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RAPPORT

Rapport nr.: 2002.033	ISSN 0800-3416	Gradering: Åpen

Tittel: Drinking water quality, Rift Valley, Ethiopia	
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Fylke: Ethiopia	Kommune: Ethiopia
Kartblad (M=1:250.000)	Kartbladnr. og -navn (M=1:50.000)
Forekomstens navn og koordinater:	Sidetall: **131** Pris: NOK 250.- Kartbilag:

Feltarbeid utført: 2000	Rapportdato: 30.04.2002	Prosjektnr.: 298100	Ansvarlig:

Sammendrag:

138 samples from wells, springs, hot springs and rivers, all used as drinking water, were collected from the Ethiopian part of the Rift Valley. In addition one sample was collected from each of the 8 Ethiopian Rift Valley lakes. These lake waters are non-potable. At each site two samples were collected: one unfiltered and unacidified and one filtered and acidified. The decision to collect unfiltered samples was consciously taken to represent waters "as drunk". The unacidified samples were used for analysis of the anions Br, Cl, F, NO_2, NO_3, and SO_4 by ion chromatography (IC). Furthermore the major cations Ca, K, Mg, and Na were determined on these samples by inductively coupled plasma optical emission spectrometry (ICP-OES). The acidified samples were used for cation analysis by ICP-OES: Al, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Si, Sr, Ti, V, and Zn and inductively coupled plasma mass spectrometry (ICP-MS): Ag, Al, As, B, Ba, Be, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Hf, Hg, Ho, I, In, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, and Zr. Temperature, alkalinity, conductivity and pH were measured in the field. These determinations were later repeated in the laboratory, using the unacidified portion of the samples.

When results for all elements/parameters are considered, more than 75% of all waters tested do not fulfill European drinking water requirements. In terms of health risks associated with drinking these waters, sample RV026, showing the highest arsenic (As) and fluoride (F) concentrations of all drinking water samples, needs immediate attention. In general, the very high F-concentrations found in a substantial number of wells (58% of all wells above the recommended value of 0.7 mg/L for high temperature drinking water, 35% above the MAC of 1.5 mg/L!) present probably the major health risk. Furthermore, the many samples returning high Na-concentrations and the samples that returned high nitrate (NO_3) values need consideration in a health-related context. High bromine (Br) concentrations were found in many Rift Valley drinking waters. Considering the toxicity of Br and the fact that Br may also be an essential element for human beings, it is astonishing, that no western authority has set a MAC or GL for this element (note that there exists a MAC for bromate). The unusually high vanadium (V) concentrations in the Rift Valley waters may also warrant further investigations.

Emneord: grunnvann	Geokjemi	vannkvalitet
varme kilder	Innsjøer	helse
elvevann	Borebrønn	

INNHOLD

FIGURER

TABELLER

VEDLEGG

1. INTRODUCTION

Increasing population density, scarcity of drinking water and pollution of surface waters pose a serious problem to drinking water supplies in Ethiopia. Furthermore, drinking water is often not directly available where the people live and, traditionally, women had to walk many hours to get the daily water ration for a family. The use of groundwater from drilled deep wells, many in bedrock, has thus been sharply increasing. Development aid organisations or the world health organisation (WHO) have often sponsored drilling of such wells.

It is often assumed that natural, uncontaminated waters from deep (bedrock) wells are just clean and healthy (Banks et al., 1998b). This is usually true with regards to their bacteriological composition but high concentrations of many chemical elements can occur in such waters due to regional geology or water/rock interactions. The inorganic chemical quality of these waters is, however, rarely sufficiently tested before such wells are put into production. Many studies during the last 5-10 years have shown, that such wells can deliver water that does not meet established drinking water norms (e.g. Varsanyi et al., 1991; Bjorvatn et al., 1992, 1994; Edmunds and Trafford, 1993; Banks et al., 1995 a,b, 1998a; Sæther et al., 1995; Reimann et al., 1996; Edmunds and Smedley, 1996; Smedley et al., 1996; Williams et al., 1996; Morland et al., 1997, 1998; Midtgård et al., 1998; Frengstad et al., 2000, Smedley and Kinniburgh, 2002) without any need for anthropogenic contamination. These studies also documented that quite a number of elements for which no norms have been established can occur at unpleasantly high levels in natural well waters (e.g. Be, Th, Tl, U). While in Norway F and Rn are the most problematic elements (see Frengstad et al., 2000) in terms of possible health effects, one of the most drastic examples of undesired natural chemical "contamination" of "clean" groundwater has been reported from Bangladesh and India. Here several hundred-thousands of people suffer of skin cancer due to too high As concentrations in drinking water from tube wells (e.g. Chatterjee et al., 1995; Das et al., 1995).

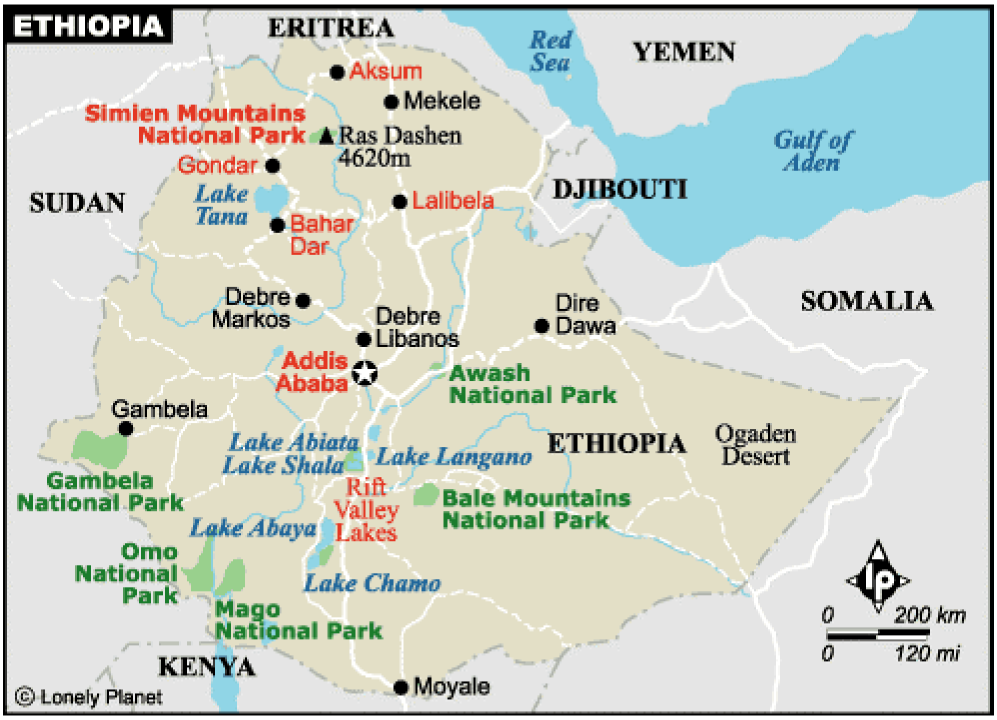
Water-related health problems can occur due to element deficiencies as well as by excess. This problem is not covered by present days water regulations. Such deficiencies most often occur in developing countries in rural communities, where mostly local water and food is consumed. The elements I, Se and F have well documented deficiency-related health problems (Se: Låg, 1984; I: Kelly and Sneddon, 1960; F: Rajagopal and Tobin, 1991). After many years of use of drinking water from drilled wells in the Rift Valley, Ethiopia, dental as well as skeletal fluorosis has become a serious medical problem in some villages. Fluorosis due to a too high intake of fluoride from drinking waters has previously been reported from several parts of the world, e.g. Algeria and Kenya (Tjook, 1983), China (Zhaoli et al., 1989), India (Teotia et al., 1981), Sri Lanka (Dissanayake, 1991) and even Norway (Bjorvatn et al., 1992). High values of F in well water from the Rift Valley have been reported as early as 1953 (Ockerse, 1953 – Kenya). At present, a program to test drinking water wells from all over Ethiopia for their fluoride concentrations is under way. As part of this program, additional water samples for multi-element analysis were collected in the Rift Valley. This paper reports concentrations of more than 70 inorganic chemical parameters in 138 drinking water samples from various sources (deep wells, shallow wells, springs, hot springs, and rivers) plus 9 non-potable waters (8 lakes, 1 river) from the Rift Valley, Ethiopia.

2. BRIEF DESCRIPTION OF THE STUDY AREA

2.1 Location

Ethiopia is located in the eastern part of Africa neighbouring Eritrea, Kenya, Somalia, Djibouti and the Sudan (Fig. 1). This area is usually called the Horn of Africa. Ethiopia's Capital city is Addis Ababa with a population of more than 3 millions. Ethiopia covers an area of c. 1,100,000 km^2. It has one of the largest populations in Africa (c. 60,000,000 in 2000). It can be divided into three major relief regions: the Western Highlands, the Eastern Highlands and the Rift Valley and Western Lowlands. The Ethiopian part of the Rift Valley covers an area of 310,981 km^2.

Fig. 1: Location of Ethiopia in Eastern Africa. The Rift Valley runs in a southwesterly direction through all of Ethiopia (the chain of lakes from Lake Chamo to Lake Langano marks the Rift Valley). Map source: Lonely Planet Travel Guide Internet site for Ethiopia.



The cliffs that border the Rift Valley, known as escarpments, rise an average 600 to 900 meters above the valley floor. In some places, however, such as in the Mau Escarpment in Kenya, these walls rise as much as 2,700 meters above the valley floor and provide some of the valley's most spectacular scenery. Many of Africa's highest mountains - including Mount Kilimanjaro, Mount Kenya, and Mount Margherita - are in ranges fronting the Rift Valley. Some faulting activity has occurred within the last 10,000 years. Volcanic eruptions that accompanied the early phases of the rift's formation are nearly unknown today, though some volcanic and seismic activity do still occur. The Rift has no outlet to the sea. Its lakes tend to be shallow and have a high mineral content as the evaporation of water leaves the salts behind.

In Ethiopia the Rift Valley runs in a southwesterly direction through all of the country. Active volcanoes are located on the Danakil Plane to the north. To the north the valley widens into the Awash river basin. The Awash River begins in the East African Rift Valley and flows into the Afar Triangle, but the waters of the Awash never reach the Red Sea. Instead, they spread out and evaporate in the Danakil Depression. Eight lakes mark the central part of the Ethiopian Rift Valley: Lake Quoqua, Lake Ziway, Lake Abijata, Lake Shala, Lake Langano, Lake Awassa, Lake Abaya and Lake Chamo (some are shown in Fig. 1).

2.2 Climate

Elevation and geographic location produce three climatic zones: a cool zone occurs above 2,400 meters where temperatures range from near freezing to 16° C. A temperate zone occurs at elevations of 1,500 to 2,400 meters with temperatures from 16° C to 30° C. A hot zone follows below 1,500 meters with both tropical and arid conditions and daytime temperatures ranging from 27° C to 50° C. There is a rainy season from mid-June to mid-September (longer in the southern highlands) preceded by intermittent showers from February or March. The remainder of the year is generally dry. The mean annual rainfall in the Rift Valley is 725 mm.

2.3 Geology

The Rift Valley is the longest rift on the Earth's surface. It starts in Jordan near Syria in the Mideast and terminates near Beira, on the coast of Mozambique, about 6,400 kilometers later. It has an average width of 50 - 80 km. It is a long, deep depression with steep, wall-like cliffs, two sets of highland regions separated by a valley. Some experts refer to it as a huge scar that crosses from north to south through the eastern half of Africa and the Middle East. Along its enormous depression, the earth is patched with extinct or inactive volcanoes (Fig. 2 shows the location of some of these) alternating with tectonic lakes. At least three tectonic plates all converge on each other and are thought to be actually drawing away from each other (Fig. 2). The activity of the Rift Valley started about 50 million years. The Rift Valley owes its existence to a deep-seated, linear, strike-slip (or transcurrent) fault marking the boundary between the Arabian and African Plates. The major geologic activity responsible for the Rift probably dates from the Pliocene Epoch, some 2 million to 7 million years ago.

The East African Rift Valley is an example of an active divergent rift valley, one of the few areas on Earth where a continent is being actively separated (rifted) by the ongoing forces of plate tectonics. The actual profile of the valley is a nearly exact match to the profile of the central axis of mid-ocean ridges. The East African Rift Valley connects to the seafloor of the Red Sea. The central depths of the Red Sea are also the site of active tectonic movement, as the African Plate slowly separates from the Arabian Plate (Fig. 2). At the bottom of the Red Sea, Earth's inner heat creates hot pools of brine (extremely salty water) that give rise to exotic copper, zinc, manganese, and iron minerals.

The Great Rift is a continental extension of the mid-oceanic ridge system, a generally submerged mountain range encircling the globe. The valley is least eroded and therefore most conspicuous in eastern Africa where it is also known as the East African Rift Valley. The floor of the valley is at many locations below sea level. The topography is varied and includes lakes, volcanoes, deserts, and plains. The main section of the valley in Africa continues from the Red Sea SW across Ethiopia and S across Kenya, Tanzania, and Malawi to the lower Zambezi River valley in Mozambique. Many small lakes in Ethiopia and several long narrow lakes, notably lakes Turkana and Nyasa, lie on its course. Just N of Lake Nyasa there is a western branch, which runs north, chiefly along the eastern border of Congo (Kinshasa). This branch is marked by a chain of lakes, including lakes Tanganyika, Kivu, Edward, and Albert (Mobutu). Lake Victoria does not lie in the Rift Valley but between its main and western branches. The elevation ranges from c. 395 m below sea level (the Dead Sea) to c. 1,830 m above sea level in S Kenya.

Fig. 2: Map of East Africa showing some of the historically active volcanoes (red triangles) and the Afar Triangle (shaded, center) -- a so-called triple junction (or triple point), where three plates are pulling away from one another: the Arabian Plate, and the two parts of the African Plate (the Nubian and the Somalian) splitting along the East African Rift Zone (Source: USGS).

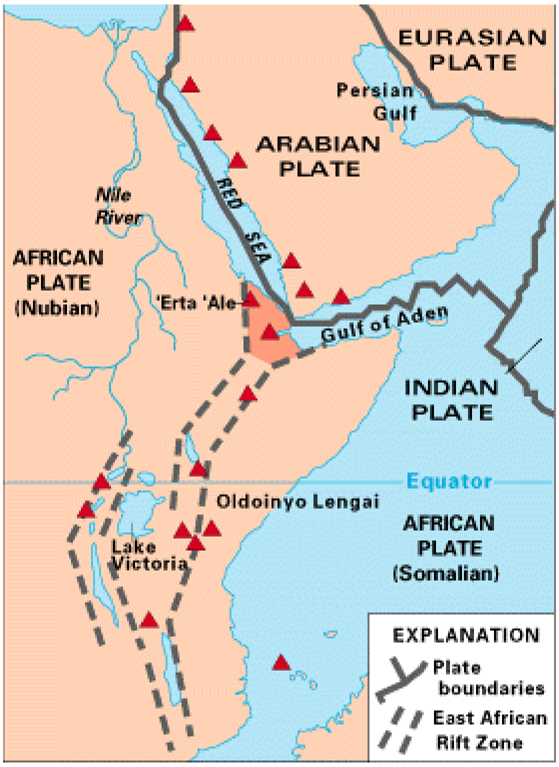
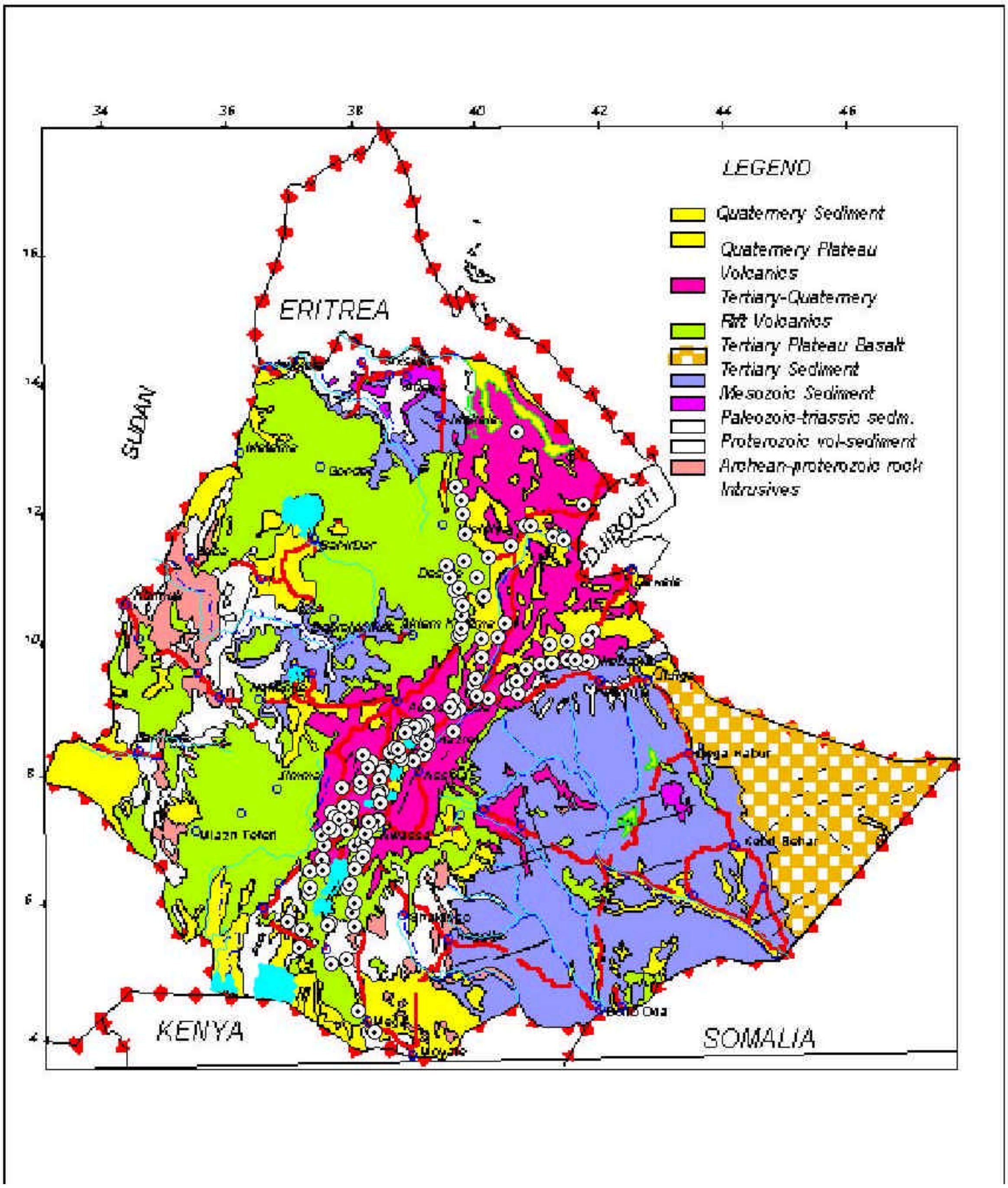


Figure 3 shows a simplified geological map of Ethiopia. The area of the Rift Valley is clearly visible in this map. Three main subdivisions can be made. The northern part of the Rift Valley is reaching from the border to Eritrea/Djibouti/Somalia to about Awash. Tertiary to Quaternary rift volcanics (Fig. 3) and young Quaternary sediments which can be alluvial, elluvial, colluvial or lacustrine deposits underlie this part. Many samples collected in this area are from wells in the Tertiary plateau basalts (Fig. 3).

The central part of the Ethiopian Rift Valley, reaching from about Awash to Lake Chamo (see Fig. 1), is mostly underlain by Tertiary to Quaternary rift volcanics: ignimbrites and pumices of the rift floor and basaltic lava flows. Near the lakes important lacustrine deposits of the rift floor occur.

Tertiary plateau basalts dominate the southernmost part of the Ethiopian Rift Valley (from Lake Chamo to the border of Kenia). Rhyolithes, trachybasalts and fissural basalts are important rock types. Locally some basement rocks, mainly high grade metamorphic gneisses, may occur.

Figure 3: Simplified geological map of Ethiopia. In addition to the geology the location of the sampled wells is also shown. Map source: Geological Survey of Ethiopia, unpublished map.

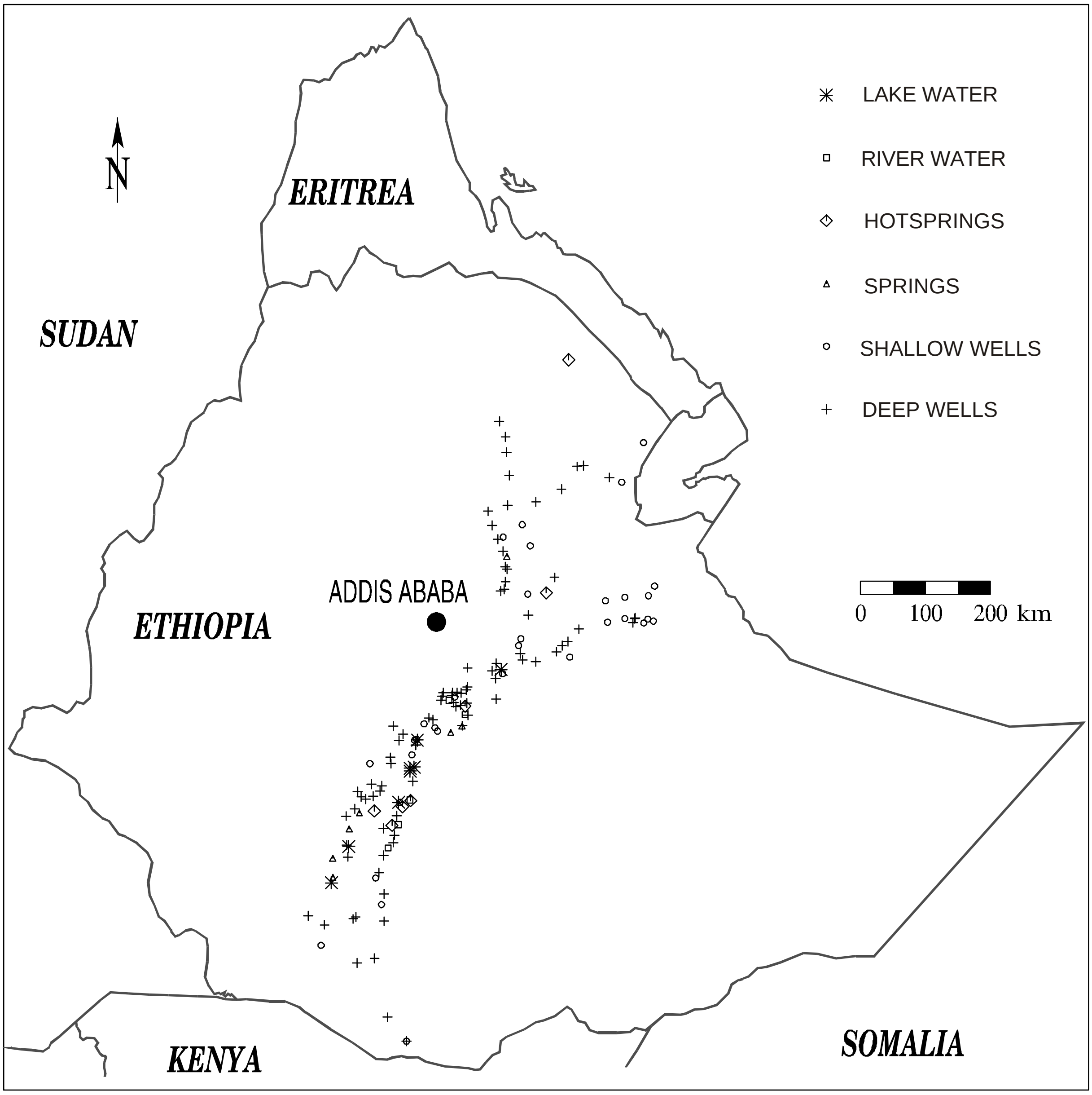


3. SAMPLING

Most samples reported here were taken from drinking water wells in small villages and settlements scattered throughout the Ethiopian part of the Rift Valley. A photo documentation of all sample sites can be found on the accompanying CD-ROM. The wells were subdivided into "deep wells" (N=88, depth >60 m or reportedly drilled in bedrock) and "shallow wells" (N=32, depth <60 m or reportedly drilled or dug in sediments). The majority of deep wells will thus draw water from bedrock aquifers, while the majority of shallow wells will draw water from sedimentary aquifers. At present, no better subdivision of these wells is possible.

