
> 30.0 - 47.0
> 14.0 - 30.0
6.0 - 14.0
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY
- NGU -


W
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
W [ppm]
2.40
0.180
0.120
0.090
0.080
0.070
0.060
0.050
0.025
0.025
0.025
NOTE: Poor duplicate results!
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY
- NGU -


Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Y
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Y [ppm]
> 14.6 - 54.1
> 6.61 - 14.6
> 3.84 - 6.61
> 1.41 - 3.84
0.28 - 1.41
0 5 10 km
N
GEOLOGICAL SURVEY OF NORWAY
- NGU -


Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Zn
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Zn [ppm]
> 67.0 - 117
> 43.0 - 67.0
> 24.0 - 43.0
> 8.5 - 24.0
1.0 - 8.5
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY
NGU


Percentiles:
0-2, 2-25, 25-75, 75-98, 98-100%
Zr
Mineral Soil
Grain size: < 2 mm
Extr.: Aqua Regia
Zr [ppm]
> 7.50 - 17.9
> 2.30 - 7.50
> 0.70 - 2.30
> 0.25 - 0.70
0.25 - 0.25
N
0 5 10 km
GEOLOGICAL SURVEY OF NORWAY
NGU