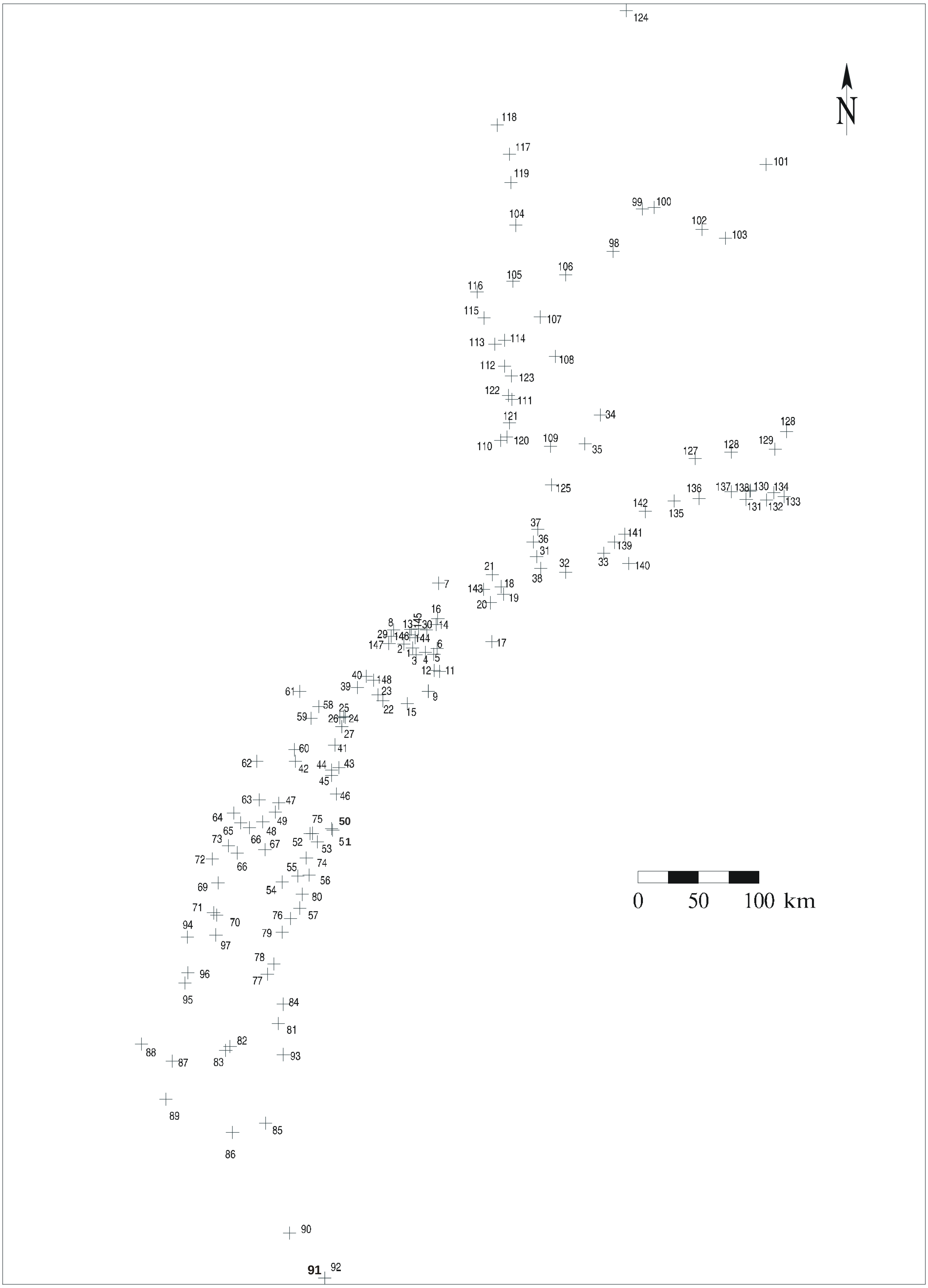
Some few additional samples were collected from springs (T<32°C, N=7), hot springs (T>36°C, N=7), and rivers (N=5), which, with the exception of one river water sample, are all used for drinking water purposes. In order to give a more complete picture of surface water quality in the Rift Valley, samples from 8 alkaline lakes (non-potable) were also taken. Thus in total 147 samples (+14 duplicates and 14 further quality control samples) were analysed. Figure 4 shows the location of the different sample types within the rift valley. Figure 5 gives the sample number for each site.

Fig. 4: Location of the sampling sites in Ethiopia. The different sample types are represented by different symbols.



A training program for water sampling was carried out directly in the Rift Valley prior to regional sampling. Just one team of two samplers collected all samples during the year 2000. All necessary equipment was shipped from Norway or Germany to Ethiopia. It was decided to follow as closely as possible the previously established standards in Norway (Reimann et al., 1996, Frengstad et al., 2000). Factory new, unwashed 100 mL high-density-polyethylene (HDPE)-plastic bottles were used for sampling.

Figure 5: Sample locations (compare with Fig. 4 for location in Ethiopia, Fig. 9 gives geochemical distribution maps for all elements/parameters) and sample number for each locality visited.



In the field the bottles were three times rinsed with running water and then filled to the top. Sampling took place directly at the tap or the well head. In order to collect fresh well water, the water was left running for at least 5 minutes or until temperature and conductivity did not change any longer. In many cases each of these wells supply more than 100 people with their daily drinking water and the water will never accumulate over longer times in the well. In contrast to Norway, water temperature does not decrease over time but rather increases by 1 to 2 degrees.

Because this study is supposed to reflect water quality "as drunk" the samples were not filtered. Reimann et al. (1999b) studied the influence of filtration on the chemistry of water samples from bedrock wells. They demonstrated that even unfiltered water samples will satisfactorily reflect general water chemistry as long as drinking water (i.e. by definition rather clean water, with low particulates) is collected (Reimann et al., 1999b). This may not be true for river and lake water and the results reported for these waters here (in total 13 samples) must be used with care (see also discussion below and Figure 10).

Two 100 mL flasks were filled at each site. The first sample was left unfiltered and unacidified for anion analysis. The unfiltered water of the second sample was acidified with 2 mL of concentrated nitric acid (Merck ultrapure) and used for cation analysis. The acid was tested for its trace element content using the same analytical procedure as for the water samples. In the field the samples were stored in a cool box and in the evening transferred to a refrigerator, where they were stored until shipment to the laboratory in Germany.

Several parameters like pH, electrical conductivity and temperature were measured directly in the field. Alkalinity was determined at the sample site, using a Hach titrator. To document the sampling conditions, the sampling site and the general landscape around the wells, a set of 3 photos (minimum) was taken at each sample site (see accompanying CD-ROM). If available, the well depth and the number of people receiving their drinking water from this well were recorded. Possible contamination sources in a radius of about 100 m around the well were noted.

4. ANALYSES

All samples were shipped by courier to BGR (Bundesanstalt für Geowissenschaften und Rohstoffe) Hannover for analysis after completion of the field sampling campaign. In the laboratory, pH, electrical conductivity and alkalinity were determined once more on the unacidified samples. In addition these samples were used for anion analysis (Br, Cl, F, NO_2, NO_3, and SO_4) by ion chromatography (IC). Furthermore the major elements Ca, K, Mg, and Na were determined on these samples by inductively coupled plasma optical emission spectrometry (ICP-OES) (note that only the values from the acidified samples were used later on).

The acidified samples were used for cation analysis by ICP-OES (Al, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Si, Sr,Ti, V, and Zn) and inductively coupled plasma mass spectrometry (ICP-MS) (Ag, Al, As, B, Ba, Be, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Hf, Hg, Ho, I, In, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, and Zr). Table 1 summarises the complete analytical program and gives details on the detection limits reached and the isotope (ICP-MS) or wavelength (ICP-OES) used for the measurement.

Table 1: Analytical program, water samples Rift Valley, Ethiopia (all analyses except field measurements: BGR). ICP-MS: inductively coupled plasma-mass spectrometry; ICP-OES: inductively coupled plasma - optical emission spectrometry; ICP-OES(na): as above but on non-acidified sample; IC: ion chromatography. **BOLD PRINT:** values from this method used in all further tables.

Detection limit: value in brackets indicates practical detection limit according to results of quality control. T1, T2: Temperature at arrival at sampling site (1) and at time of sampling (2). EC1, EC2: electrical conductivity 1,2 as above, EC_L: electrical conductivity as measured in laboratory. ALK_F: alkalinity, titrated at sample site, ALK_L: alkalinity determined in laboratory. ISOTOPE(S) (ICP-MS): 109 (107): isotope 109 preferred for measurement, 107 used if 109 disturbed, 111 + 114: sum of isotopes used to increase the number of counts; 47, 49: both isotopes are measured for control purposes but just the first is used; WAVELENGTH (ICP-OES): in nanometer, nm; 317.933 (315,887): second wavelength used for high concentrations.

	PARAMETER	METHOD	DETECTION LIMIT	UNIT	ISOTOPE(S)/WAVE-LENGTH measured
1	**Ag**	**ICP-MS**	**0.002**	**mg/L**	109 (107)
2	Al	ICP-OES	30	µg/L	308.215
	Al	**ICP-MS**	**1**	**mg/L**	27
3	**As**	**ICP-MS**	**0.01**	**mg/L**	75
4	B	ICP-OES	5	µg/L	249.678
	B	**ICP-MS**	**0.1**	**mg/L**	11
5	Ba	ICP-OES	1	µg/L	313
	Ba	**ICP-MS**	**0.008**	**mg/L**	137
6	Be	ICP-OES	0.5	µg/L	313.042
	Be	**ICP-MS**	**0.005**	**mg/L**	9
7	**Bi**	**ICP-MS**	**0.002**	**mg/L**	209
8	Br	IC	10	µg/L	
	Br	**ICP-MS**	**1**	**mg/L**	79
9	**Ca**	**ICP-OES**	**20**	**mg/L**	317.933 (315.887)
	Ca	ICP-OES(na)	20	µg/L	317.933 (315.887)
	Ca	ICP-MS	10	µg/L	43
10	Cd	ICP-OES	5 (10)	µg/L	228.802
	Cd	**ICP-MS**	**0.002**	**mg/L**	111 + 114
11	**Ce**	**ICP-MS**	**0.002**	**mg/L**	140
12	**Cl**	**IC**	**50**	**mg/L**	
13	Co	ICP-OES	5 (10)	µg/L	228.616
	Co	**ICP-MS**	**0.002**	**mg/L**	59
14	Cr	ICP-OES	5 (10)	µg/L	267.716
	Cr	**ICP-MS**	**0.01**	**mg/L**	52 (53)
15	**Cs**	**ICP-MS**	**0.002**	**mg/L**	133
16	Cu	ICP-OES	5 (10)	µg/L	324.754
	Cu	**ICP-MS**	**0.02**	**mg/L**	63 (65)
17	**Dy**	**ICP-MS**	**0.002**	**mg/L**	163
18	**Er**	**ICP-MS**	**0.002**	**mg/L**	166
19	**Eu**	**ICP-MS**	**0.002**	**mg/L**	151
20	**F**	**IC**	**3**	**mg/L**	
21	**Fe**	**ICP-OES**	**3**	**mg/L**	259.940
	Fe	ICP-MS	1	µg/L	54, 56, 57
22	**Ga**	**ICP-MS**	**0.002**	**mg/L**	71
23	**Gd**	**ICP-MS**	**0.002**	**mg/L**	158, 160
24	**Ge**	**ICP-MS**	**0.002**	**mg/L**	74
25	**Hf**	**ICP-MS**	**0.002**	**mg/L**	178
26	**Hg**	**ICP-MS**	**0.01**	**mg/L**	202
27	**Ho**	**ICP-MS**	**0.002**	**mg/L**	165

	PARAMETER	METHOD	DETECTION LIMIT	UNIT	ISOTOPE(S)/WAVE-LENGTH measured
28	**I**	**ICP-MS**	**0.1**	m**g/L**	127
29	**In**	**ICP-MS**	**0.002**	m**g/L**	115
30	**K**	**ICP-OES**	**100**	m**g/L**	766.491
	K	ICP-OES(na)	100	µg/L	766.491
	K	ICP-MS	10	µg/L	39
31	**La**	**ICP-MS**	**0.002**	m**g/L**	139
32	Li	ICP-OES	3 (10)	µg/L	670.784
	Li	**ICP-MS**	**0.002**	m**g/L**	7
33	**Lu**	**ICP-MS**	**0.002**	m**g/L**	175
34	**Mg**	**ICP-OES**	**20**	m**g/L**	285.213 (279.079)
	Mg	ICP-OES(na)	20	µg/L	285.213 (279.079)
	Mg	ICP-MS	10	µg/L	25
35	Mn	ICP-OES	1	µg/L	257.61
	Mn	**ICP-MS**	**0.1**	m**g/L**	55
36	**Mo**	**ICP-MS**	**0.002**	m**g/L**	95
37	**Na**	**ICP-OES**	**100**	m**g/L**	589.592
	Na	ICP-OES(na)	100	µg/L	589.592
	Na	ICP-MS	10	µg/L	23
38	**Nb**	**ICP-MS**	**0.002**	m**g/L**	93
39	**Nd**	**ICP-MS**	**0.002**	m**g/L**	146
40	Ni	ICP-OES	10	µg/L	231.604
	Ni	**ICP-MS**	**0.012**	m**g/L**	60
41	**NO2**	**IC**	**5**	m**g/L**	
42	**NO3**	**IC**	**50**	m**g/L**	
43	**Pb**	**ICP-MS**	**0.002**	m**g/L**	206 + 207 + 208
44	**Pr**	**ICP-MS**	**0.002**	m**g/L**	141
45	**Rb**	**ICP-MS**	**0.007**	m**g/L**	85
46	**Sb**	**ICP-MS**	**0.002**	m**g/L**	121
47	(Sc)	ICP-MS	0.01	µg/L	45
48	**Se**	**ICP-MS**	**0.01**	m**g/L**	77, 78, 82
49	**Si**	**ICP-OES**	**50**	m**g/L**	251.611
50	**Sm**	**ICP-MS**	**0.002**	m**g/L**	147
51	**Sn**	**ICP-MS**	**0.002**	m**g/L**	118
52	**SO4**	**IC**	**50**	m**g/L**	
53	Sr	ICP-OES	1	µg/L	407.771
	Sr	**ICP-MS**	**1**	m**g/L**	88
54	**Ta**	**ICP-MS**	**0.002**	m**g/L**	181
55	**Tb**	**ICP-MS**	**0.002**	m**g/L**	159
56	**Te**	**ICP-MS**	**0.005**	m**g/L**	126
57	**Th**	**ICP-MS**	**0.002**	m**g/L**	232
58	Ti	ICP-OES	1 (25)	µg/L	334.941
	Ti	**ICP-MS**	**0.01**	m**g/L**	47, 49
59	**Tl**	**ICP-MS**	**0.002**	m**g/L**	205
60	**Tm**	**ICP-MS**	**0.002**	m**g/L**	169
61	**U**	**ICP-MS**	**0.001**	m**g/L**	238
62	V	ICP-OES	5	µg/L	311.071
	V	**ICP-MS**	**0.01**	m**g/L**	51
63	**W**	**ICP-MS**	**0.002**	m**g/L**	182
64	**Y**	**ICP-MS**	**0.002**	m**g/L**	89
65	**Yb**	**ICP-MS**	**0.002**	m**g/L**	172

	PARAMETER	METHOD	DETECTION LIMIT	UNIT	ISOTOPE(S)/WAVE-LENGTH measured
66	Zn	ICP-OES	5	µg/L	213.856
	Zn	**ICP-MS**	**0.05**	**mg/L**	66, 68
67	**Zr**	**ICP-MS**	**0.002**	**mg/L**	90
68	T1	Thermometer	0.1	^{o}C	
	T2	**Thermometer**	**0.1**	**^{o}C**	
69	**pH_F**	**pH-meter**	**0.1**	**pH**	
70	EC1	Conductivity-meter	1	µS/cm	
	EC2	Conductivity-meter	1	µS/cm	
	EC_L	**Conductivity-meter**	**1**	**mS/cm**	
71	Alk_F	Titrator	1	mg/L	
	Alk_L	**Titrator**	**1**	**mg/L**	
	Total Hardness	**calculated**		**^{o}dH**	
	Carbonate-hardness	**calculated**		**^{o}dH**	
	Sum diss.solids	**calculated**		**mg/L**	
	Diff.ion balance	**calculated**		**+/- %**	

5. QUALITY CONTROL

For quality control purposes duplicate samples were taken in the field at the rate of 1 in 10. These were treated as completely separate samples, receiving their own sample number. The duplicates were thus not recognisable for the laboratory. Several blind samples were included to check for possible contamination sources. At the laboratory in Hannover, additional duplicates were prepared and analysed. The three international water standards NIST-1640, NIST-1643d and NIST-SLRS-4 as well as several in-house standards were analysed on a routine base over several months.

Table 2: Comparison of analytical results of three international water standards frequently (N=) analysed over a period of several months with the certified values. "SDEV" = standard deviation.

		NIST-1640				NIST-1643d				NIST-SLRS-4			
		N=58, 15 months		certified		N=70, 15 months		certified		N=35, 4 months		certified	
	UNIT	MEAN	SDEV	value	SDEV	MEAN	SDEV	value	SDEV	MEAN	SDEV	value	SDEV
Ag	µg/L	7.70	0.555	7.62	± 0.25	1.23	0.109	1.27	± 0.057	0.0022	0.0013		
Al	µg/L	54.0	8.46	52	± 1.5	128	11.4	127.6	± 3.5	55.5	6.52	54	± 4
As	µg/L	27.6	1.17	26.67	± 0.41	55.7	2.14	56.02	± 0.73	0.798	0.0673	0.68	± 0.06
B	µg/L	305	19.5	301.1	± 6.1	148	8.35	144.8	± 5.2	5.40	0.727		
Ba	µg/L	148	4.71	148	± 2.2	508	16.3	506.5	± 8.9	13.3	0.557	12.2	± 0.6
Be	µg/L	37.1	2.72	34.94	± 0.41	12.8	0.876	12.53	± 0.28	0.0151	0.0118	0.007	± 0.002
Bi	µg/L	0.0157	0.0145			11.8	0.519	13		0.0065	0.0048		
Br	µg/L	2.90	3.05			0.570	0.621			5.71	0.840		
Ca	µg/L	7199	485	7045	± 89	30991	1900	31040	± 500	6222	285	6200	± 200
Cd	µg/L	24.2	1.23	22.79	± 0.96	6.44	0.322	6.47	± 0.37	0.0137	0.0021	0.012	± 0.002
Ce	µg/L	0.369	0.0140			0.0182	0.0155			0.385	0.0161		
Co	µg/L	21.2	0.902	20.28	± 0.31	25.8	0.921	25	± 0.59	0.0471	0.0191	0.033	± 0.006
Cr	µg/L	38.3	1.32	38.6	± 1.6	18.8	0.653	18.53	± 0.20	0.376	0.0868	0.33	± 0.02
Cs	µg/L	0.150	0.0668			5.08	0.346			0.0078	0.0010		
Cu	µg/L	90.4	5.25	85.2	± 1.2	21.4	1.09	20.5	± 3.8	2.03	0.108	1.81	± 0.08
Dy	µg/L	0.0	0.0047			0.0027	0.0016			0.0240	0.0023		
Er	µg/L	0.0168	0.0025			0.0023	0.0005			0.0142	0.0013		

		NIST-1640				NIST-1643d				NIST-SLRS-4			
		N=58, 15 months		certified		N=70, 15 months		certified		N=35, 4 months		certified	
	UNIT	MW	SDEV	value	SDEV	MW	SDEV	value	SDEV	MW	SDEV	value	SDEV
Eu	µg/L	0.0190	0.0127			0.0408	0.0416			0.0088	0.0014		
Fe	µg/L	29.4	19.3	34.3	± 1.6	97.8	22.4	91.2	± 3.9	102	7.54	103	± 5
Ga	µg/L	0.0312	0.0200			0.035	0.0263			0.0207	0.0126		
Gd	µg/L	0.0575	0.0068			0.0029	0.0014			0.0403	0.0027		
Ge	µg/L	0.0179	0.0076			0.120	0.0139			0.0077	0.0023		
Hf	µg/L	0.0123	0.0111			0.0058	0.0045			0.0151	0.0081		
Hg	µg/L	0.212	0.188			0.250	0.266			0.300	0.309		
Ho	µg/L	0.0059	0.0009			0.003	<0.002			0.0048	0.0006		
I	µg/L	0.286	0.700			0.341	1.01			0.131	0.0279		
In	µg/L	0.0035	0.0028			0.0115	0.0258			0.002	0		
K	µg/L	999	79.2	994	± 27	2374	101	2356	± 35	691	39.0	680	± 20
La	µg/L	0.325	0.0153			0.0274	0.0036			0.302	0.0123		
Li	µg/L	51.1	3.49	50.7	± 1.4	16.9	0.989	16.5	± 0.55	0.576	0.0798		
Lu	µg/L	0.0022	0.0004			0.0020	<0.002			0.0021	0.0003		
Mg	µg/L	6279	925	5819	± 56	8471	1080	7989	± 35	1753	254	1600	± 100
Mn	µg/L	122	7.08	121.5	± 1.1	38.4	4.93	37.66	± 0.83	3.45	0.555	3.4	± 0.18
Mo	µg/L	46.3	1.70	46.75	± 0.26	113	4.10	112.9	± 1.7	0.219	0.0408	0.21	± 0.02
Na	µg/L	29263	2181	29350	± 310	21317	1597	22070	± 640	2331	128	2400	± 200
Nb	µg/L	0.0085	0.0061			0.0075	0.0048			0.0081	0.0034		
Nd	µg/L	0.407	0.0222			0.0104	0.0037			0.285	0.0160		
Ni	µg/L	28.4	1.33	27.4	± 0.8	59.3	2.43	58.1	± 2.7	0.916	0.129	0.67	± 0.08
Pb	µg/L	27.4	1.22	27.89	± 0.14	17.9	0.740	18.15	± 0.64	0.0782	0.0063	0.086	± 0.007
Pr	µg/L	0.0983	0.0058			0.0022	0.0006			0.0733	0.0031		
Rb	µg/L	2.10	0.1389	2	± 0.02	12.2	0.606	13		1.66	0.0778		
Sb	µg/L	13.6	0.480	13.79	± 0.42	53.3	1.93	54.1	± 1.1	0.257	0.0164	0.23	± 0.04
Sc	µg/L	2.07	0.479			1.26	0.263			0.932	0.204		
Se	µg/L	23.4	1.52	21.96	± 0.51	11.5	0.791	11.43	± 0.17	0.355	0.157		
Sm	µg/L	0.0716	0.0083			0.0059	0.0030			0.0588	0.0043		
Sn	µg/L	1.52	0.256			3.25	0.281			0.0084	0.0068		
Sr	µg/L	126	18.0	124.2	± 0.7	301	24.7	294.8	± 3.4	28.8	3.37	26.3	± 3.2
Ta	µg/L	0.0063	0.0041			0.0056	0.0037			0.0047	0.0011		
Tb	µg/L	0.0071	0.0013			0.002	0			0.0049	0.0007		
Te	µg/L	0.0143	0.0088			0.852	0.0817	1		0.0082	0.0032		
Th	µg/L	0.0261	0.0090			0.0100	0.0069			0.0201	0.0046		
Ti	µg/L	0.441	0.129			0.185	0.189			1.40	0.105		
Tl	µg/L	0.0131	0.0041	<0.1		7.39	0.328	7.28	± 0.25	0.0078	0.0017		
Tm	µg/L	0.0024	0.0006			<0.002	<0.002			0.0020	0.0002		
U	µg/L	0.787	0.0350			0.0212	0.0017			0.0504	0.0018	0.05	± 0.003
V	µg/L	13.0	0.526	12.99	± 0.37	35.5	1.17	35.1	± 1.4	0.331	0.0483	0.32	± 0.03
W	µg/L	0.0171	0.0064			0.0205	0.0058			0.0052	0.0030		
Y	µg/L	0.200	0.0143			0.0092	0.0017			0.146	0.0115		
Yb	µg/L	0.0123	0.0029			0.0033	0.0022			0.0122	0.0021		
Zn	µg/L	59.3	4.15	53.2	± 1.1	75.6	5.23	72.48	± 0.65	0.981	0.166	0.9	± 0.10
Zr	µg/L	0.153	0.0211			0.0095	0.0051			0.101	0.0096		

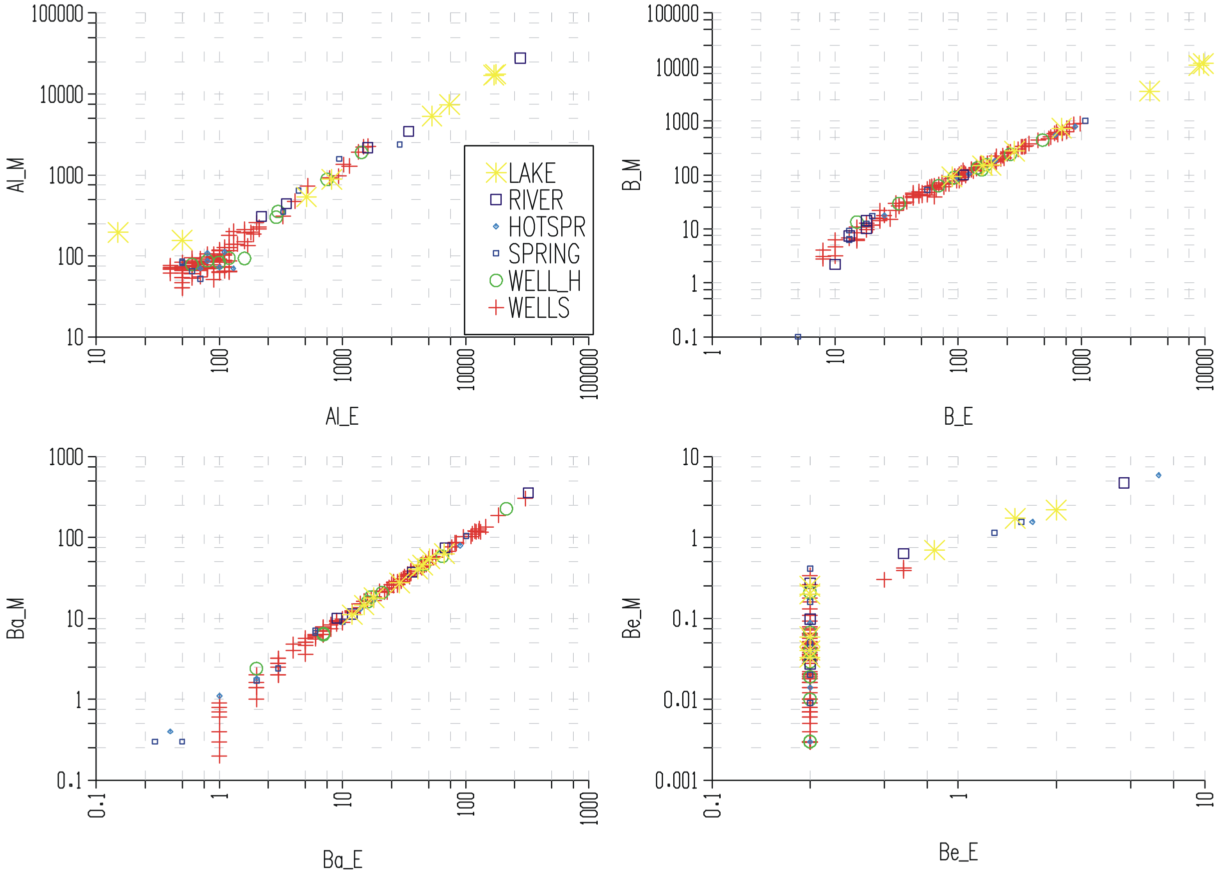
Results of standard analysis during the time when the Rift Valley waters were run are presented in Table 2. The Table shows one of the difficulties with multi-element analyses as presented here: no international reference material covering the whole range of elements analysed exists. Table 2 demonstrates, that both, accuracy as well as precision, is excellent for those elements where reference values exist. Precision judged from the project duplicates is on average in the range of 10-14 % for La, Fe, Ce, Cd, and Sn. It is in the range of 5-10 % for: Pb, Se, Be, Ti, Y, Pr, Hf, Gd, Nd, Zr, Sb, Co, Cu, and Ga. Precision is on average better than 5% for all other elements/parameters (Ag, Bi, electrical conductivity, Eu, Hg, Ho, In, Lu, NO_2, Ta, Tb, Te, Tm, SO_4, Cl, Ba, K, Si, W, Mg, Na, Ca, alkalinity, F, Dy, Sr, Cs, U, Li, Rb, Ge, B, V, Br, As, NO_3, Er, Th, Mo, Yb, Ni, Tl, Cr, Sm, Al, I, Zn, Nb, and Mn). The maximum deviation between single duplicate pairs can, however, be considerably worse (worst for NO_2 and NO_3) – see Table 3.

Table 3: Water samples Rift Valley, Ethiopia - Precision of Duplicate analyses in ± %, N=14.

PARAMETER	MEDIAN	MINIMUM	MAXIMUM	PARAMETER	MEDIAN	MINIMUM	MAXIMUM
Ag	0	0	20	Nd	7.7	0	45.8
Al	2.5	0	15.5	Ni	2.3	0	66.4
Alkalinity	0.5	0	5.4	NO_2	0	0	200
As	1.4	0.2	77.8	NO_3	1.6	0	200
B	1.3	0.2	15	Pb	5.1	0	36.2
Ba	0.3	0	57.7	Pr	6.6	0	58.3
Be	5.3	0	71.4	Rb	0.8	0.1	5.4
Bi	0	0	23.1	Sb	8.1	0	37.5
Br	1.4	0	20.1	Se	5.2	0	21.2
Ca	0.5	0	64.8	Si	0.3	0	1.3
Cd	12	0	81.4	Sm	2.5	0	47.4
Ce	11.5	0	67.6	Sn	13.6	0	68.4
Cl	0.3	0	3.7	SO_4	0.2	0	2.8
Co	8.6	0	90.4	Sr	0.7	0	61.2
Cr	2.4	0	59.7	Ta	0	0	13
Cs	0.7	0	15.8	Tb	0	0	33.3
Cu	8.8	1	35.4	Te	0	0	22.8
Dy	0.5	0	29	Th	1.9	0	76
Conductivity	0	0	0	Ti	5.6	0.6	30
Er	1.6	0	31.1	Tl	2.4	0	62.5
Eu	0	0	25	Tm	0	0	20
F	0.5	0	4.1	U	0.8	0	16.4
Fe	10.4	1.1	83.8	V	1.3	0.1	26.7
Ga	9.8	0	40	W	0.3	0	33.3
Gd	7.1	0	33.3	Y	5.9	0	33.3
Ge	1.1	0	40.2	Yb	2	0	32
Hf	7	0	33.3	Zn	3.9	0.5	93.7
Hg	0	0	28.6	Zr	7.8	0.1	20.9
Ho	0	0	33.3				
I	3.3	1.2	75.4				
In	0	0	3.1				
K	0.3	0	3.7				
La	10.4	0	63.9				
Li	0.8	0	43.7				
Lu	0	0	20				
Mg	0.4	0	85.4				
Mn	4.6	0	99.5				
Mo	1.9	0	87.8				
Na	0.4	0	33.9				
Nb	4	0	89.5				

The fact that many elements were analysed by more than just one method also allows to directly compare results from principally different analytical techniques in simple XY-plots as a further means of quality control. In most cases these diagrams show that the results from the different methods are very well comparable. For a number of elements it turns out that the detection limit given for the ICP-OES-results was too optimistic – a more realistic value is given in these cases in Table 1 (values in brackets). Figure 6A – 6E shows these XY-plots:

Fig. 6 A: XY-Plots (Al, B, Ba, Be) comparing analytical results as received from the different methods. "_M": Element analysed by ICP-MS," _E": ICP-OES.



Al: Results of ICP-OES and ICP-MS analyses are well comparable. Two lake water samples at the low end show considerably higher values in the ICP-MS data than received from the ICP-OES. For these two samples there exists most likely a mass disturbance on the ICP-MS.

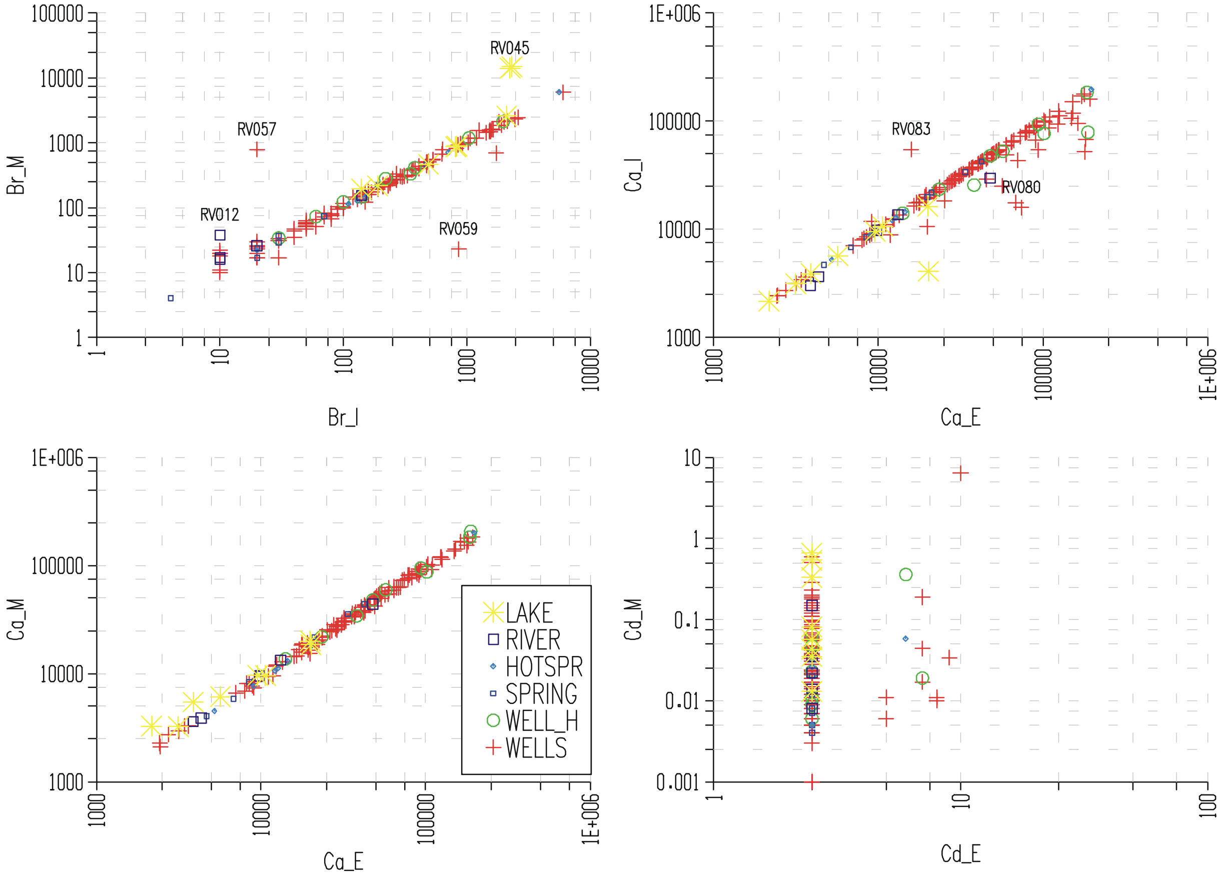
B: both methods return practically identical results.

Ba: results are very well comparable. The detection limit reached on the ICP-OES is, however, not quite sufficient.

Be: the results are comparable at the high end. The detection limit on the ICP-OES is by far too high to give useful data for the majority of data.

Br: the diagram suggests that there exists a mass disturbance for the ICP-MS data for two lake water samples at the high end of the analyses. In addition, samples RV057 and RV059 were probably exchanged when carrying out the IC-analyses. This has subsequently been corrected for all IC-results.

Fig. 6 B: XY-Plots (Br, Ca, Cd) comparing analytical results as received from the different methods. "_M": Element analysed by ICP-MS, "_E": ICP-OES," _I": analysed by IC (Br), or on the unacidified sampes by ICP-OES (Ca).



Ca: In addition to above mentioned pair (RV057/RV059) samples RV080 and RV083 appear also to have been exchanged (later corrected) prior to analysis. The Ca_I vs. Ca_E-diagram compares results of non-acidified with acidified samples. The slight deviation of some samples from the 1:1 line (towards higher values in the acidified samples) shows the effect of acidification (some particles are brought into solution). In general results from non-acidified and acidified samples compare surprisingly well.

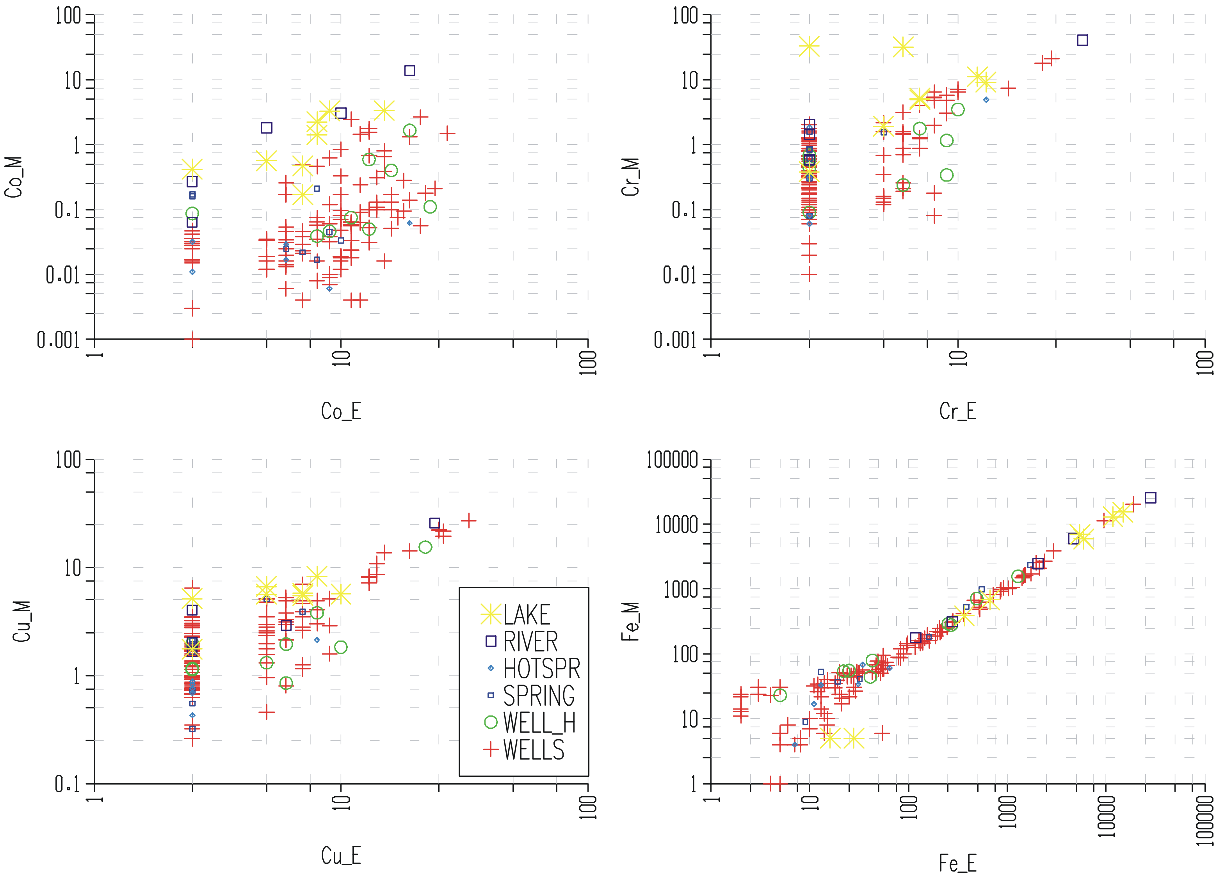
Cd: the detection limit on the ICP-OES is insufficient.

Co: the detection limit on the ICP-OES is insufficient. It is also possible that the determination of Co on the ICP-MS is disturbed by Ca-oxides, the correlation Ca/Co is, however not very prominent. It may still be advisable to treat the Co-results as preliminary.

Cr: the detection limit on the ICP-OES is insufficient.

Cu: the detection limit on the ICP-OES is insufficient. Results are comparable for concentrations above 10 µg/L.

Fig. 6 C: XY-Plots (Co, Cr, Cu, Fe) comparing analytical results as received from the different methods. _M: Element analysed by ICP-MS, _E: ICP-OES.



Fe: in general well comparable, but some spread for values below 25 µg/L.

K: excellent comparability for all three methods.

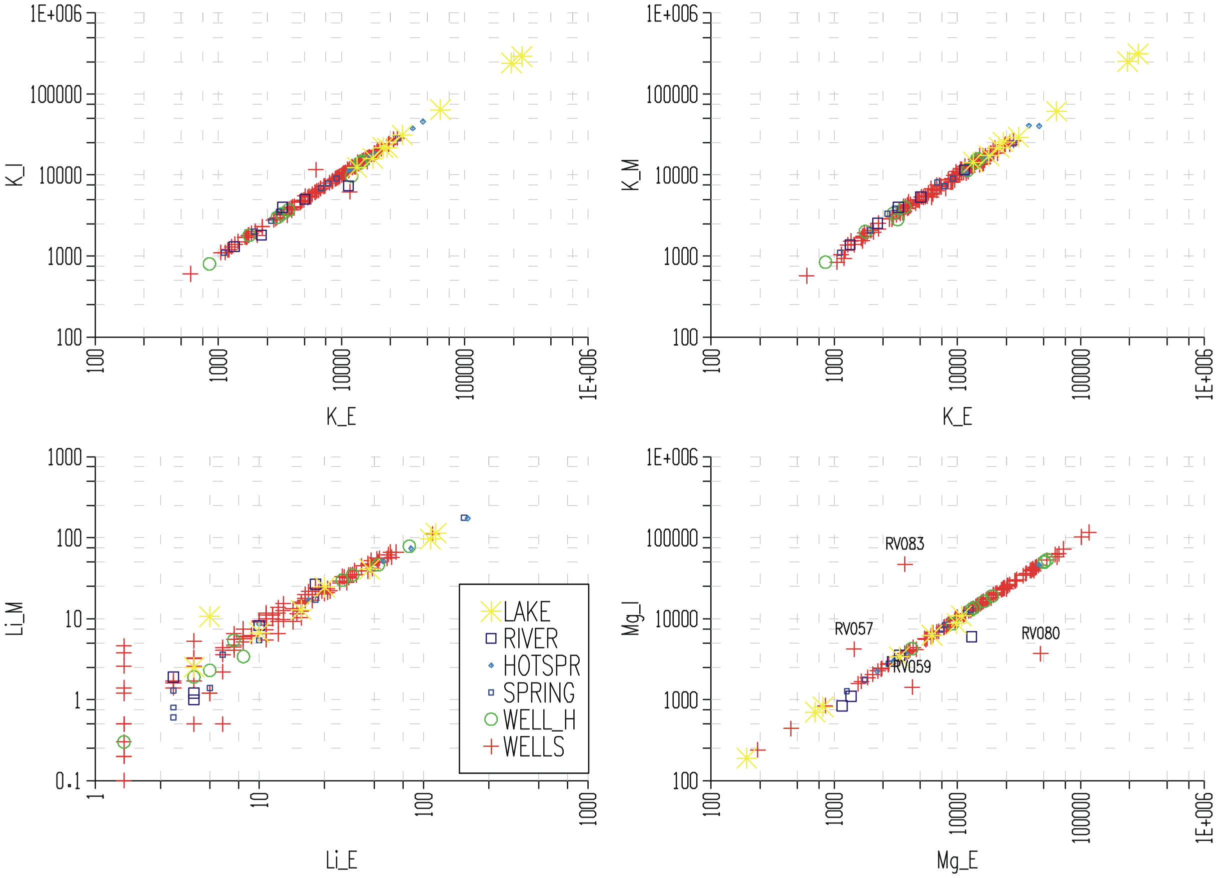
Li: good comparability at higher concentrations, some disagreement near detection limit.

Mg: shows nicely the two pairs of samples that were exchanged in the laboratory prior to the IC-analyses (and ICP-OES-analyses of the non-acidified samples). Otherwise an excellent comparability between the two methods is observed.

Mn: the detection limit on the ICP-OES is at around 10 µg/L – above that value the comparability is good.

Na: shows again the two pairs of exchanged samples, values between ICP-OES and ICP-MS are very well comparable at the lower end of the distribution but get somewhat uneven at the higher end where the salt concentration is already too high for ICP-MS analyses

Fig. 6 D: XY-Plots (K, Li, Mg) comparing analytical results as received from the different methods. "_M": Element analysed by ICP-MS, "_E": ICP-OES, "_I": analysed on the unacidified sampes by ICP-OES (K, Mg).



Ni: most likely the detection limit on the ICP-OES is higher than anticipated. However, for Ni a CaO-mass interference is possible on the ICP-MS. The high correlation between Ni and Ca suggests that all Ni-values may be unreliable. Ni concentrations given here should thus be taken as preliminary only.

Sr: excellent comparability.

Ti: Some problems at the lower end of the distribution suggest that a more realistic detection limit for Ti on the ICP-OES is at about 25 µg/L.

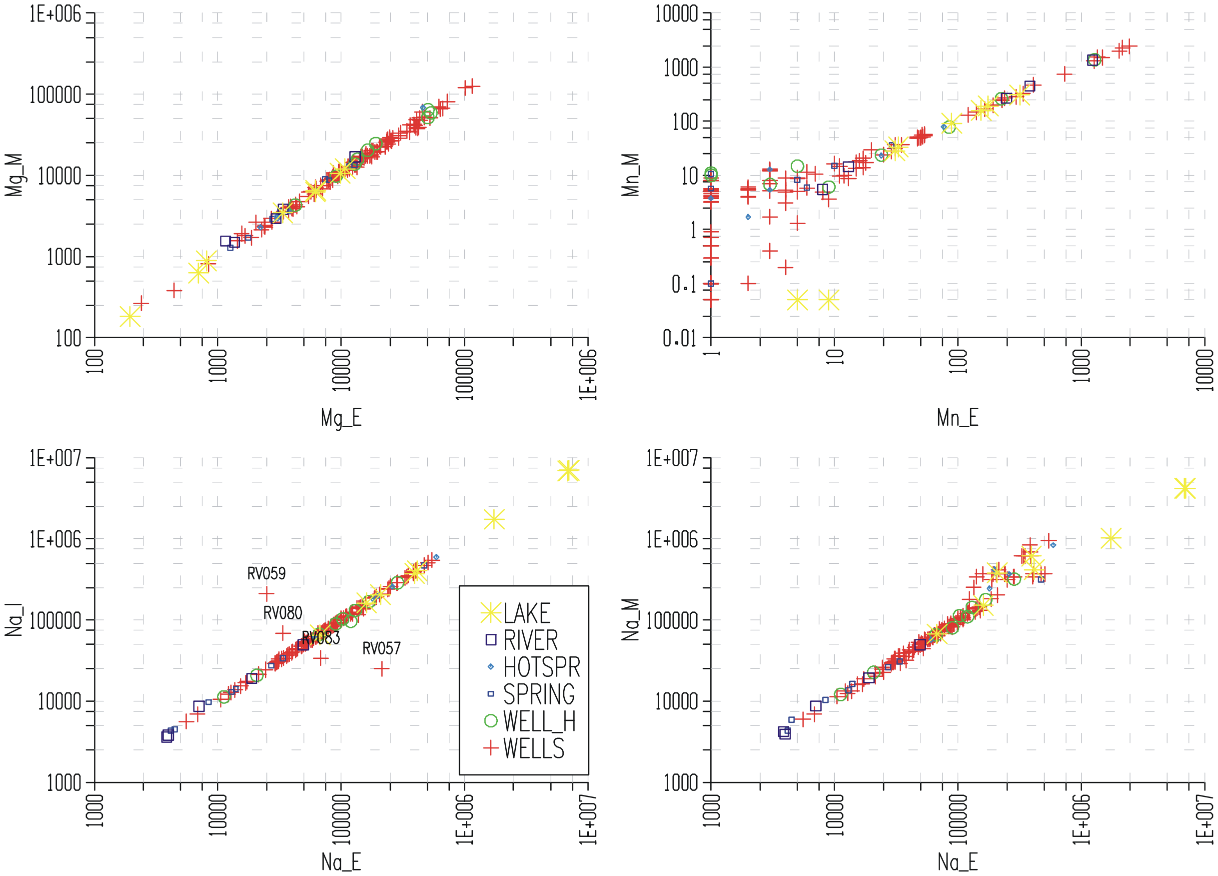
V: generally well comparable, at the lower end problems with the detection limit on the ICP-OES.

Zn: good comparability.

Electrical conductivity (EC): some samples were entered with the wrong unit into the data base – this has been corrected.

Alkalinity (Alk): shows a surprisingly good correlation between alkalinity as titrated directly in the field to alkalinity as titrated many weeks later in the laboratory.

Fig. 6 E: XY-Plots (Mg, Mn, Na) comparing analytical results as received from the different methods. "_M": Element analysed by ICP-MS, "_E": ICP-OES, "_I": analysed on the unacidified sampes by ICP-OES (Na).



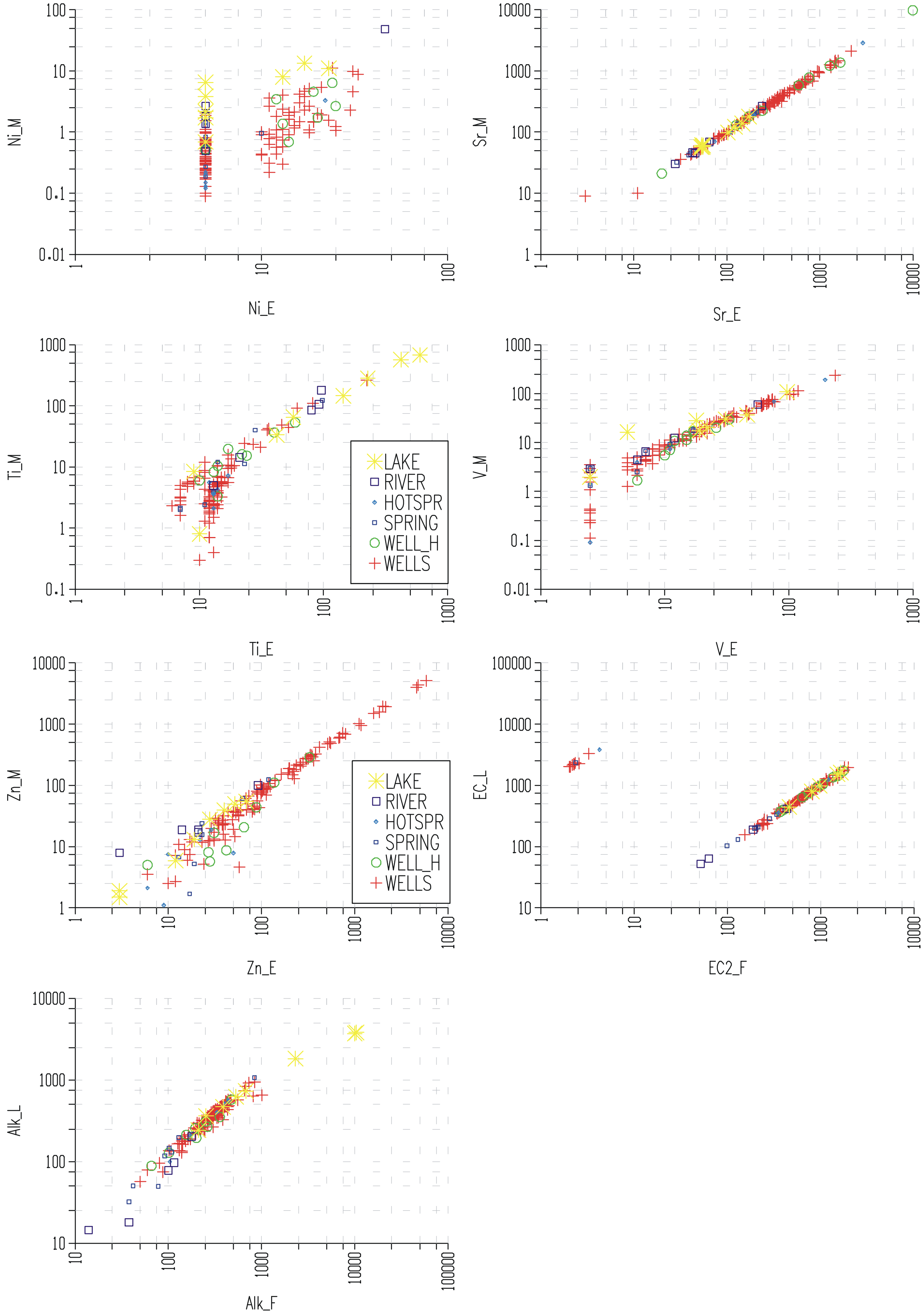
For Hg it must be noted that the given values represent at best the minimum concentration in the sample because the sampling campaign was not optimised for Hg, which would need special stabilisation procedures in the field.

Scandium shows an excellent correlation with Si (not shown here), which should not exist for geochemical reasons. In addition the Sc-values are unusually high (by almost two orders of magnitude) for waters. Mass-disturbance of Si-oxides on the Sc-mass is the most likely reason for the observed correlation and the Sc-values should not be used.

As a further method of quality control the ion balance has been calculated for all samples. The sum of the anions should equal the sum of the cations. The quality of water analysis is usually taken as acceptable if the deviation is less than 2.5%. For the data set the ionic balance is on average +/- 0.85% - the largest observed deviation was 2.6%.

Based on all results of quality control, detection limits reached and experience with this kind of water analysis the final selection of methods for presentation of data in the following tables and graphics was made.

Fig. 6 F: XY-Plots (Ni, Sr, Ti, V) comparing analytical results as received from the different methods. _M: Element analysed by ICP-MS, _E: ICP-OES; EC: electrical conductivity, Alk: Alkalinity, _L: measured in laboratory, _F: measured in the field.



6. RESULTS

Given the quite different origin of the samples (deep and shallow wells, springs, hot springs, rivers, lakes) it was decided to treat these samples in the form of several data subsets. The first major division was into "drinking water" (N=138) and "non-potable water" (N=9, 8 lake waters and 1 river water). Further more each of the different water types (deep wells, shallow wells, springs, hot springs, rivers and lakes) were treated as an own data subset. These were then compared in statistical tables and graphically using the box plot.

Table 4 summarises (median, minimum and maximum) the analytical results for the "drinking water" subset. It provides additional information on water standards (mostly European Union, but some others were also included, either where no standards exist in the European Union directives or when there exist big differences between standards). Furthermore it shows the number of samples (and the percentage) above maximum acceptable concentration limits.

Table 4: Statistics for "drinking water", Rift Valley, Ethiopia. N=138.
MAC: maximum acceptable concentration, European Union directive, chemical parameter. MACi: maximum acceptable concentration, European Union directive, indicatorl parameter.. RU: Russian standard, USEPA: United States Environmental Protection Agency. WHO: World Health Organisation. P: provisional. N>STAND.: number of samples exceeding the quoted water standard. %>STAND.: % of samples exceeding the quoted water standard. Temperature at time of sampling. EC: electrical conductivity. ToHa: total hardness (in degree German hardness). CaHa: Carbonate-hardness. Solids: Sum of dissolved ions. IBD: ion balance, difference S cations – S anions as a measure of analytical quality (should be low).

	UNIT	MINIMUM	MEDIAN	MAXIMUM	WATER STANDARDS	N>STAND.	%>STAND.
Ag	µg/L	<0.002	<0.002	0.021			
Al	µg/L	39.7	85	3440	200(MACi)	26	19
As	µg/L	0.016	0.97	96	10(MAC)	9	7
B	µg/L	0.1	70	997	1000(MACi)	0	0
Ba	µg/L	0.23	16.3	305	700(WHO)	13	9
Be	µg/L	<0.005	0.016	5.91	0.2(RU:MAC)	13	9
Bi	µg/L	<0.002	<0.002	0.03			
Br	µg/L	3.64	175	6110	200(RU:MAC)	67	49
Ca	µg/L	2429	35665	196500			
Cd	µg/L	<0.002	0.021	6.41	5(MAC)	1	0.8
Ce	µg/L	<0.002	0.06	24.6			
Cl	µg/L	870	20250	1240000	250000(MACi)	9	7
Co	µg/L	<0.002	0.049	3.07	100(RU:MAC)	0	0
Cr	µg/L	<0.01	0.485	21.3	50(MAC)	0	0
Cs	µg/L	<0.002	0.0305	12.1			
Cu	µg/L	0.26	1.98	27	2000 (MAC - weekly average)	0	0
Dy	µg/L	<0.002	0.008	2.06			
Er	µg/L	<0.002	0.006	1.03			
Eu	µg/L	<0.002	<0.002	0.42			
F	µg/L	48	909	11600	1500 (MAC)	80/45	58/33
Fe	µg/L	1.5	48	18860	200(MACi)	39	28
Ga	µg/L	0.003	0.023	1.58			
Gd	µg/L	<0.002	0.007	2.86			
Ge	µg/L	0.014	0.295	11.6			
Hf	µg/L	<0.002	0.004	0.4			
Hg	µg/L	<0.01	<0.01	0.8	1(MAC)	0	0
Ho	µg/L	<0.002	0.002	0.38			
I	µg/L	0.31	11	961			

	UNIT	MINIMUM	MEDIAN	MAXIMUM	WATER STANDARDS	N>STAND.	%>STAND.
In	μg/L	<0.002	<0.002	0.017			
K	μg/L	598	7320	45800			
La	μg/L	0.002	0.029	19.4			
Li	μg/L	0.1	11	176	30(RU:MAC)	35	25
Lu	μg/L	<0.002	<0.002	0.13			
Mg	μg/L	240	12045	116100			
Mn	μg/L	<0.1	8.52	2440	50 (MACi)	29	21
Mo	μg/L	<0.002	2.93	78.3	250(RU:MAC)	0	0
Na	μg/L	3858	71750	595000	200000(MAC)	24	17
Nb	μg/L	<0.002	0.013	2.37	10(RU:MAC)	0	0
Nd	μg/L	0.002	0.0295	18.2			
Ni	μg/L	0.086	0.74	11.2	20(MAC)	0	0
NO2	μg/L	<5	<5	1120	500(MAC)	4	3
NO3	μg/L	<50	3960	149000	10000/50000(MAC-USEPA/EU)	42/9	30/7
Pb	μg/L	0.023	0.45	46	10(MAC- weekly average)	2	1
Pr	μg/L	<0.002	0.007	4.97			
Rb	μg/L	0.38	8.39	82			
Sb	μg/L	<0.002	0.028	1.78	5(MAC)	0	0
Se	μg/L	0.015	0.615	7.58	10(MAC)	0	0
Si	μg/L	7427	35387	67881	10000(RU:MAC)	136	99
Sm	μg/L	<0.002	0.007	3.47			
Sn	μg/L	<0.002	0.018	7.48			
SO4	μg/L	<50	14000	692000	250000(MACi)	9	6.5
Sr	μg/L	8.8	232	9850	70000(RU:MAC)	0	0
Ta	μg/L	<0.002	0.002	0.054			
Tb	μg/L	<0.002	<0.002	0.41			
Te	μg/L	<0.005	<0.005	0.019	10(RU:MAC)	0	0
Th	μg/L	<0.002	0.008	1.59			
Ti	μg/L	0.3	4.74	264			
Tl	μg/L	<0.002	0.005	0.15	0.1(RU:MAC)	1	0.8
Tm	μg/L	<0.002	<0.002	0.13			
U	μg/L	0.005	1.84	48	30(USEPA:MAC)/2(WHO:P)	3/65	2/47
V	μg/L	0.093	13.35	235	100(RU:MAC)	3	2
W	μg/L	<0.002	0.011	3.81			
Y	μg/L	0.003	0.068	10.3			
Yb	μg/L	<0.002	0.005	0.77			
Zn	μg/L	1.1	44	5140			
Zr	μg/L	0.009	0.11	25			
T	^{o}C	15.6	28.5	67.3			
pH		5.2	7.1	8.6	>6.5<9.5	18	13
EC	μS/cm	52	719	3850	2500(MACi)	2	1
Alkalinity	mg/L	15	341	1070			
ToHa	^{o}dH	0.4	7.6	51.6			
CaHa	^{o}dH	0.7	15.6	49.1			
Solids	mg/L	34	598	2401	1500(MAC)	8	6
IBD	+/-%	0	0.85	2.6			

Tables 5 – 10 give statistical summaries for all other water types – deep wells, shallow wells, springs, hot springs, rivers and lakes.

Table 5: Statistics for deep wells (n=88), predominantly in bedrock, Rift Valley, Ethiopia. Units see Table 4.

	MINIMUM	MAXIMUM	MEDIAN
Ag	<0.002	0.006	<0.002
Al	40	2250	79
As	0.016	16.9	0.985
B	2.81	898	65
Ba	0.23	188	16.5
Be	<0.005	0.42	0.01
Bi	<0.002	0.011	<0.002
Br	11.1	2450	172
Ca	2429	193000	37380
Cd	<0.002	6.41	0.021
Ce	<0.002	9.31	0.0405
Cl	870	290000	19550
Co	<0.002	2.66	0.038
Cr	<0.01	21.3	0.465
Cs	<0.002	2.25	0.033
Cu	0.26	27	2.20
Dy	<0.002	0.62	0.007
Er	<0.002	0.29	0.0055
Eu	<0.002	0.15	<0.002
F	48	7570	946
Fe	1.5	9580	52
Ga	0.005	0.67	0.022
Gd	<0.002	0.75	0.006
Ge	0.023	5.15	0.345
Hf	<0.002	0.3	0.003
Hg	<0.01	0.094	<0.01
Ho	<0.002	0.11	0.002
I	0.38	961	11.25
In	<0.002	0.011	<0.002
K	598	28590	8890
La	0.002	4.35	0.022
Li	0.1	111	11.8
Lu	<0.002	0.038	<0.002
Mg	240	72700	12580
Mn	<0.1	2440	5.9
Mo	0.01	77.4	2.9
Na	5560	546000	66950
Nb	<0.002	2.26	0.011
Nd	0.002	4.57	0.023
Ni	0.086	11.2	0.645
NO2	<5	1120	<5
NO3	<50	149000	3750
Pb	0.047	46.4	0.625
Pr	<0.002	1.16	0.005
Rb	0.49	75	9.6

	MINIMUM	MAXIMUM	MEDIAN
Sb	<0.002	0.55	0.028
Se	0.015	7.58	0.6
Si	13012	55747	37245
Sm	<0.002	0.85	0.005
Sn	<0.002	7.48	0.018
SO4	90	460000	12300
Sr	8.8	1480	252
Ta	<0.002	0.054	0.002
Tb	<0.002	0.11	<0.002
Te	<0.005	0.019	<0.005
Th	<0.002	0.64	0.007
Ti	0.3	264	4.25
Tl	<0.002	0.084	0.005
Tm	<0.002	0.039	<0.002
U	0.008	19.9	2.3
V	0.11	235	14.8
W	<0.002	3.81	0.011
Y	0.004	2.94	0.066
Yb	<0.002	0.23	0.005
Zn	2.49	5140	74
Zr	0.009	13	0.098
T	20	45.6	29
pH	5.9	8.6	7.1
EC	156	2330	695
Alkalinity	74	920	359
ToHa	0.40	39.2	7.95
CaHa	3.40	42.2	16.5
Solids	108	1821	580
IBD_%	0	2.4	0.9
DEPTH	30	330	108

Table 6: Statistics for shallow wells (n=32) (predominantly in sediments - dug and drilled)), Rift Valley, Ethiopia. Units see Table 4.

	MINIMUM	MAXIMUM	MEDIAN
Ag	<0.002	0.021	<0.002
Al	54	1900	96
As	0.088	96	1.48
B	3.97	760	121
Ba	0.85	305	18.2
Be	<0.005	0.21	0.015
Bi	<0.002	0.019	<0.002
Br	10	6010	265
Ca	8510	187900	52485
Cd	<0.002	0.36	0.027
Ce	0.004	9.39	0.07
Cl	1580	602000	33400
Co	0.004	2.46	0.069
Cr	0.01	7.36	0.47
Cs	<0.002	0.62	0.014
Cu	0.32	21.6	1.9
Dy	<0.002	0.7	0.007
Er	<0.002	0.38	0.005
Eu	<0.002	0.11	<0.002
F	170	11600	778
Fe	4.5	18860	36.05
Ga	0.003	0.74	0.0225
Gd	<0.002	1.01	0.007
Ge	0.014	2.07	0.145
Hf	<0.002	0.4	0.004
Hg	<0.01	0.8	<0.01
Ho	<0.002	0.14	0.002
I	1.6	469	19
In	<0.002	0.009	<0.002
K	849	24400	4430
La	0.003	4.16	0.037
Li	0.18	78.4	9.645
Lu	<0.002	0.057	<0.002
Mg	444.8	116100	15875
Mn	<0.1	1990	11.23
Mo	0.11	78.3	3.53
Na	10520	507000	101950
Nb	0.002	2.37	0.0115
Nd	0.002	4.02	0.034
Ni	0.22	6.39	1.18
NO2	<5	593	<5
NO3	<50	100000	9170
Pb	0.038	8.62	0.26
Pr	<0.002	1.04	0.008
Rb	0.38	27.5	3.59

	MINIMUM	MAXIMUM	MEDIAN
Sb	0.003	0.34	0.0265
Se	0.15	6.87	0.875
Si	7427	49974	29991
Sm	<0.002	0.83	0.008
Sn	<0.002	0.2	0.016
SO4	<50	692000	49150
Sr	21.4	9850	316
Ta	<0.002	0.028	0.002
Tb	<0.002	0.12	0.001
Te	<0.005	0.015	0.0025
Th	<0.002	0.3	0.007
Ti	2.2	53.3	5.8
Tl	<0.002	0.05	0.004
Tm	<0.002	0.056	0.001
U	0.006	47.7	1.4
V	0.41	97.8	11.05
W	<0.002	2.22	0.019
Y	0.003	3.77	0.062
Yb	<0.002	0.36	0.005
Zn	2.67	4370	37.35
Zr	0.015	25	0.1
T	20.6	38.2	26.1
pH	6.2	8.3	7.2
EC	238	3300	915
Alkalinity	57	938	324
ToHa	1.8	51.6	10.15
CaHa	2.6	43	14.85
Solids	180	2008	788
IBD_%	0.1	2.6	0.8
DEPTH	5	54	27.5

Table 7: Statistics for spring water (n=7), Rift Valley, Ethiopia. Units see Table 4.

	MINIMUM	MAXIMUM	MEDIAN
Ag	<0.002	<0.002	<0.002
Al	52	2380	347
As	0.053	0.67	0.1
B	0.1	52	9.3
Ba	0.3	104	6.6
Be	0.009	1.55	0.051
Bi	<0.002	0.002	<0.002
Br	3.64	221	28.6
Ca	4671	42360	9660
Cd	0.004	0.02	0.008
Ce	0.05	12.7	1.36
Cl	1200	17800	2370
Co	0.017	0.21	0.045
Cr	0.075	1.59	0.84
Cs	0.009	0.43	0.029
Cu	0.32	5.09	1.95
Dy	0.005	2.06	0.072
Er	0.002	1.03	0.045
Eu	<0.002	0.42	0.008
F	107	1330	204
Fe	13.3	1706	160
Ga	0.011	1.47	0.13
Gd	0.006	2.86	0.072
Ge	0.021	0.45	0.046
Hf	<0.002	0.3	0.025
Hg	<0.01	0.016	<0.01
Ho	<0.002	0.38	0.015
I	0.31	4.03	3.33
In	<0.002	0.017	<0.002
K	1111	9130	3121
La	0.026	19.4	0.26
Li	0.59	17.2	1.4
Lu	<0.002	0.13	0.006
Mg	1266	12850	3211
Mn	<0.1	36.3	8.3
Mo	<0.002	3.48	0.42
Na	4166	33750	12950
Nb	0.005	1.02	0.12
Nd	0.026	18.2	0.29
Ni	0.19	2.16	0.95
NO2	<5	389	<5
NO3	2520	45300	3980
Pb	0.025	2.03	0.34
Pr	0.006	4.97	0.074
Rb	1.04	26.3	8.1

	MINIMUM	MAXIMUM	MEDIAN
Sb	0.004	0.057	0.018
Se	0.12	0.91	0.29
Si	15331	54784	21828
Sm	0.006	3.47	0.056
Sn	0.003	0.11	0.035
SO4	420	12400	1280
Sr	32	213	69
Ta	<0.002	0.026	0.006
Tb	<0.002	0.41	0.012
Te	<0.005	0.008	0.0025
Th	<0.002	1.59	0.047
Ti	2.01	123	11
Tl	<0.007	0.021	0.008
Tm	<0.002	0.13	0.006
U	0.026	1.47	0.43
V	1.32	18.7	2.92
W	<0.002	0.078	0.009
Y	0.029	10.3	0.38
Yb	0.003	0.77	0.039
Zn	1.69	124	17.4
Zr	0.041	12.3	0.88
T	16	32	21
pH	5.2	6.9	6.3
EC	103	333	203
Alkalinity	32	197	117
ToHa	0.9	7.7	2.1
CaHa	1.5	9	5.4
Solids	72	270	174
IBD_%	0.1	2.3	1

Table 8: Statistics for hot springs (N=7), Rift Valley, Ethiopia. Units see Table 4.

	MINIMUM	MAXIMUM	MEDIAN
Ag	<0.002	<0.002	<0.002
Al	70	111	82
As	0.99	25.8	4.94
B	17.8	997	183
Ba	0.29	79.6	1.83
Be	<0.005	5.91	0.088
Bi	0.002	0.03	0.002
Br	21.7	6110	146
Ca	5210	196500	12750
Cd	0.005	0.058	0.034
Ce	0.018	0.18	0.075
Cl	3760	1240000	29400
Co	0.006	0.062	0.022
Cr	0.059	4.93	0.3
Cs	0.035	12.1	0.57
Cu	0.43	2.14	0.76
Dy	<0.002	0.051	0.009
Er	<0.002	0.048	0.005
Eu	<0.002	0.004	0.001
F	1320	9920	2910
Fe	7.2	63.6	12.7
Ga	0.018	0.051	0.035
Gd	<0.002	0.038	0.007
Ge	0.77	11.6	3.89
Hf	0.008	0.038	0.01
Hg	<0.01	0.017	<0.01
Ho	<0.002	0.013	0.002
I	1.81	51.4	11.1
In	<0.002	<0.002	<0.002
K	11540	45800	18600
La	0.009	0.085	0.035
Li	8.6	176	51.2
Lu	<0.002	0.008	0.001
Mg	2227	46120	3804
Mn	<0.1	79.4	5.41
Mo	9.74	34.6	23.4
Na	60900	595000	204100
Nb	0.012	0.5	0.025
Nd	0.01	0.099	0.033
Ni	0.12	3.32	0.2
NO2	<5	28	<5
NO3	20	6710	1410
Pb	0.023	0.23	0.15
Pr	<0.002	0.023	0.007
Rb	11.9	82.2	61.2

	MINIMUM	MAXIMUM	MEDIAN
Sb	0.016	1.78	0.043
Se	0.17	2.15	0.78
Si	30517	67881	53209
Sm	0.002	0.02	0.005
Sn	<0.002	0.18	0.003
SO4	170	164000	45600
Sr	47	2890	99
Ta	0.002	0.035	0.008
Tb	<0.002	0.007	0.002
Te	<0.005	0.016	<0.005
Th	0.007	0.1	0.011
Ti	2.1	7.2	3.9
Tl	<0.007	0.15	0.03
Tm	<0.002	0.006	0.001
U	0.005	6.44	1.65
V	0.093	191	7.35
W	0.029	3.66	1.02
Y	0.011	0.57	0.063
Yb	<0.002	0.043	0.003
Zn	1.06	18.7	7.77
Zr	0.079	1.46	0.2
T	36	66	44
pH	6.1	7.7	7.1
EC	354	3850	1002
Alkalinity	99	1070	511
ToHa	1.2	38.1	2.7
CaHa	4.6	49.1	23.4
Solids	304	2401	840
IBD_%	0.1	1.5	0.8

Table 9: Statistics for river water (n=5), Rift Valley, Ethiopia. Units see Table 4.

	MINIMUM	MAXIMUM	MEDIAN
Ag	<0.002	0.018	<0.002
Al	307	27760	1307
As	0.032	1.24	0.565
B	2.2	101	12
Ba	10.1	358	24
Be	0.027	4.72	0.184
Bi	<0.002	0.016	0.002
Br	16	154	27.7
Ca	4334	47740	11475
Cd	0.008	0.15	0.018
Ce	0.42	147	5.86
Cl	1410	20100	2050
Co	0.064	13.9	1.04
Cr	0.58	40.9	1.02
Cs	0.01	0.7	0.0565
Cu	1.67	25.7	2.465
Dy	0.047	12.5	0.495
Er	0.024	6.97	0.273
Eu	0.008	2.58	0.0955
F	81	2170	344
Fe	118	28290	1160.3
Ga	0.12	12.4	0.44
Gd	0.05	14	0.575
Ge	0.038	0.22	0.074
Hf	0.031	0.23	0.0565
Hg	<0.01	<0.01	<0.01
Ho	0.008	2.45	0.0985
I	2.31	71.1	5.53
In	<0.002	0.11	0.005
K	1346	11390	4182
La	0.25	74.7	2.925
Li	0.99	26.5	4.675
Lu	0.003	1	0.038
Mg	1367	13000	3177
Mn	5.54	1350	139.7
Mo	0.065	1.2	0.735
Na	3983	49430	13025
Nb	0.096	1.4	0.335
Nd	0.25	71.5	2.99
Ni	0.49	48.4	1.59
NO2	<5	17	<5
NO3	1140	6190	3770
Pb	0.094	15.6	0.93
Pr	0.065	19	0.785
Rb	2.84	53.9	6.305

	MINIMUM	MAXIMUM	MEDIAN
Sb	0.012	0.041	0.028
Se	0.091	0.73	0.175
Si	12353	69872	27983
Sm	0.051	14.5	0.62
Sn	0.017	0.056	0.0355
SO4	830	10800	1570
Sr	44.9	269	57.6
Ta	0.003	0.13	0.004
Tb	0.008	2.14	0.086
Te	0.008	0.018	0.013
Th	0.017	3.94	0.0985
Ti	5	179.6	49.7
Tl	0.007	0.24	0.0195
Tm	0.004	1	0.0375
U	0.12	3.3	0.275
V	2.91	59.9	8.36
W	0.005	0.073	0.019
Y	0.24	64.8	2.57
Yb	0.021	6.3	0.24
Zn	7.87	99.8	18
Zr	1.32	7.66	2.96
T	17	22	20
pH	6.2	8.1	6.3
EC	52	415	161
Alkalinity	14	178	100
ToHa	0.8	5.5	2.4
CaHa	0.8	9.3	4.05
Solids	37	333	128
IBD_%	0.01	1.2	0.105

Table 10: Statistics for lake water (n=8), Rift Valley, Ethiopia. Units see Table 4.

	MINIMUM	MAXIMUM	MEDIAN
Ag	<0.002	0.007	<0.002
Al	156	17600	3106
As	1.74	189	4.1
B	92.6	11700	505
Ba	11.1	62.7	34.1
Be	0.033	2.18	0.225
Bi	0.002	0.014	0.007
Br	196	14900	879
Ca	2167	20180	7610
Cd	0.013	0.66	0.069
Ce	1.93	87	9.41
Cl	13000	3012000	138000
Co	0.17	3.36	0.99
Cr	0.38	33	7.16
Cs	0.082	0.66	0.235
Cu	1.76	8.28	5.66
Dy	0.2	5.81	0.9
Er	0.12	3.29	0.605
Eu	0.032	0.98	0.205
F	1610	175000	8810
Fe	15.5	14820	3032
Ga	0.08	7.42	1.05
Gd	0.2	6.21	1.035
Ge	0.17	7.75	0.805
Hf	0.12	3.28	0.295
Hg	<0.01	0.015	<0.01
Ho	0.039	1.14	0.195
I	13.9	285	109
In	<0.002	0.066	0.014
K	13400	292000	27365
La	0.56	36.4	2.86
Li	2.5	114	18.8
Lu	0.016	0.51	0.115
Mg	194.7	10780	4786
Mn	<0.1	309	63
Mo	2.21	746	20.9
Na	67700	7030000	405100
Nb	0.78	5.24	1.515
Nd	0.89	34.1	4.005
Ni	0.69	13.4	5.2
NO2	<5	<5	<5
NO3	1050	5840	2050
Pb	0.1	6.39	0.915
Pr	0.19	9.23	0.875
Rb	7.38	136	40.05

	MINIMUM	MAXIMUM	MEDIAN
Sb	0.052	0.96	0.13
Se	0.26	8.78	1.84
Si	16434	61014	50150
Sm	0.19	6.65	1.005
Sn	<0.002	0.52	0.22
SO4	380	494000	16450
Sr	57	178	80
Ta	0.017	0.74	0.085
Tb	0.031	0.98	0.155
Te	<0.005	0.32	0.0215
Th	0.13	6	0.765
Ti	0.8	681	106
Tl	<0.007	0.11	0.0125
Tm	0.016	0.48	0.1035
U	0.23	43.2	4.6
V	1.96	108	24.15
W	0.027	304	2.62
Y	1.24	28.6	5.4
Yb	0.11	3.15	0.67
Zn	1.45	55	21
Zr	6.1	179	20
T	21.3	31.8	25.4
pH	7.4	10.2	9
EC	445	23300	1568
Alkalinity	242	3820	677
ToHa	0.3	4.3	1.8
CaHa	11.1	175	31
Solids	372	19137	1328
IBD_%	0.01	1.8	0.65

Table 11 compares the median values of these different waters against the "deep well" data set (highest number of samples) and with median concentrations reported for different drinking waters from Norway and Europe.

Table 11: Water quality, Rift Valley, Ethiopia. Median comparison and comparison with other published data sets.
Ref. a): Misund et al., 1999; Ref. b): Reimann et al., 1996; Ref. c): Frengstad et al., 2000 and Banks et al. 1998a.

		ETHIOPIA RIFT VALLEY WATER											EUROPE MINERAL WATER	NORWAY BEDROCK GROUNDWATER	
													Ref a)	Ref b)	Ref c)
		MEDIAN CONCENTRATION						NORMALISED TO BEDROCK					N=56	N=145	N=476
PARAM	UNIT	BEDROCK	SEDIMENT	SPRING	HOTSPR	RIVER	LAKE	SEDIMENT	SPRING	HOTSPR	RIVER	LAKE	MEDIAN	MEDIAN	MEDIAN
Ag	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002						<0.002	<0.001	<0.002
Al	µg/L	79	96	347	82	1307	3106	1.2	4	1.0	17	39	5.57	12	13
As	µg/L	0.985	1.48	0.1	4.94	0.565	4.1	1.5	0.10	5	0.6	4	0.45	0.2	0.18
B	µg/L	65	121	9.3	183	12	505	1.9	0.14	3	0.19	8	92.2	20.6	14
Ba	µg/L	16.5	18.2	6.6	1.83	24	34.1	1.1	0.40	0.11	1.5	2.1	26.3	16.7	15
Be	µg/L	0.01	0.015	0.051	0.088	0.184	0.225	1.5	5	9	18	23	0.01	0.04	0.012
Bi	µg/L	<0.002	<0.002	<0.002	0.002	0.002	0.007						0.001	0.001	<0.001
Br	µg/L	172	265	28.6	146	27.7	879	1.5	0.17	0.8	0.16	5	81	35.1	30
Ca	µg/L	37380	52485	9660	12750	11475	7610	1.4	0.26	0.34	0.31	0.20	68800	25700	26900
Cd	µg/L	0.021	0.027	0.008	0.034	0.018	0.069	1.3	0.38	1.6	0.9	3	0.006	0.032	0.017
Ce	µg/L	0.0405	0.07	1.36	0.075	5.86	9.41	1.7	34	1.9	145	232	0.006	0.147	0.11
Cl	µg/L	19550	33400	2370	29400	2050	138000	1.7	0.12	1.5	0.10	7	25100		9400
Co	µg/L	0.038	0.069	0.045	0.022	1.04	0.99	1.8	1.2	0.6	27	26	0.11	0.062	0.065
Cr	µg/L	0.465	0.47	0.84	0.3	1.02	7.16	1.0	1.8	0.6	2.2	15	2.92	0.54	0.14
Cs	µg/L	0.033	0.014	0.029	0.57	0.0565	0.235	0.43	0.9	18	1.7	7	0.029	0.097	0.096
Cu	µg/L	2.20	1.9	1.95	0.76	2.465	5.66	0.9	0.9	0.35	1.1	3	0.57	11.75	16
Dy	µg/L	0.007	0.007	0.072	0.009	0.495	0.9	1.0	10	1.3	71	129	0.002	0.021	0.022
Er	µg/L	0.0055	0.005	0.045	0.005	0.273	0.605	0.9	8	0.9	50	110	<0.002	0.016	0.015
Eu	µg/L	<0.002	<0.002	0.008	0.001	0.0955	0.205						<0.002	0.011	0.003
F	µg/L	946	778	204	2910	344	8810	0.8	0.22	3	0.36	9	270	330	210
Fe	µg/L	52	36.05	160	12.7	1160.3	3032	0.7	3	0.24	22	58	41	25	28
Ga	µg/L	0.022	0.0225	0.13	0.035	0.44	1.05	1.0	6	1.6	20	48	<0.002	0.028	0.013
Gd	µg/L	0.006	0.007	0.072	0.007	0.575	1.035	1.2	12	1.2	96	173	<0.002	0.029	0.024
Ge	µg/L	0.345	0.145	0.046	3.89	0.074	0.805	0.42	0.13	11	0.21	2	0.032	0.018	0.017
Hf	µg/L	0.003	0.004	0.025	0.01	0.0565	0.295	1.3	8	3	19	98	0.015	0.01	0.004

		ETHIOPIA RIFT VALLEY WATER											EUROPE MINERAL WATER	NORWAY BEDROCK GROUNDWATER	
													Ref a)	Ref b)	Ref c)
		MEDIAN CONCENTRATION						NORMALISED TO BEDROCK							
PARAM	UNIT	BEDROCK	SEDIMENT	SPRING	HOTSPR	RIVER	LAKE	SEDIMENT	SPRING	HOTSPR	RIVER	LAKE	MEDIAN	MEDIAN	MEDIAN
Hg	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01						0.015	0.034	0.018
Ho	µg/L	0.002	0.002	0.015	0.002	0.0985	0.195	1.0	8	1.0	49	98	<0.001	0.005	0.005
I	µg/L	11.25	19	3.33	11.1	5.53	109	1.6	0.30	1.0	0.49	10	2.22	2.03	0.6
In	µg/L	<0.002	<0.002	<0.002	<0.002	0.005	0.014						<0.001	<0.001	<0.001
K	µg/L	8890	4430	3121	18600	4182	27365	0.50	0.35	2.1	0.47	3	5830	2175	2260
La	µg/L	0.022	0.037	0.26	0.035	2.925	2.86	1.7	12	1.6	133	130	0.005	0.145	0.1
Li	µg/L	11.8	9.645	1.4	51.2	4.675	18.8	0.8	0.12	4	0.40	1.6	15.7	3.62	2.9
Lu	µg/L	<0.002	<0.002	0.006	<0.002	0.038	0.115						0.001	0.003	0.003
Mg	µg/L	12580	15875	3211	3804	3177	4786	1.3	0.26	0.30	0.25	0.38	25000	4250	3430
Mn	µg/L	5.9	11.23	8.3	5.41	139.7	63	1.9	1.4	0.9	24	11	5.6	7.5	12
Mo	µg/L	2.9	3.53	0.42	23.4	0.735	20.9	1.2	0.14	8	0.25	7	0.37	1.63	1.4
Na	µg/L	66950	101950	12950	204100	13025	405100	1.5	0.19	3	0.19	6	26580	17300	11250
Nb	µg/L	0.011	0.0115	0.12	0.025	0.335	1.515	1.0	11	2.3	30	138	0.065	0.008	0.004
Nd	µg/L	0.023	0.034	0.29	0.033	2.99	4.005	1.5	13	1.5	133	178	0.004	0.155	0.12
Ni	µg/L	0.645	1.18	0.95	0.2	1.59	5.2	1.8	1.5	0.31	2.5	8	2.46	0.74	0.53
NO2	µg/L	<5	<5	<5	<5	<5	<5								
NO3	µg/L	3750	9170	3980	1410	3770	2050	2.4	1.1	0.38	1.0	0.5	442		670
Pb	µg/L	0.625	0.26	0.34	0.15	0.93	0.915	0.42	0.5	0.24	1.5	1.5	0.01	0.3	0.36
Pr	µg/L	0.005	0.008	0.074	0.007	0.785	0.875	1.6	15	1.4	157	175	<0.002	0.04	0.027
Rb	µg/L	9.6	3.59	8.1	61.2	6.305	40.05	0.37	0.8	6	0.7	4	4.79	2.23	2.6
Sb	µg/L	0.028	0.0265	0.018	0.043	0.028	0.13	0.9	0.6	1.5	1.0	5	0.165	0.032	0.033
Se	µg/L	0.6	0.875	0.29	0.78	0.175	1.84	1.5	0.48	1.3	0.29	3	0.64	0.3	0.2
Si	µg/L	37245	29991	21828	53209	27983	50150	0.8	0.6	1.4	0.8	1.3	5565		
Sm	µg/L	0.005	0.008	0.056	0.005	0.62	1.005	2	11	1.0	124	201	<0.002	0.028	0.022
Sn	µg/L	0.018	0.016	0.035	0.003	0.0355	0.22	0.9	1.9	0.17	2.0	12	<0.002	<0.005	0.008
SO4	µg/L	12300	49150	1280	45600	1570	16450	4	0.10	4	0.13	1.3	32000		11900
Sr	µg/L	252	316	69	99	57.6	80	1.3	0.27	0.39	0.23	0.32	448	179	131

		ETHIOPIA RIFT VALLEY WATER											EUROPE MINERAL WATER	NORWAY BEDROCK GROUNDWATER	
													Ref a)	Ref b)	Ref c)
		MEDIAN CONCENTRATION						NORMALISED TO BEDROCK							
PARAM	UNIT	BEDROCK	SEDIMENT	SPRING	HOTSPR	RIVER	LAKE	SEDIMENT	SPRING	HOTSPR	RIVER	LAKE	MEDIAN	MEDIAN	MEDIAN
Ta	µg/L	0.002	0.002	0.006	0.008	0.004	0.085	1.0	3	4	2.0	43	0.039	<0.001	0.002
Tb	µg/L	<0.002	<0.002	0.012	0.002	0.086	0.155						<0.001	0.004	0.003
Te	µg/L	<0.005	<0.005	<0.005	<0.005	0.013	0.0215						0.010	0.009	<0.005
Th	µg/L	0.007	0.007	0.047	0.011	0.0985	0.765	1.0	7	1.6	14	109	0.031	0.013	0.006
Ti	µg/L	4.25	5.8	11	3.9	49.7	106	1.4	3	0.9	12	25	0.91	0.635	0.59
Tl	µg/L	0.005	0.004	0.008	0.03	0.0195	0.0125	0.8	1.6	6	4	3	0.007	0.003	0.007
Tm	µg/L	<0.002	<0.002	0.006	0.001	0.0375	0.1035						<0.001	0.002	0.002
U	µg/L	2.3	1.4	0.43	1.65	0.275	4.6	0.6	0.19	0.7	0.12	2.0	0.104	3.51	2.5
V	µg/L	14.8	11.05	2.92	7.35	8.36	24.15	0.7	0.20	0.50	0.6	1.6	0.65	0.5	0.24
W	µg/L	0.011	0.019	0.009	1.02	0.019	2.62	1.7	0.8	93	1.7	238	0.78	0.05	0.071
Y	µg/L	0.066	0.062	0.38	0.063	2.57	5.4	0.9	6	1.0	39	82	0.026	0.14	0.21
Yb	µg/L	0.005	0.005	0.039	0.003	0.24	0.67	1.0	8	0.6	48	134	<0.002	0.014	0.013
Zn	µg/L	74	37.35	17.4	7.77	18	21	0.5	0.24	0.11	0.24	0.28	2.97	23.4	14
Zr	µg/L	0.098	0.1	0.88	0.2	2.96	20	1.0	9	2.0	30	204	0.029	0.47	0.018
T	^{o}C	29	26.1	21	44	20	25.4	0.9	0.7	1.5	0.7	0.9			
pH	pH	7.1	7.2	6.3	7.1	6.3	9	1.0	0.9	1.0	0.9	1.3			8.1
EC	µS/cm	695	915	203	1002	161	1568	1.3	0.29	1.4	0.23	2.3			
Alkalinity	mg/L	359	324	117	511	100	677	0.9	0.33	1.4	0.28	1.9			1920
ToHa	^{o}dH	7.95	10.15	2.1	2.7	2.4	1.8	1.3	0.26	0.34	0.30	0.23			
CaHa	^{o}dH	16.5	14.85	5.4	23.4	4.05	31	0.9	0.33	1.4	0.25	1.9			
Solids	mg/L	580	788	174	840	128	1328	1.4	0.30	1.4	0.22	2.3			
IBD_%	+/- %	0.9	0.8	1	0.8	0.105	0.65	0.9	1.1	0.9	0.12	0.7			
DEPTH	m	108	27.5												

Table 12 (see attachment) gives all results after quality control. Duplicates, standards, blind samples are removed and sample mixups corrected. This file is used for all further work with the data.

Table 13 shows only samples with values above EU-maximum acceptable concentration limits (U: Canadian guidelines). It can be used to easily find wells that fulfil the drinking water norm – or to detect those wells with the most serious deviations from the norm.

Table 13: Drinking water, Rift Valley, Ethiopia. Summary of values >EU MAC (U: USEPA-MAC). "deep": deep wells (> 60 m), predominantly in bedrock; "hspring": hotspring, "shallow": shallow wells (< 60 m, predominantly in sediments).

*ID	*TYPE	Al	As	Cd	Cl	F	Fe	Mn	Na	NO_2	NO_3	Pb	SO_4	U	pH	EC
	MAC	200	10	5	250	1.5	200	50	200	500	50	10	250	30US	>6.5	2500
		ug/L	ug/L	ug/L	mg/L	mg/L	ug/L	ug/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	<9.5	uS/cm
RV001	DEEP	61	2.25	0.29	34	2.6	10	326	125	<5	30.5	0.42	36	18.6	6.94	1079
RV003	DEEP	118	6.43	0.11	201	1.6	146	2280	251	<5	13.7	0.17	156	19.9	7.14	2330
RV004	DEEP	72	4.36	0.005	33	2.2	5	<0.1	135	<5	40.4	0.42	18	1.92	7.31	798
RV005	hspring	82	25.1	0.033	120	4.6	9	<0.1	473	<5	1.45	0.04	107	3.40	7.19	2350
RV006	DEEP	69	8.12	0.017	49	2.3	280	169	188	<5	<0.05	0.05	53	1.24	7.51	1057
RV007	DEEP	76	0.69	0.011	9	0.9	6	<0.1	63	<5	10.5	1.17	12	3.97	7.29	593
RV008	DEEP	201	1.60	0.007	5	1.3	97	<0.1	65	<5	<0.05	0.22	7	6.77	7.14	574
RV009	DEEP	76	3.10	0.021	24	1.1	49	<0.1	71	<5	8.01	1.18	13	7.25	7.33	789
RV011	DEEP	68	0.55	0.024	6	0.7	<3	<0.1	36	<5	3.3	1.80	5	3.46	6.61	528
RV013	DEEP	80	0.58	0.087	6	1.2	12	<0.1	33	<5	3.48	4.14	4	4.19	7.43	445
RV014	DEEP	71	13.1	0.014	8	2.5	<3	<0.1	142	19	13.5	0.32	8	3.91	8.03	715
RV015	spring	1580	0.22	0.007	2	0.2	550	5.9	5	<5	6.94	0.34	2	0.12	6.34	130
RV016	DEEP	83	4.07	0.017	12	2.3	223	<0.1	100	24	1.53	0.26	16	3.02	7.66	623
RV019	SHALL	150	26.4	0.18	259	4.3	89	1990	288	<5	22.6	0.38	156	32.2	6.94	2160
RV020	DEEP	83	9.18	0.19	98	5.9	79	5.0	282	<5	3.61	2.85	68	4.09	8.29	1344
RV021	DEEP	73	10.7	0.096	122	5.1	10	0.5	407	<5	2.82	0.75	84	7.48	8.55	1776
RV022	SHALL	98	1.53	0.015	2	2.0	28	0.9	31	<5	0.69	0.09	2	1.14	6.68	238
RV023	SHALL	353	2.03	0.011	3	2.6	253	23.8	67	<5	0.88	0.19	2	2.40	6.88	401
RV025	SHALL	97	2.65	0.021	15	1.6	50	742	101	<5	<0.05	0.20	0	4.38	7.17	887
RV026	SHALL	105	96.0	0.036	103	11.6	127	5.4	473	<5	1.35	0.60	50	42.5	8.01	1966
RV027	DEEP	84	11.7	0.006	9	3.5	3	5.1	193	<5	<0.05	0.09	4	3.97	7.99	855
RV028	DEEP	72	2.06	0.013	45	7.6	4	4.1	206	41	0.25	0.50	2	5.22	7.44	982
RV029	DEEP	75	2.35	0.037	8	1.6	47	5.6	78	<5	0.4	2.89	9	4.25	7.18	590
RV030	DEEP	86	16.9	0.022	20	3.1	24	5.5	159	12	1.65	2.23	22	1.77	7.54	785
RV032	DEEP	94	1.49	0.013	58	0.4	24	6.1	92	<5	9.1	1.55	50	3.71	6.73	900
RV033	DEEP	213	0.79	0.016	154	0.1	206	14.8	75	59	149	2.20	22	1.54	6.56	1240
RV034	DEEP	67	6.45	0.048	264	1.2	<3	3.3	408	<5	35.4	0.15	158	4.32	7.65	2020
RV035	hspring	108	3.95	0.044	120	2.0	13	3.8	259	<5	3.51	0.21	105	2.20	7.73	1245
RV036	SHALL	105	4.56	0.042	96	3.7	32	4.6	244	28	3.94	0.15	60	5.23	7.75	1184
RV037	SHALL	74	7.79	0.046	206	3.6	5	9.0	507	47	12.8	0.04	165	8.50	7.36	2200
RV038	DEEP	70	1.43	0.010	32	1.0	<3	3.8	90	7	3.4	3.66	22	3.08	6.65	656
RV039	SHALL	93	1.68	0.007	28	1.6	28	17.6	99	<5	9.25	0.13	16	9.22	7.21	810
RV040	DEEP	74	4.30	0.024	61	7.1	3	4.3	239	<5	0.07	0.97	3	1.25	7.83	1031
RV041	SHALL	78	7.86	0.065	20	3.5	5	6.8	120	<5	0.91	1.43	5	3.24	7.41	739
RV042	DEEP	74	7.9	0.022	3	3.1	21	0.4	105	23	1.53	0.60	2	4.07	7.53	555
RV047	DEEP	78	2.29	0.016	16	3.1	14	4.9	143	118	12	1.75	20	8.69	7.30	801
RV048	DEEP	68	3.25	0.028	4	3.3	4	<0.1	125	16	2.54	0.89	6	6.06	7.26	689
RV049	DEEP	77	5.41	0.031	6	4.8	29	8.8	149	13	6.86	0.63	7	4.42	7.82	700
RV050	river	443	0.44	0.014	2	0.4	277	5.5	19	7	1.14	0.40	1	0.12	7.49	189
RV051	hspring	87	2.34	0.005	23	1.3	64	23.1	181	8	0.02	0.15	0	0.005	7.09	976
RV053	hspring	70	25.8	0.034	29	5.6	7	79.4	197	<5	0.08	0.05	46	1.65	6.07	1002

*ID	*TYPE	Al	As	Cd	Cl	F	Fe	Mn	Na	NO_2	NO_3	Pb	SO_4	U	pH	EC
	MAC	200	10	5	250	1.5	200	50	200	500	50	10	250	30US	>6.5	2500
		ug/L	ug/L	ug/L	mg/L	mg/L	ug/L	ug/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	<9.5	uS/cm
RV054	DEEP	73	2.49	6.41	1	1.5	7	36.8	37	<5	<0.05	8.90	1	0.81	6.74	344
RV055	hspring	111	0.99	0.035	4	1.6	31	1.7	61	11	1.41	0.15	5	0.30	6.60	354
RV056	river	2170	0.03	0.022	1	0.1	2044	265	4	17	6.19	1.46	1	0.22	6.21	64
RV057	DEEP	116	2.90	0.017	106	0.4	216	31.1	214	<5	1.79	0.72	73	5.19	6.11	216
RV058	DEEP	66	3.23	0.004	8	2.6	8	3.6	152	34	<0.05	0.21	0	2.12	7.19	755
RV059	DEEP	195	0.20	0.019	1	2.1	1747	2440	25	<5	<0.05	0.13	0	0.20	7.43	1017
RV060	DEEP	74	1.09	0.010	3	1.1	31	4.0	45	27	3.78	0.53	2	2.27	7.07	416
RV061	DEEP	69	0.41	0.006	3	0.5	12	3.2	21	12	3.11	0.14	2	1.37	6.33	377
RV062	SHALL	70	0.65	0.008	3	2.1	19	3.9	64	8	0.05	0.12	1	2.60	6.47	509
RV063	DEEP	78	1.04	0.010	4	1.9	53	4.1	74	12	0.77	1.00	2	4.31	6.9	543
RV064	DEEP	86	0.74	0.13	2	1.1	30	5.4	31	18	0.53	3.44	1	1.50	6.33	224
RV065	DEEP	475	0.67	0.011	17	1.2	361	18.6	51	16	13.1	1.00	3	5.45	6.66	626
RV066	DEEP	88	0.76	0.057	3	1.7	34	5.2	51	<5	0.36	0.30	2	1.34	6.44	407
RV067	hspring	72	5.58	0.026	18	9.9	11	5.4	204	28	1.36	0.023	22	6.44	6.97	968
RV068	spring	347	0.64	0.020	2	1.3	160	8.3	34	97	3.12	0.13	0	1.47	6.21	203
RV069	spring	2380	0.08	0.012	14	0.3	1706	36.3	27	40	45.3	2.03	3	0.62	5.22	199
RV071	DEEP	63	0.17	0.010	9	0.4	20	285	40	55	27.8	0.07	12	1.62	7.06	805
RV072	DEEP	83	0.12	0.23	1	0.4	59	8.7	13	122	1.32	0.26	0	0.34	5.90	156
RV073	DEEP	62	0.20	0.023	4	0.6	13	5.7	21	27	9.2	0.94	0	0.41	5.95	237
RV074	DEEP	83	0.88	0.068	7	0.4	13	55.6	24	33	15	1.67	2	0.28	5.88	194
RV075	SHALL	1900	0.94	0.36	23	4.3	1283	262	168	<5	0.71	1.75	7	0.54	7.41	945
RV076	river	3440	0.10	0.035	2	0.1	4705	448	4	8	6.57	2.90	1	0.44	6.16	52
RV077	SHALL	178	0.43	0.16	3	0.2	18860	472	11	<5	<0.05	4.22	<0.05	0.006	6.19	277
RV080	DEEP	85	0.08	0.078	4	1.9	1494	57.6	34	<5	<0.05	0.74	11	0.041	7.7	369
RV081	SHALL	91	0.09	0.033	2	0.2	14	0.3	15	<5	0.51	0.61	7	0.069	6.70	268
RV082	DEEP	2220	0.24	0.16	22	0.5	2949	130	55	<5	<0.05	20.4	2	2.24	6.69	688
RV085	DEEP	72	0.58	0.005	111	0.9	54	5.8	60	<5	51.7	0.12	100	3.26	6.53	832
RV086	DEEP	1340	0.43	0.013	39	1.1	2387	51.1	88	<5	5.24	1.86	73	2.55	7.75	720
RV087	DEEP	140	0.55	0.006	44	0.3	276	3.1	48	5	40.1	1.78	11	4.15	7.41	984
RV088	DEEP	225	0.13	0.51	6	0.1	131	9.9	14	<5	1.74	2.19	1	0.062		390
RV090	DEEP	65	0.95	0.044	55	0.2	519	1510	29	<5	5.79	1.12	30	4.41	6.99	678
RV091	SHALL	880	1.43	0.023	265	0.5	490	1370	131	<5	27	0.56	49	3.10	6.56	1358
RV092	DEEP	186	0.30	0.044	54	0.3	1033	20.8	58	<5	5.33	2.76	304	0.52	6.80	1037
RV093	DEEP	215	0.66	0.007	24	0.4	138	10.6	24	16	16	0.44	10	2.17	6.35	235
RV094	spring	640	0.05	0.008	1	0.1	385	14.9	4	<5	2.71	0.43	0	0.026	6.89	103
RV096	spring	65	0.07	0.004	3	0.2	32	5.7	13	389	3.98	0.08	1	0.43	6.76	287
RV098	DEEP	116	3.47	0.042	58	0.7	246	8.9	110	<5	6.69	1.02	94	0.86	7.74	899
RV099	DEEP	127	6.55	0.012	290	1.2	137	50.8	330	<5	0.12	0.13	253	0.26	7.6	1713
RV100	DEEP	67	7.50	0.11	241	2.0	26	36.7	343	<5	0.06	0.13	143	1.18	7.83	1500
RV101	SHALL	968	1.98	0.061	9	0.4	852	20.8	17	5	16	0.50	17	0.26	7.33	243
RV102	DEEP	61	4.89	0.059	166	2.2	18	5.3	352	<5	13	0.22	131	2.90	8.04	1492
RV103	SHALL	1290	3.03	0.011	602	0.5	1522	1310	391	<5	0.04	0.18	143	0.23	7.17	3300
RV104	DEEP	60	2.03	0.080	60	0.6	13	5.6	87	<5	3.4	3.13	112	2.92	6.85	967
RV105	DEEP	53	0.15	0.59	24	0.3	43	48.7	49	1120	14	0.47	25	0.36	6.99	729
RV106	DEEP	86	1.92	0.038	58	0.5	140	7.1	209	19	68.9	1.33	112	2.88	7.3	1122
RV109	SHALL	66	3.66	0.082	29	0.6	24	54.2	111	593	6.03	8.62	68	0.90	7.57	635
RV111	DEEP	127	0.51	0.008	23	0.9	915	267	54	<5	<0.05	0.11	17	0.008	6.95	567
RV112	DEEP	92	0.02	0.003	12	0.2	545	13.5	12	<5	25	0.20	15	0.22	6.17	379
RV113	DEEP	47	2.47	0.14	12	0.4	54	1530	31	<5	3.14	0.41	13	3.34	6.95	593
RV115	DEEP	40	0.47	0.005	24	0.4	82	245	87	<5	<0.05	0.10	54	1.93	7.38	739
RV116	DEEP	55	1.68	0.012	8	0.2	1417	200	29	<5	4.08	0.22	5	2.36	7.26	676
RV118	DEEP	919	2.79	0.20	153	0.8	1461	49.6	386	<5	4.1	1.48	460	0.08	7.54	2020
RV119	DEEP	1920	0.75	0.19	119	0.4	9580	247	123	<5	3.72	46.4	205	1.46	7.41	1210

*ID	*TYPE	Al	As	Cd	Cl	F	Fe	Mn	Na	NO_2	NO_3	Pb	SO_4	U	pH	EC
	MAC	200	10	5	250	1.5	200	50	200	500	50	10	250	30US	>6.5	2500
		ug/L	ug/L	ug/L	mg/L	mg/L	ug/L	ug/L	mg/L	ug/L	mg/L	ug/L	mg/L	ug/L	<9.5	uS/cm
RV120	DEEP	51	1.02	0.024	254	0.6	188	0.1	120	<5	55.4	14.2	130	4.18	6.72	1615
RV121	DEEP	2250	0.52	0.021	36	0.8	1962	148	93	895	7.97	0.69	91	1.26	6.91	718
RV123	spring	52	0.10	0.005	18	0.2	13	10.5	14	4	22	0.03	12	0.14	5.99	333
RV124	hspring	70	4.94	0.058	1240	2.9	34	12.9	595	<5	6.71	0.23	164	0.66	7.08	3850
RV126	SHALL	94	2.52	0.048	282	1.9	43	10.0	287	<5	12	0.06	264	0.40	7.63	1725
RV127	SHALL	93	0.43	0.019	49	0.5	25	14.8	103	<5	9.09	0.04	692	1.25	7.38	1415
RV128	SHALL	134	1.41	0.034	263	0.8	96	13.0	385	<5	56.8	0.15	617	0.93	7.82	2280
RV130	DEEP	87	0.35	0.004	67	0.4	2105	29.3	41	<5	18.9	0.10	66	2.64	6.73	980
RV131	DEEP	73	0.44	0.007	106	0.2	196	12.5	54	<5	27.8	0.08	316	1.82	6.78	1467
RV132	SHALL	95	0.60	0.031	149	0.5	1124	16.4	74	<5	100	0.29	71	7.11	6.84	1279
RV133	SHALL	101	0.45	<0.002	120	0.3	530	11.5	73	<5	97.2	0.15	68	43.3	7.00	1236
RV134	SHALL	106	0.70	0.044	181	1.1	20	48.3	138	<5	90.2	0.13	58	47.7	7.08	1327
RV136	SHALL	300	0.42	0.006	49	0.5	270	78.1	90	<5	3.14	0.12	273	1.55	7.76	1041
RV137	SHALL	65	0.75	0.017	222	0.3	15	9.0	111	<5	71.2	0.27	358	3.08	6.94	1969
RV138	DEEP	63	0.23	0.019	50	0.5	22	8.1	34	<5	22.9	0.62	57	2.16	6.93	856
RV139	DEEP	72	0.91	0.022	13	1.0	28	8.0	52	20	14.3	0.17	7	2.33	7.34	471
RV141	DEEP	140	0.65	0.098	25	0.5	209	1.3	109	5	2.44	2.28	16	2.86	7.35	765
RV142	DEEP	729	0.49	0.035	48	1.4	463	17.1	62	<5	3.12	0.57	30	3.42	6.71	789
RV143	DEEP	115	13.7	0.12	159	7.1	61	0.2	546	<5	5.87	4.68	110	8.40	8.33	2220
RV144	SHALL	102	1.56	0.021	9	1.4	21	0.3	108	63	12.7	0.25	12	10.5	7.47	668
RV145	DEEP	194	1.29	0.021	6	1.3	83	14.0	69	9	6.15	0.46	6	4.28	7.31	469
RV146	DEEP	85	0.61	0.012	5	1.2	8	0.5	54	16	1.09	0.50	4	4.69	7.13	438
RV147	DEEP	256	7.94	0.047	17	2.6	866	52.0	139	<5	0.88	8.27	7	3.32	7.80	725
RV148	DEEP	308	4.09	0.065	2	7.1	724	24.1	84	<5	1.6	1.66	4	1.10	7.27	353

Table 14 (see attachment) gives inter-element correlation coefficients for the well waters. Results for deep wells and shallow wells are given. The other subsets contain too few samples to calculate reliable correlation coefficients. The data were ln-transformed prior to calculating correlation coefficients (except pH, which is logarithmic). Elements with more than 10% of all values below detection were excluded.

Table 15 gives a listing of data outliers as identified via the boxplot. Only wells with at least one outlier are shown in this table. The table allows to easily identify unusual wells and to detect element associations. This list shows all samples with upper (or lower – one case only) outliers. The outlier identification is based on boxplot statistics (values falling outside the upper (or lower) whisker) and thus depends on the statistical distribution of each element within the data set. The list is sorted according to sample ID. For each of the samples with an outlier the element(s) showing outliers and the measured concentration in µg/L (exception: pH: no unit) is given. ATTENTION: The list is not based on MAC or GL-values, but will show all wells with unusually high concentration (in relation to all other wells) in any of the selected elements. Several REEs were not included in the element selection when computing the list. These will correlate highly with Ce, La, and Y and show outliers in the same samples. The combination of elements showing outliers can give first ideas about the process(es) causing these.

Table 15: Outlier listing for "drinking water" data subset (N=138). Only wells with at least one data outlier are shown. The outliers are "upper outliers" if not otherwise stated. "_M": analyses by ICP-MS, "_E": analyses by ICP-AES, "_I": analyses by IC, "_F": as measured in the field, "_L": as measured in the laboratory.

RV001 -Ag_M(0.006), Ba_M(118), Bi_M(0.009), Cd_M(0.29), Co_M(0.62), Hg_M(0.067), I_M(69), In_M(0.002), Mn_M(326), Nb_M(0.17), Th_M(0.17), Tl_M(0.084), U_M(18.6), W_M(0.25), Y_M(0.49)

RV003 -Ba_M(120), Bi_M(0.009), Br_M(2450), Ca_E(181700), Cd_M(0.11), Cl_I(201000), Co_M(0.8), I_M(961), In_M(0.002), Mn_M(2280), Mo_M(29.7), Nb_M(0.13), Ni_M(4.19), Tl_M(0.046), U_M(19.9)

RV004 -Ag_M(0.003), Ge_M(2.54), NO3_I(40400)

RV005 - As_M(25.1), B_M(997), Be_M(0.41), Cs_M(2.24), F_I(4580), Ge_M(7.83), Li_M(176), Mo_M(23.4), Na_E(473300), Nb_M(0.5), Rb_M(68.2), Ta_M(0.008), Tl_M(0.042), W_M(0.4), Zr_M(1.46), Alk_L(1070)

RV006 - As_M(8.12), In_M(0.002), Mn_M(169), W_M(0.74)

RV007 - Ag_M(0.002), Hg_M(0.039), In_M(0.002)

RV008 - Ag_M(0.003), Ce_M(0.54), In_M(0.002), La_M(0.24), Sn_M(0.17), Zr_M(1)

RV009 - Sb_M(0.27)

RV011 - Zn_M(718)

RV013 - Pb_M(4.14), Zn_M(1950)

RV014 - As_M(13.1), Cr_M(4.06), W_M(0.24)

RV015 - Al_M(1580), Be_M(0.16), Ce_M(1.68), Ga_M(0.48), Gd_M(0.17), Hf_M(0.077), In_M(0.003), La_M(0.59), Nb_M(0.47), Nd_M(0.65), Ta_M(0.026), Th_M(0.12), Ti_M(40), Y_M(1.02), Zr_M(3.04)

RV016 - Bi_M(0.01), Cr_M(5.28)

RV017 - Te_M(0.015)

RV019 - As_M(26.4), Bi_M(0.008), Br_M(1880), Cd_M(0.18), Cl_I(259000), Co_M(0.66), Cr_M(3.05), I_M(126), In_M(0.002), Mn_M(1990), Mo_M(78.3), Nb_M(0.14), Sn_M(0.14), Ta_M(0.012), U_M(32.2), V_M(75.9), W_M(2.22)

RV020 - As_M(9.18), B_M(621), Cd_M(0.19), Cs_M(0.56), F_I(5920), Ge_M(2.1), In_M(0.002), Mo_M(39.5), Ta_M(0.014), V_M(70.7), W_M(1.73)

RV021 - As_M(10.7), B_M(866), Cs_M(0.56), F_I(5120), Ge_M(2.39), In_M(0.002), Mo_M(77.4), Na_E(406600), Rb_M(45.1), Ta_M(0.008), Te_M(0.013), W_M(1.71), pH_F(8.55)

RV022 - Ag_M(0.021), In_M(0.003)

RV023 - Ag_M(0.008), Al_M(353), Ce_M(1.29), Ga_M(0.13), Gd_M(0.13), Hf_M(0.058), In_M(0.003), La_M(0.64), Nb_M(0.34), Nd_M(0.61), Ta_M(0.007), Th_M(0.06), Y_M(0.63), Zr_M(3.28)

RV025 - Mn_M(742)

RV026 - As_M(96), B_M(734), Cs_M(0.62), F_I(11600), Gd_M(1.008), I_M(83.2), Mo_M(30.9), Na_E(472800), Sb_M(0.34), Ta_M(0.028), U_M(42.5), W_M(0.23), Alk_L(938)

RV027 - As_M(11.7), Sb_M(0.12), V_M(235), W_M(0.35)

RV028 - Be_M(0.16), Cs_M(0.4), F_I(7570), Nb_M(0.19), NO2_I(41), Sb_M(0.17), Ta_M(0.01), W_M(0.79)

RV029 - Cu_M(13.7), Ge_M(1.95)

RV030 - As_M(16.9), Cs_M(1.27), Ge_M(5.15), Li_M(111), Mo_M(23.9), W_M(0.75)

RV033 - Al_M(213), Ba_M(110), Br_M(1440), Ca_E(151300), Cl_I(154000), Ni_M(4.68), NO2_I(59), NO3_I(149000), Sr_M(1480), Tl_M(0.024), Zn_M(1920)

RV034 - B_M(590), Br_M(1570), Cl_I(264000), Cr_M(5.38), Mo_M(41.6), Na_E(408000), NO3_I(35400), W_M(0.54)

RV035 - B_M(547), Mo_M(32), V_M(68.6), W_M(1.02)

RV036 - B_M(507), Mo_M(46.3), W_M(0.82)

RV037 - As_M(7.79), B_M(638), Br_M(1600), Cl_I(206000), I_M(202), Mo_M(51.1), Na_E(507000), NO2_I(47), Te_M(0.015), W_M(0.98), Alk_L(830)

RV038 - Pb_M(3.66)

RV039 - U_M(9.22)

RV040 - F_I(7100), Ta_M(0.013), W_M(3.81)

RV041 - As_M(7.86), Sb_M(0.2)

RV042 - As_M(7.9), W_M(0.34)

RV046 - Te_M(0.012), Y_M(0.59)

RV047 - Ge_M(2.74), NO2_I(118), Sn_M(1.96)

RV048 - V_M(72.5)

RV049 - F_I(4750), Mo_M(31.5), V_M(69.1), W_M(0.25)

RV050 - Al_M(443), Ce_M(1.42), Ga_M(0.16), Gd_M(0.15), Hf_M(0.06), In_M(0.002), La_M(0.76), Nb_M(0.33), Nd_M(0.71), Te_M(0.015), Th_M(0.077), Y_M(0.76), Zr_M(3.65)

RV051 - Cs_M(0.43), Ge_M(3.89), K_E(45800), Rb_M(61.2), Te_M(0.012), Th_M(0.1), Tl_M(0.03)

RV053 - As_M(25.8), Be_M(5.91), Cs_M(12.1), F_I(5590), Ge_M(11.6), Li_M(174), Rb_M(82.2), Sb_M(1.78), Ta_M(0.014), Tl_M(0.15), W_M(3.29)

RV054 - Cd_M(6.41), Pb_M(8.9), Zn_M(3980)

RV055 - Cs_M(0.21)

RV056 - Al_M(2170), Be_M(0.27), Ce_M(10.3), Co_M(1.81), Fe_E(2044), Ga_M(0.72), Gd_M(1), Hf_M(0.053), In_M(0.008), La_M(5.09), Mn_M(265), Nb_M(0.34), Nd_M(5.27), Th_M(0.12), Ti_M(85.1), Tl_M(0.032), Y_M(4.38), Zr_M(2.26)

RV057 - Ge_M(1.86)

RV058 - NO2_I(34)

RV059 - Co_M(0.49), Fe_E(1747), Ga_M(0.3), Mn_M(2440), Te_M(0.017)

RV063 - Sn_M(0.22)

RV064 - Cd_M(0.13), Cs_M(0.32), Pb_M(3.44), Zn_M(958)

RV065 - Al_M(475), Ce_M(1.83), Ga_M(0.15), Gd_M(0.14), Hf_M(0.1), La_M(0.81), Nb_M(0.21), Nd_M(0.78), Th_M(0.12), Ti_M(21), Y_M(0.64), Zr_M(5.14)

RV066 - Te_M(0.012)

RV067 - Be_M(1.56), Cs_M(1.01), F_I(9920), Ge_M(4.85), Hf_M(0.038), Mo_M(30.1), Ta_M(0.035), Te_M(0.016), Th_M(0.062), W_M(2.45), Y_M(0.57)

RV068 - Al_M(347), Be_M(1.15), Ce_M(2.6), Cs_M(0.43), Ga_M(0.13), Gd_M(0.082), Hf_M(0.3), La_M(0.36), Nb_M(1.02), Nd_M(0.31), NO2_I(97), Ta_M(0.011), Th_M(0.23), Y_M(0.94), Zr_M(12.3)

RV069 - **Lower outlier**: pH_F(5.22)
Upper outlier: Al_M(2380), Be_M(1.55), Ce_M(12.7), Fe_E(1706), Ga_M(1.47), Gd_M(2.86),Hf_M(0.078), In_M(0.017), La_M(19.4), Nb_M(0.63), Nd_M(18.2), NO2_I(40), NO3_I(45300), Ta_M(0.018), Th_M(1.59), Ti_M(123), Y_M(10.3), Zr_M(2.56)

RV071 - Mn_M(285), NO2_I(55)

RV072 - Be_M(0.39), Cd_M(0.23), NO2_I(122), Zn_M(693)

RV073 - Be_M(0.3), Cu_M(8.59)

RV074 - Cu_M(8.25), Gd_M(0.12), Y_M(1.5)

RV075 - Al_M(1900), Be_M(0.21), Cd_M(0.36), Ce_M(9.39), Co_M(0.59), Cr_M(3.48), Fe_E(1283), Ga_M(0.74), Gd_M(0.74), Ge_M(2.07), Hf_M(0.4), In_M(0.009), La_M(4.16), Li_M(78.4), Mn_M(262), Nb_M(2.37), Nd_M(4.02), Ni_M(4.58), Sn_M(0.14), Ta_M(0.017), Th_M(0.3), Ti_M(53.3), W_M(1.65), Y_M(3.77), Zr_M(25)

RV076 - Al_M(3440), Be_M(0.63), Ce_M(24.6), Co_M(3.07), Fe_E(4705), Ga_M(1.58), Gd_M(1.99), Hf_M(0.054), In_M(0.016), La_M(11.7), Mn_M(448), Nb_M(0.29), Nd_M(11.6), Th_M(0.24), Ti_M(106), Tl_M(0.045), Y_M(8.21), Zr_M(1.84)

RV077 - Cd_M(0.16), Co_M(2.46), Fe_E(18860), Mn_M(472), Pb_M(4.22), Zn_M(4370)

RV080 - Fe_E(1494), Zn_M(510)

RV082 - Al_M(2220), Ba_M(102), Be_M(0.18), Cd_M(0.16), Ce_M(9.31), Co_M(1.56), Cr_M(3.16), Cu_M(21.9), Fe_E(2949), Ga_M(0.67), Gd_M(0.75), In_M(0.004), La_M(4.35), Mn_M(130), Nb_M(0.11), Nd_M(4.57), Ni_M(3.82), Pb_M(20.4), Sn_M(0.16), Th_M(0.64), Ti_M(42.5), Tl_M(0.029), Y_M(2.94), Zn_M(476), Zr_M(0.91)

RV083 - In_M(0.004), Ta_M(0.007)

RV084 - In_M(0.003)

RV085 - NO3_I(51700)

RV086 - Al_M(1340), Ce_M(3.11), Co_M(0.84), Cr_M(6.46), Fe_E(2387), Ga_M(0.33), Gd_M(0.21), Hf_M(0.037), In_M(0.003), La_M(1.29), Nb_M(0.12), Nd_M(1.2), Te_M(0.012), Th_M(0.2), Ti_M(40.2), Y_M(0.87), Zn_M(1020), Zr_M(1.6)

RV087 - Hf_M(0.033), In_M(0.002), Mg_E(52800), NO3_I(40100), Sn_M(0.14), Zr_M(1.37)

RV088 - Al_M(225), Cd_M(0.51), Ce_M(0.8), Gd_M(0.074), La_M(0.41), Nd_M(0.41), Zn_M(1510)

RV089 - Cr_M(4.88), Hg_M(0.069), NO3_I(36300)

RV090 - Ca_E(179100), Co_M(1.31), Cu_M(14.1), I_M(140), Mn_M(1510), Ni_M(5.44), Zn_M(486)

RV091 - Al_M(880), Ba_M(226), Bi_M(0.007), Br_M(1180), Ca_E(187900), Ce_M(2.69), Cl_I(265000), Co_M(1.66), Cu_M(15.4), Ga_M(0.25), Gd_M(0.25), Hg_M(0.042), I_M(133), In_M(0.002), La_M(1.18), Mg_E(53600), Mn_M(1370), Nd_M(1.37), Ni_M(6.39), Se_M(3.25), Th_M(0.053), Ti_M(36.6), Y_M(1.13)

RV092 - Cu_M(27), Fe_E(1033), Mg_E(66500), Ni_M(8.75), Se_M(7.58), Sn_M(0.25), SO4_I(304000)

RV093 - Al_M(215), Ba_M(188), Be_M(0.26)

RV094 - Al_M(640), Ce_M(1.36), Ga_M(0.18), Gd_M(0.072), La_M(0.26), Nb_M(0.12), Nd_M(0.29)

RV096 - NO2_I(389)

RV099 - Br_M(2170), Cl_I(290000), Na_E(330200), Se_M(5.35), SO4_I(253000), W_M(0.52)

RV100 - As_M(7.5), Br_M(1610), Cd_M(0.11), Cl_I(241000), I_M(84.5), Mo_M(25.1), Na_E(342700), Se_M(3.71), V_M(70), W_M(0.65)

RV101 - Al_M(968), Ce_M(1.19), Co_M(0.46), Fe_E(852), Ga_M(0.25), Gd_M(0.1), Hf_M(0.035), In_M(0.002), La_M(0.47), Nb_M(0.13), Nd_M(0.51), Th_M(0.094), Ti_M(24.5), Y_M(0.42), Zr_M(1.31)

RV102 - B_M(474), Br_M(1190), Cl_I(166000), I_M(114), Mo_M(26.2), Na_E(351900), V_M(68.5), W_M(0.31)

RV103 - Al_M(1290), B_M(760), Ba_M(305), Bi_M(0.019), Br_M(6010), Ca_E(163000), Ce_M(1.96), Cl_I(602000), Co_M(1.5), Fe_E(1522), Ga_M(0.3), Gd_M(0.18), Hf_M(0.062), I_M(469), In_M(0.002), La_M(0.8), Mg_E(101600), Mn_M(1310), Na_E(391400), Nb_M(0.13), Nd_M(0.86), Ni_M(4.6), Sn_M(0.2), Sr_M(2120), Th_M(0.088), Ti_M(48.9), Y_M(0.8), Zr_M(2.07)

RV104 - Cr_M(5.8), Cs_M(0.24), Se_M(4.91), Tl_M(0.027), Zn_M(611)

RV105 - Cd_M(0.59), NO2_I(1120), Sr_M(1230)

RV106 - B_M(584), Cr_M(4.82), I_M(77.4), NO3_I(68900), Se_M(4.16), V_M(113)

RV107 - B_M(439), Br_M(1500), Cd_M(0.15), Cl_I(182000), Ga_M(0.35), Se_M(3.28)

RV108 - Pb_M(3.95)

RV109 - Cu_M(21.6), NO2_I(593), Pb_M(8.62), Sb_M(0.15), V_M(97.8), W_M(0.21)

RV111 - Be_M(0.34), Fe_E(915), Mn_M(267)

RV112 - Te_M(0.012)

RV113 - Cd_M(0.14), Co_M(0.68), Mn_M(1530), Te_M(0.019), Tl_M(0.025)

RV114 - Hg_M(0.8), La_M(0.47)

RV115 - Hg_M(0.074), I_M(82.2), Mn_M(245)

RV116 - Co_M(0.39), Fe_E(1417), In_M(0.002), Mn_M(200), V_M(76.9)

RV117 - Cd_M(0.19), Sb_M(0.16), Sn_M(5.18)

RV118 - Al_M(919), B_M(625), Bi_M(0.008), Br_M(1490), Cd_M(0.2), Ce_M(1.41), Cl_I(153000), Co_M(1.45), Cr_M(7.1), Cs_M(2.25), Fe_E(1461), Ga_M(0.38), Gd_M(0.16), Ge_M(1.97), Hf_M(0.065), La_M(0.55), Na_E(386300), Nb_M(0.34), Nd_M(0.81), Ni_M(11.2), Rb_M(74.9), Sn_M(7.48), SO4_I(460000), Sr_M(1430), Th_M(0.055), Ti_M(264), Y_M(0.41), Zr_M(2.49)

RV119 - Al_M(1920), Bi_M(0.009), Cd_M(0.19), Ce_M(3.76), Co_M(2.66), Cr_M(21.3), Cu_M(22.3), Fe_E(9580), Ga_M(0.55), Gd_M(0.34), Hf_M(0.035), In_M(0.011), La_M(1.4), Mg_E(62000), Mn_M(247), Nd_M(1.8), Ni_M(9.88), Pb_M(46.4), Sn_M(0.18), SO4_I(205000), Th_M(0.17), Ti_M(110), Tl_M(0.024), Y_M(1.11), Zn_M(5140), Zr_M(1.55)

RV120 - Bi_M(0.011), Br_M(2120), Ca_E(171400), Cl_I(254000), NO3_I(55400), Pb_M(14.2), Se_M(4.5), Sn_M(0.12), Sr_M(1480), Zn_M(1570)

RV121 - Al_M(2250), Be_M(0.13), Ce_M(5.57), Co_M(1.76), Cr_M(6.46), Fe_E(1962), Ga_M(0.56), Gd_M(0.47), Hf_M(0.042), In_M(0.004), La_M(2.33), Mn_M(148), Nb_M(0.17), Nd_M(2.46), Ni_M(5.12), NO2_I(895), Th_M(0.37), Ti_M(91.1), Tl_M(0.025), Y_M(1.81), Zr_M(2.25)

RV123 - Ba_M(104)

RV124 - B_M(780), Bi_M(0.03), Br_M(6110), Ca_E(196500), Cl_I(1.24e+006), Cr_M(4.93), Cs_M(0.57), K_E(37840), Mo_M(34.6), Na_E(595000), Rb_M(73.7), Sn_M(0.18), Sr_M(2890), Ta_M(0.008), Tl_M(0.038), V_M(191), W_M(3.66)

RV125 - V_M(96.3)

RV126 - B_M(443), Br_M(2130), Cl_I(282000), Cs_M(0.56), Hg_M(0.038), Mo_M(39.3), Se_M(4.99), SO4_I(264000), Tl_M(0.05), W_M(0.7)

RV127 - Ca_E(185200), Hg_M(0.062), SO4_I(692000), Sr_M(9850), Ti_M(19.7)

RV128 - B_M(556), Br_M(2120), Cl_I(263000), Cr_M(7.36), Na_E(385000), NO3_I(56800), Se_M(6.87), SO4_I(617000), Sr_M(1270)

RV129 - SO4_I(222000), Sr_M(1220)

RV130 - Ba_M(128), Fe_E(2105), Hg_M(0.086)

RV131 - Ca_E(193000), Hg_M(0.093), Mg_E(72700), Se_M(6.1), SO4_I(316000), Sr_M(1360), Tl_M(0.029)

RV132 - Ba_M(120), Br_M(1180), Ca_E(152300), Cl_I(149000), Fe_E(1124), Hg_M(0.081), NO3_I(100000)

RV133 - Ba_M(135), NO3_I(97200), U_M(43.3)

RV134 - Ba_M(103), Br_M(1550), Cl_I(181000), Hg_M(0.099), Mg_E(64100), NO3_I(90200), U_M(47.7)

RV135 - SO4_I(169000)

RV136 - Al_M(300), Co_M(0.4), SO4_I(273000), Sr_M(1370)

RV137 - Br_M(2330), Ca_E(177900), Cl_I(222000), Hg_M(0.099), Mg_E(116100), NO3_I(71200), SO4_I(358000)

RV138 - Ba_M(117), Cu_M(7.16)

RV140 - Cu_M(19.5), Hg_M(0.077), NO3_I(43700)

RV141 - Cr_M(18.1), Hg_M(0.067), Ni_M(4.04), Zn_M(594)

RV142 - Al_M(729), Be_M(0.42), Ce_M(1.55), Co_M(0.33), Cs_M(0.26), Ga_M(0.17), Gd_M(0.18), Hg_M(0.043), In_M(0.002), La_M(0.72), Nd_M(0.84), Th_M(0.055), Ti_M(23.6), Y_M(0.67)

RV143 - As_M(13.7), B_M(898), Cd_M(0.12), Cl_I(159000), Cs_M(1.51), Cu_M(8.12), F_I(7130), Ge_M(4.35), Hg_M(0.094), Mo_M(71.7), Na_E(546000), Pb_M(4.68), Rb_M(59), Sb_M(0.13), Ta_M(0.022), W_M(2.51), Alk_L(920)

RV144 - NO2_I(63), U_M(10.5)

RV145 - Cs_M(0.2)

RV147 - Al_M(256), As_M(7.94), Cu_M(10.8), Fe_E(866), In_M(0.002), Pb_M(8.27)

RV148 - Al_M(308), Be_M(0.2), Ce_M(4.1), F_I(7130), Fe_E(724), Ga_M(0.2), Gd_M(0.19), Hf_M(0.3), In_M(0.006), La_M(0.79), Nb_M(2.26), Nd_M(0.78), Sb_M(0.55), Ta_M(0.054), Th_M(0.55), Ti_M(44.4), Y_M(0.91), Zr_M(13)

Figure 7 shows CDF-diagrams for all elements in the drinking water data subset. These figures can be used to study the spread of data for any one element and to see how many samples may be below the limit of detection (DL – straight vertical line at left side of diagram).

Figure 7: CDF-Diagrams (CDF=cumulative distribution function) for drinking water from the Rift Valley, Ethiopia (N=138) (fig. 1 out of 6: Ag-Cl). Data below detection were set to ½ of the analytical detection limit and plot as a straight line at the left hand site of the diagrams.

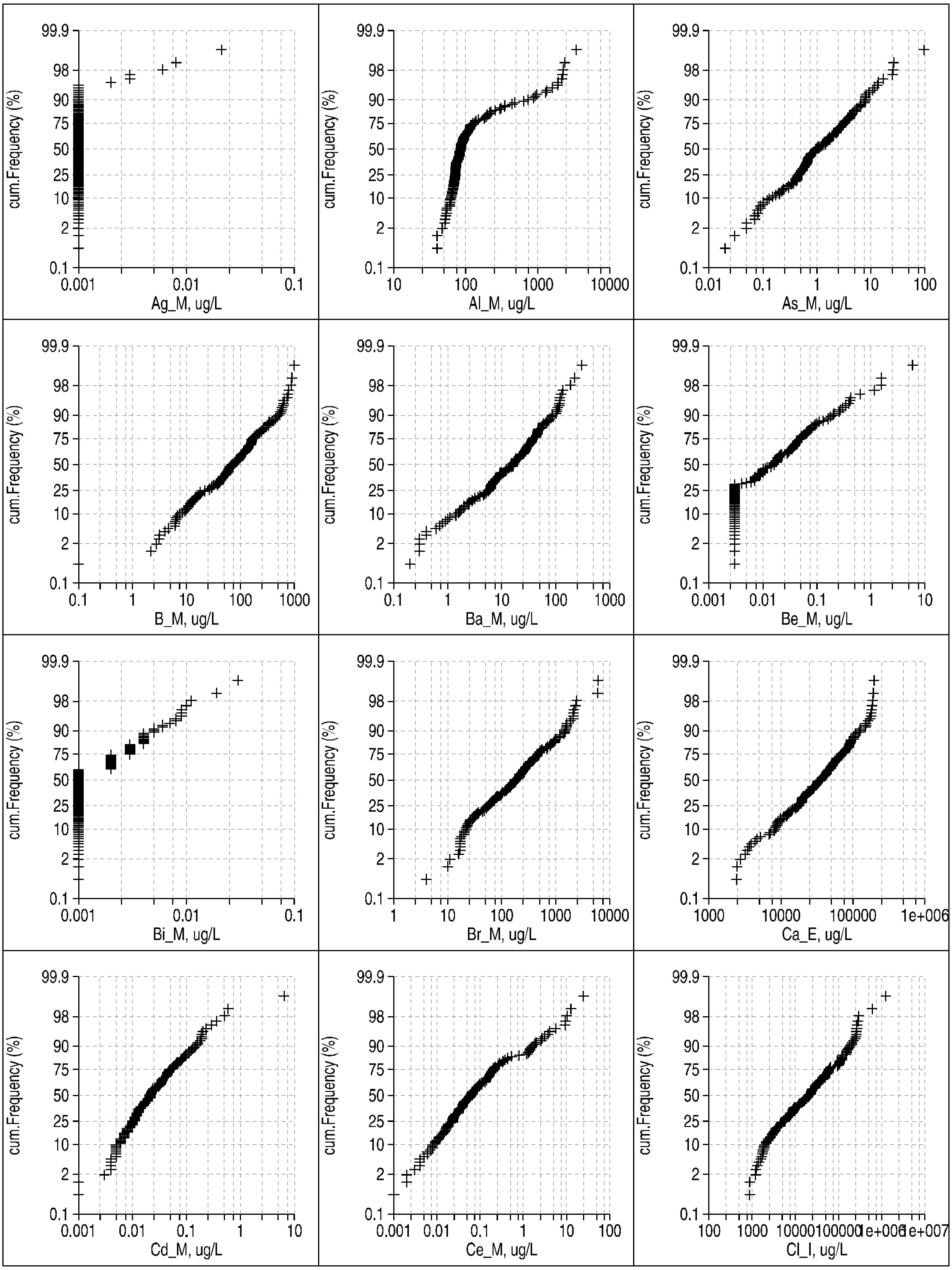


Figure 7 (continued – 2 out of 6: Co-Ge)

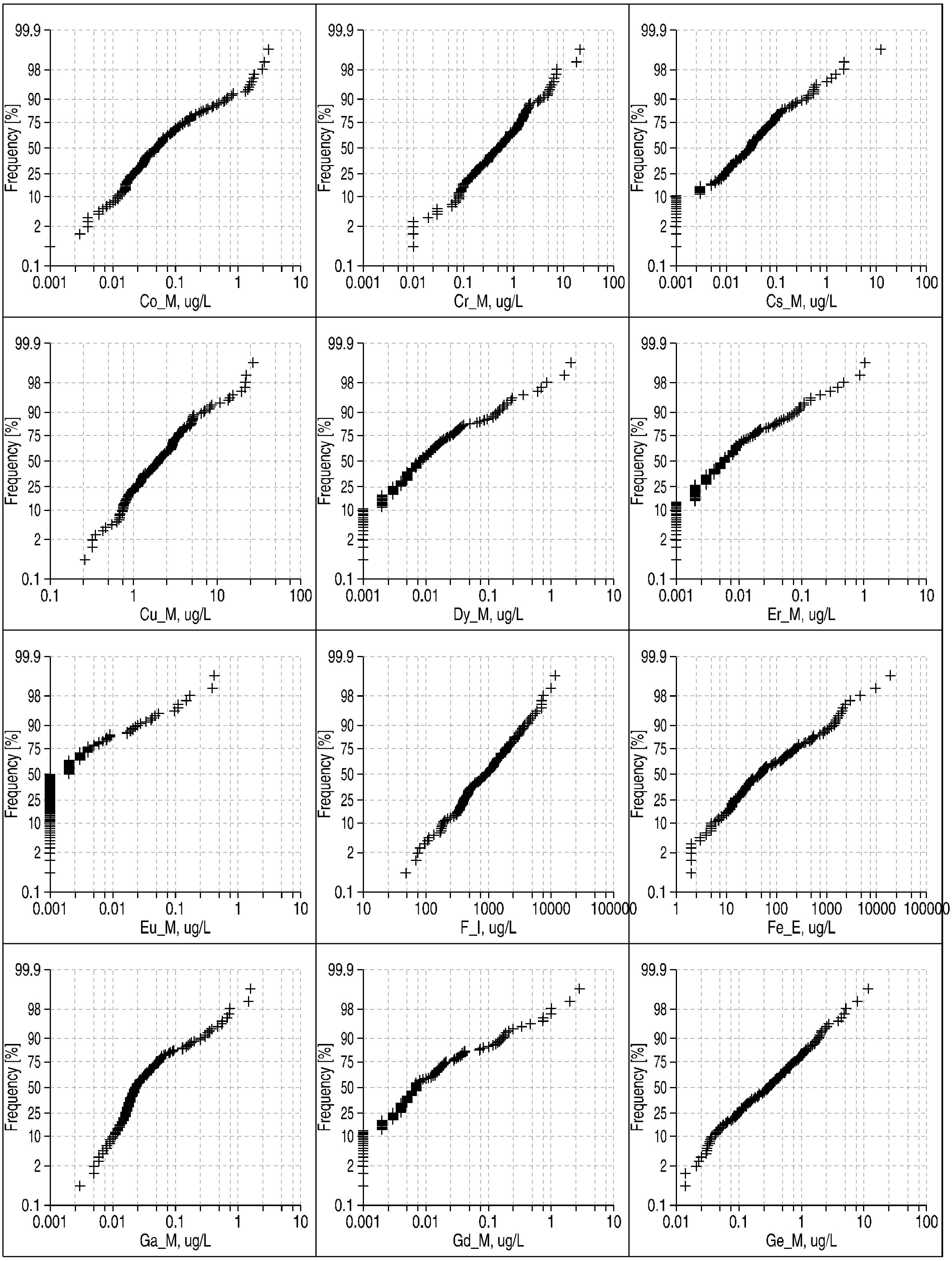


Figure 7 (continued – 3 out of 6: Hf-Mo)

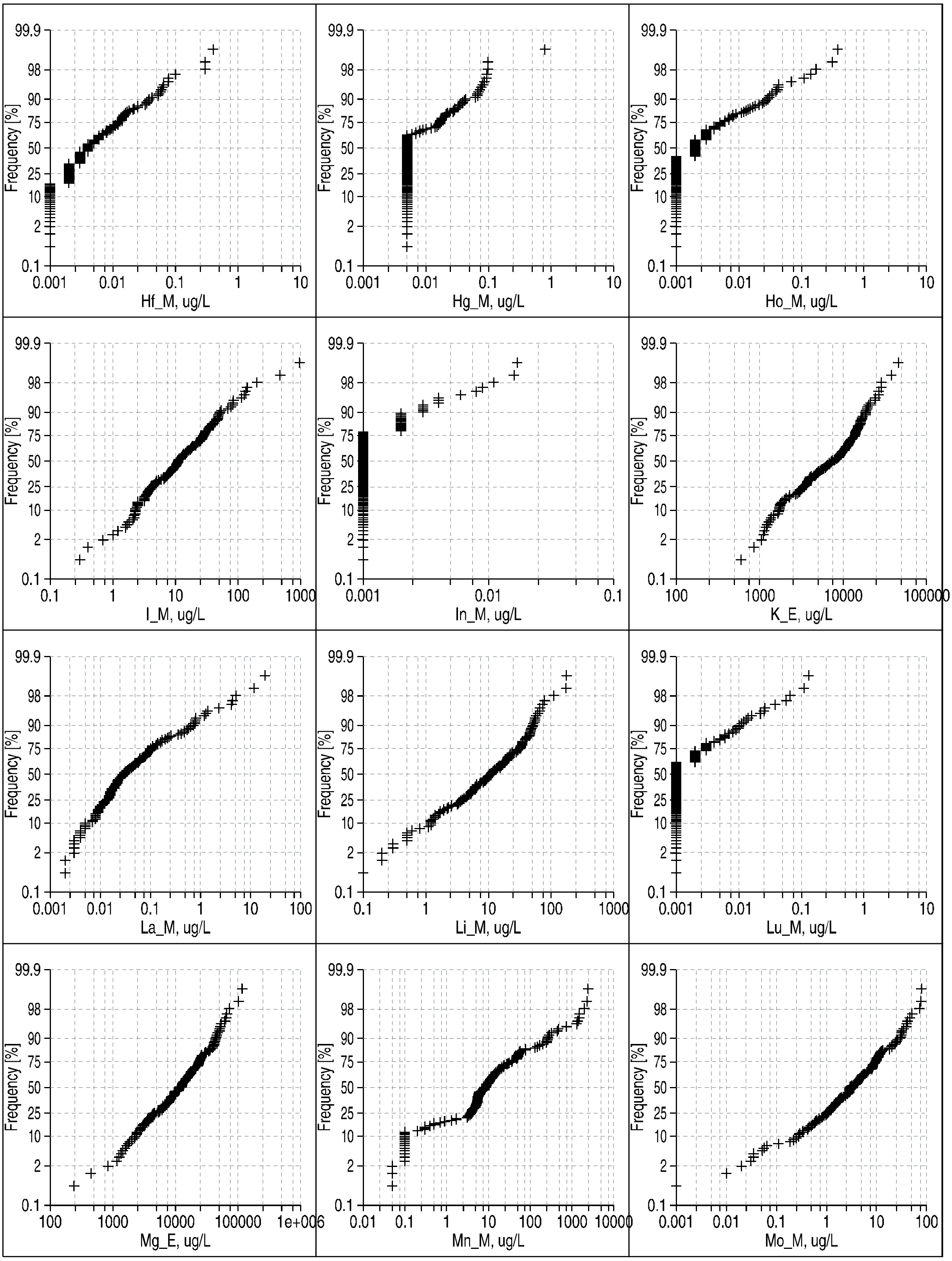


Figure 7 (continued – 4 out of 6: Na-Si)

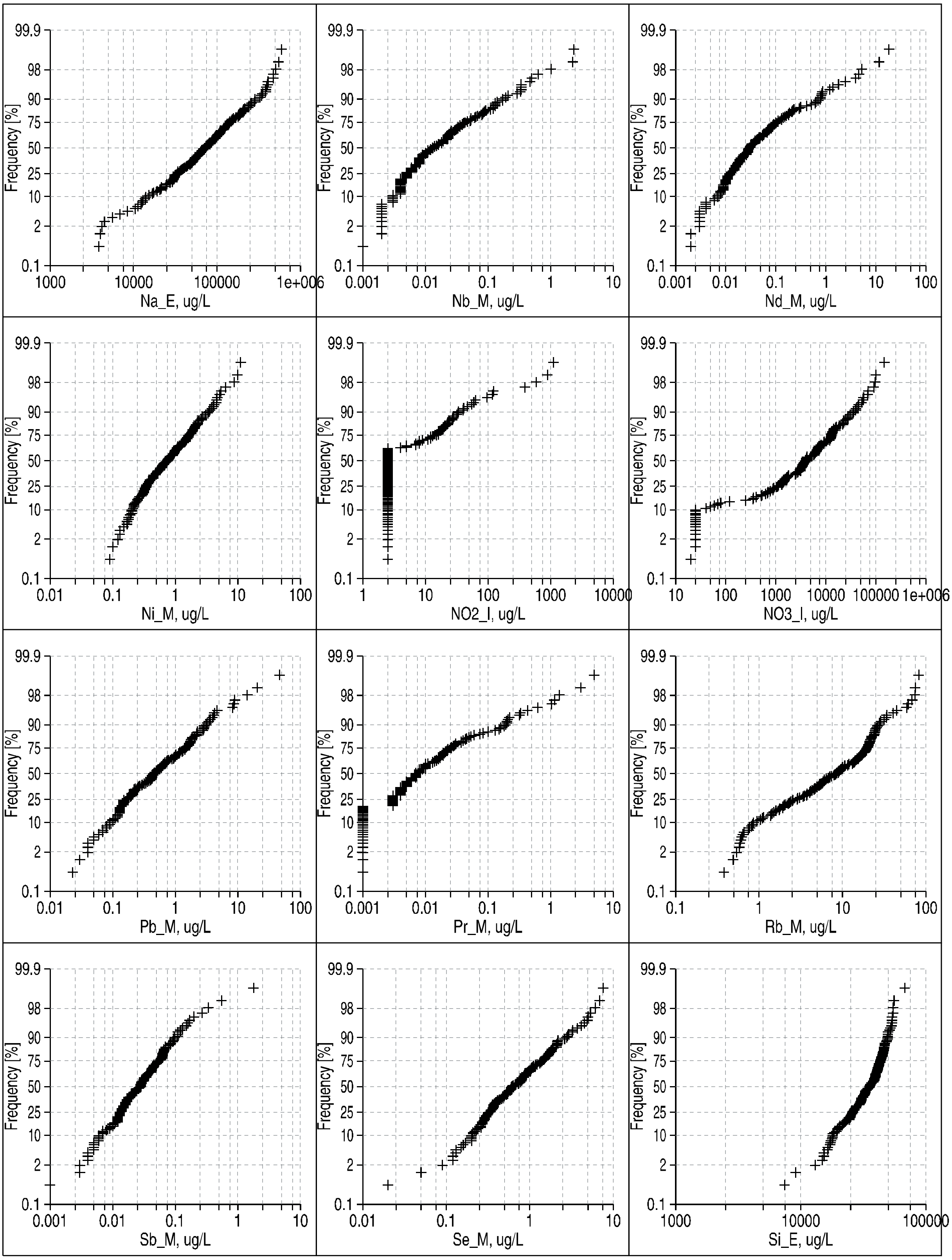


Figure 7 (continued – 5 out of 6: Sm-U)

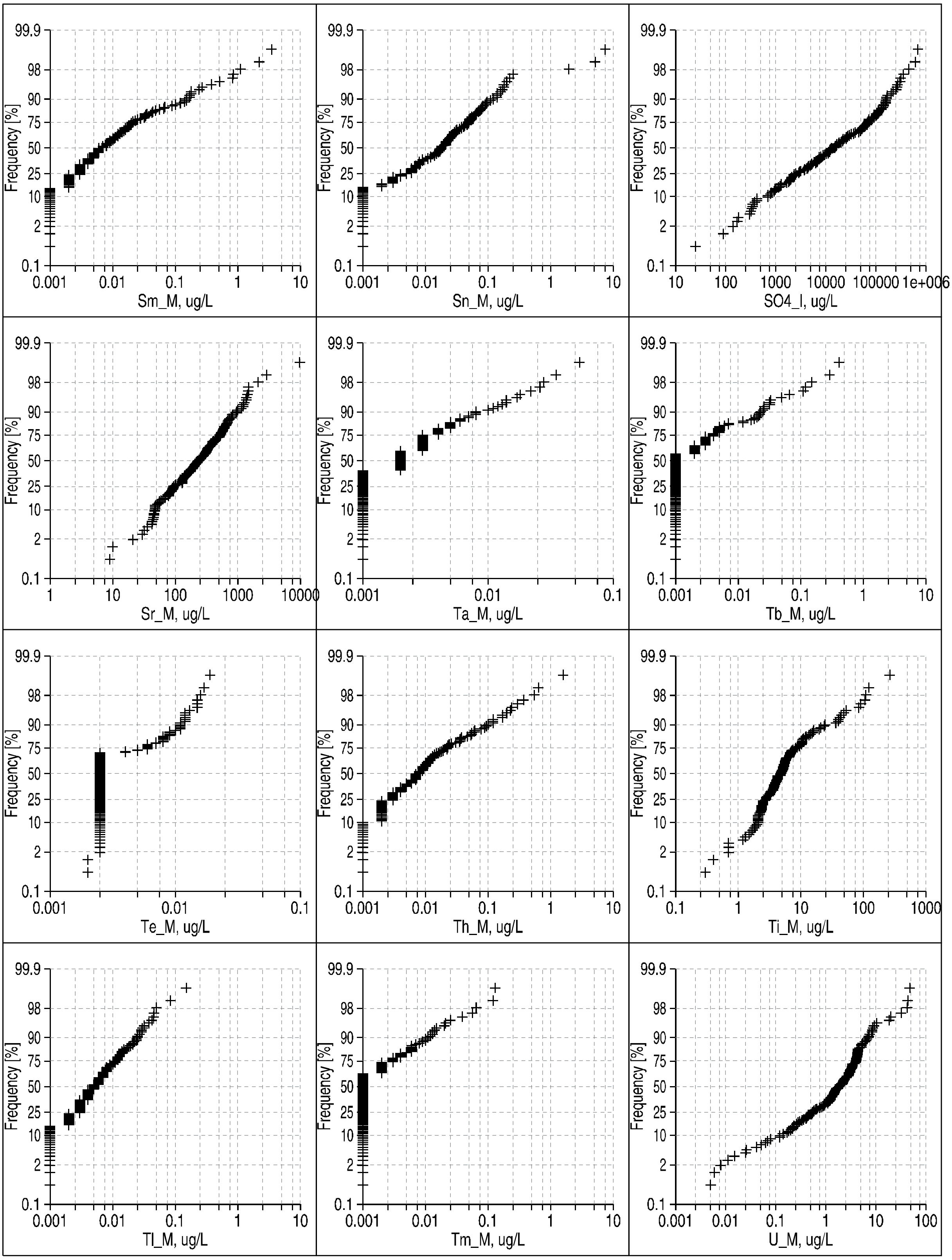


Figure 7 (continued – 6 out of 6: V-Zr and pH, electrical conductivity and alkalinity)

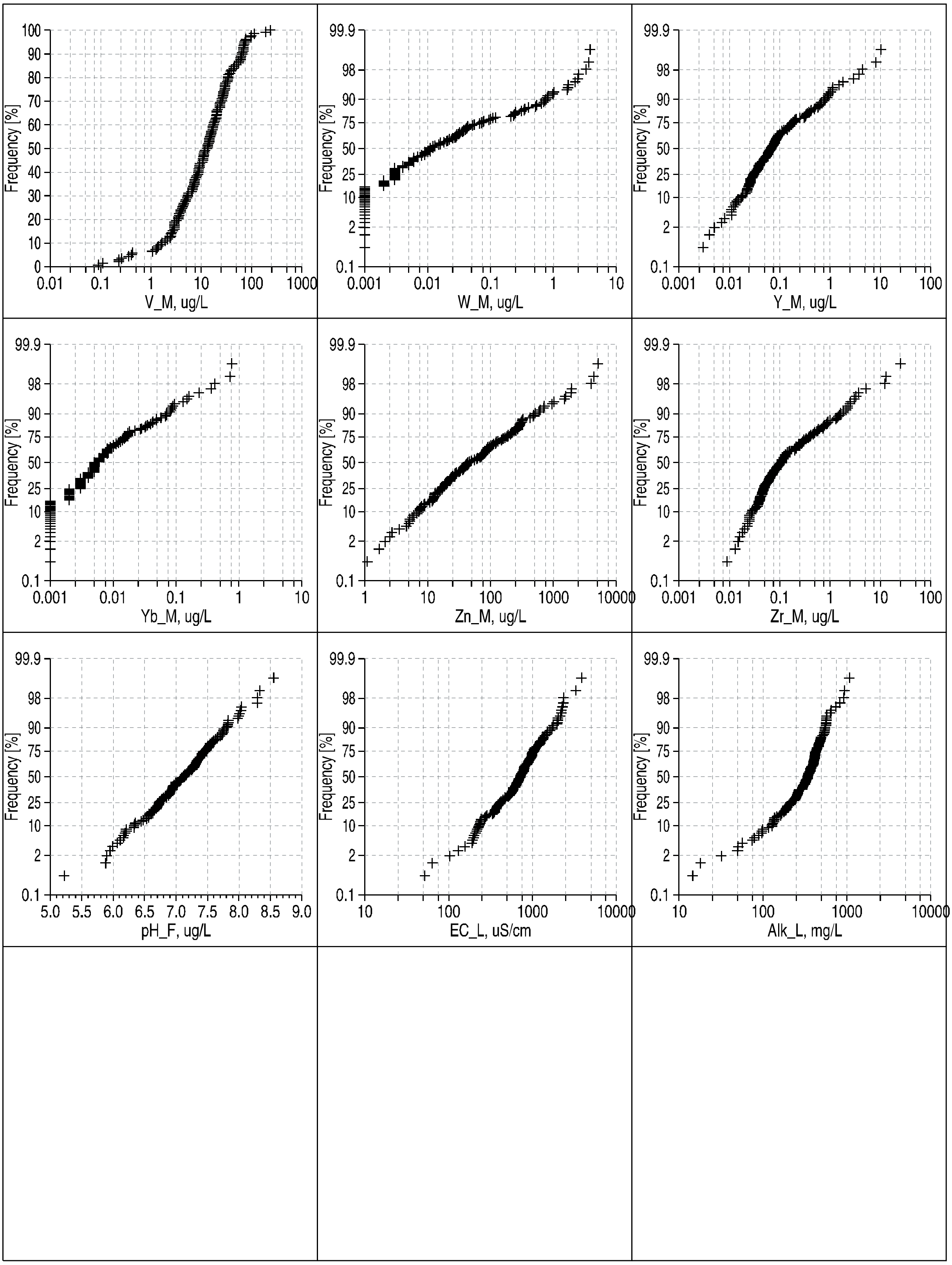


Figure 8 shows the analytical results of the different data subsets for all elements (8 per page) as boxplot comparison.

Figure 8: Comparison of the element concentration and variation in the different water sources subsets (BEDROCK=deep wells, SEDIMENT=shallow wells, HOTSPR=hot springs). In cases where there are two plots for one and the same element the second plot is an enlargement of the first plot. Values with an arrow give analytical values of extreme data outliers which were not plotted to scale. (1 of 14: Ag-Ba)

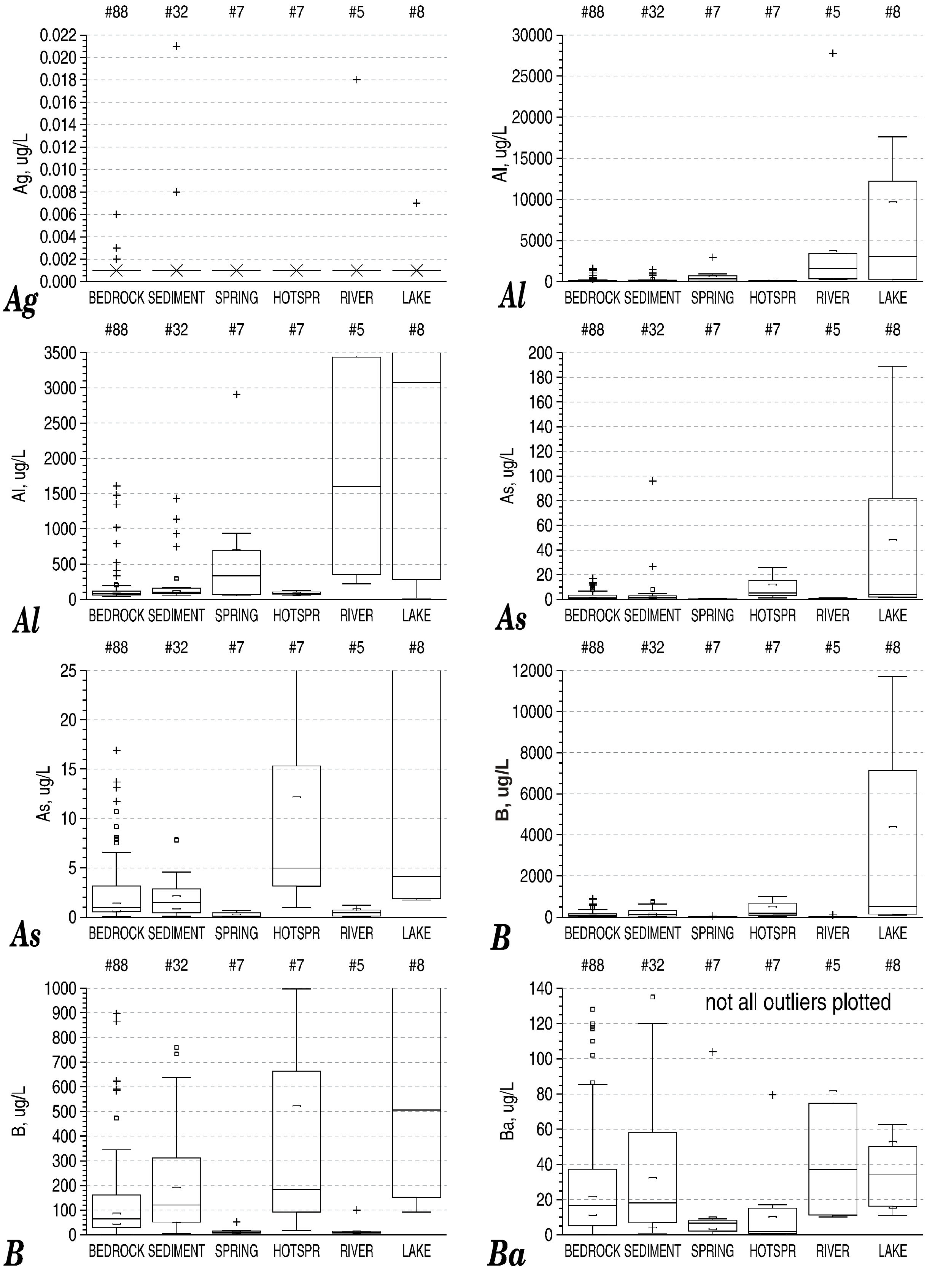


Figure 8 (continued – 2 of 14: Be-Ce)

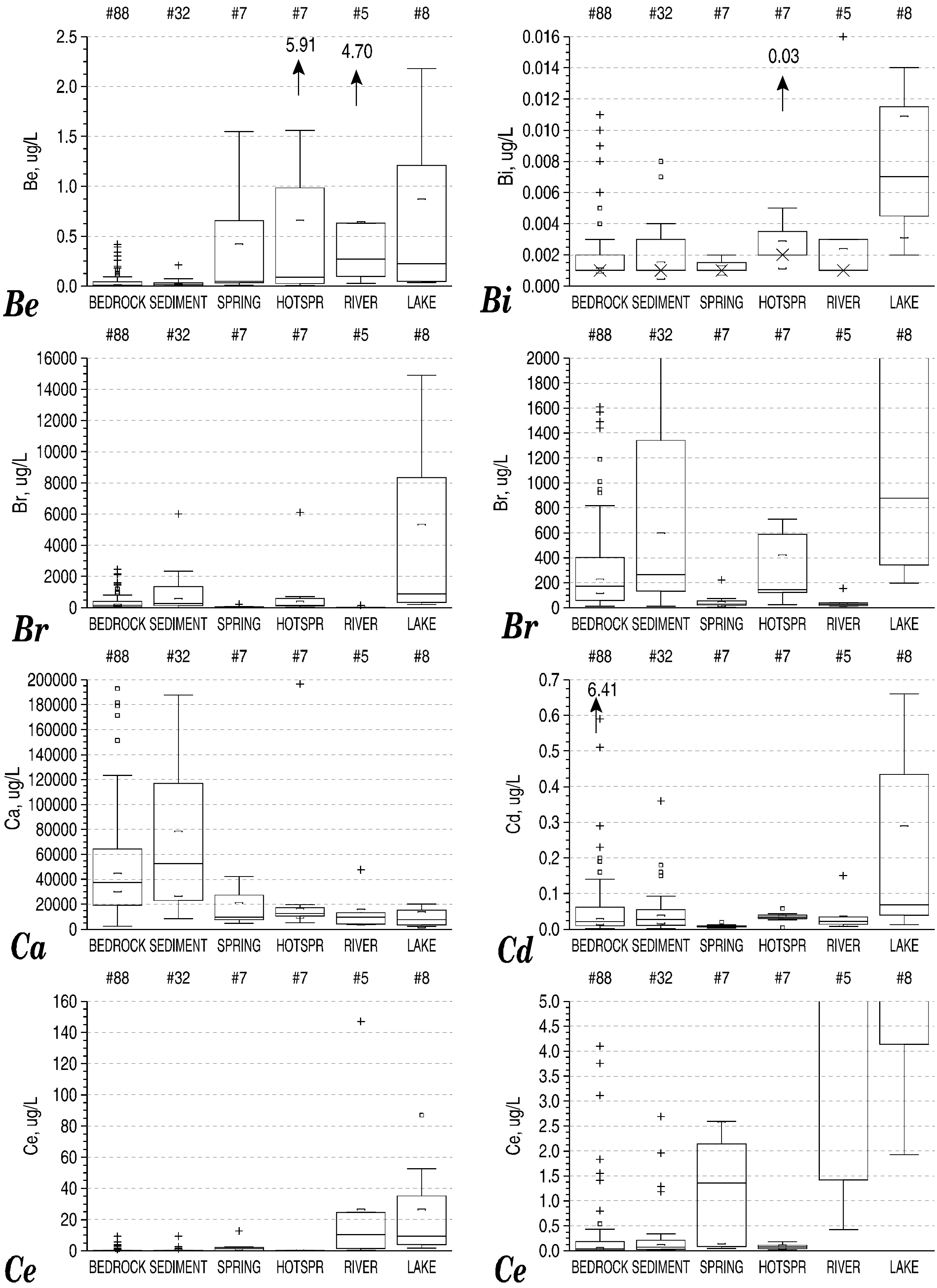


Figure 8 (continued – 3 of 14: Cl-Cu)

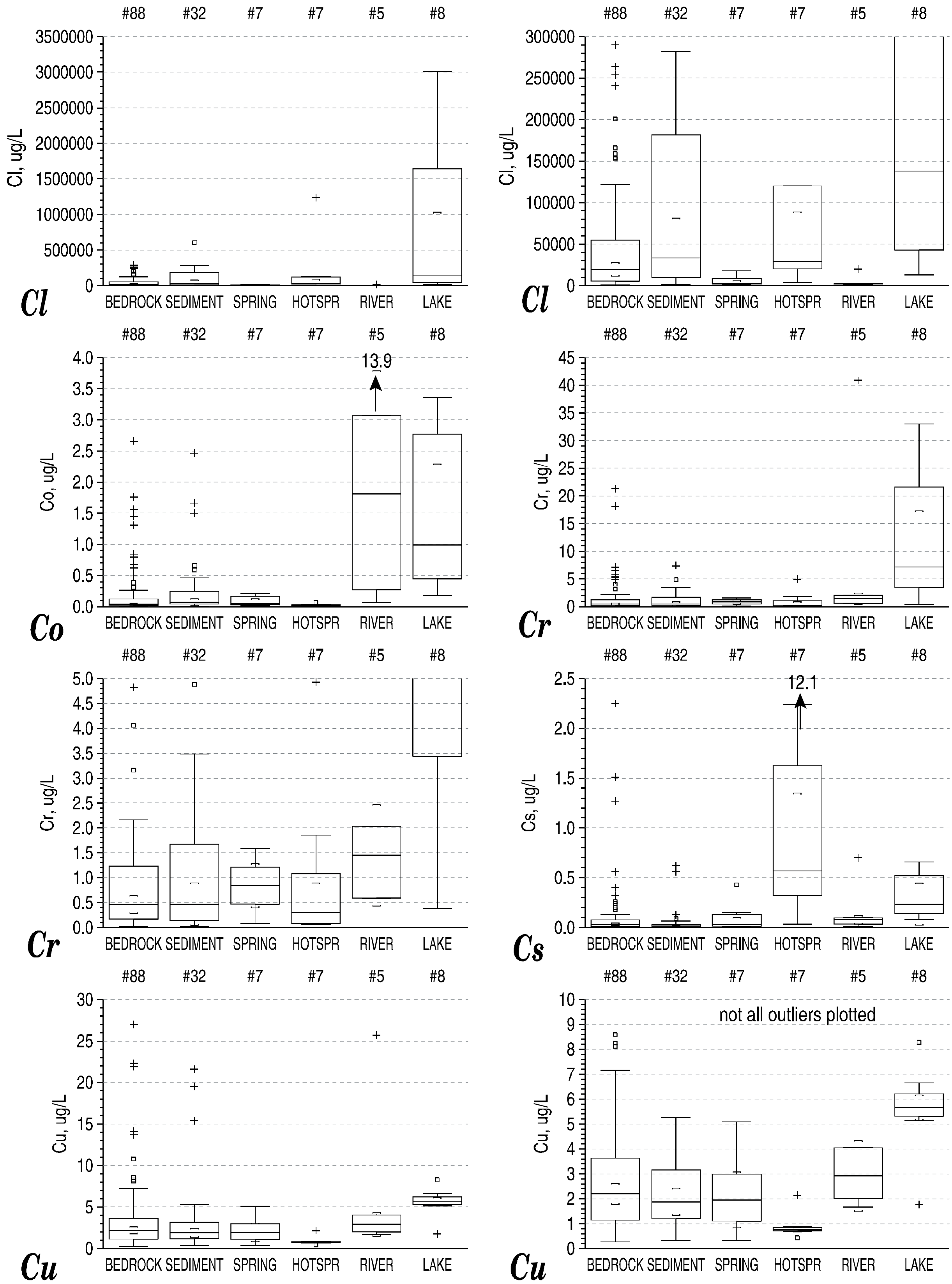


Figure 8 (continued – 4 of 14: Dy-F)

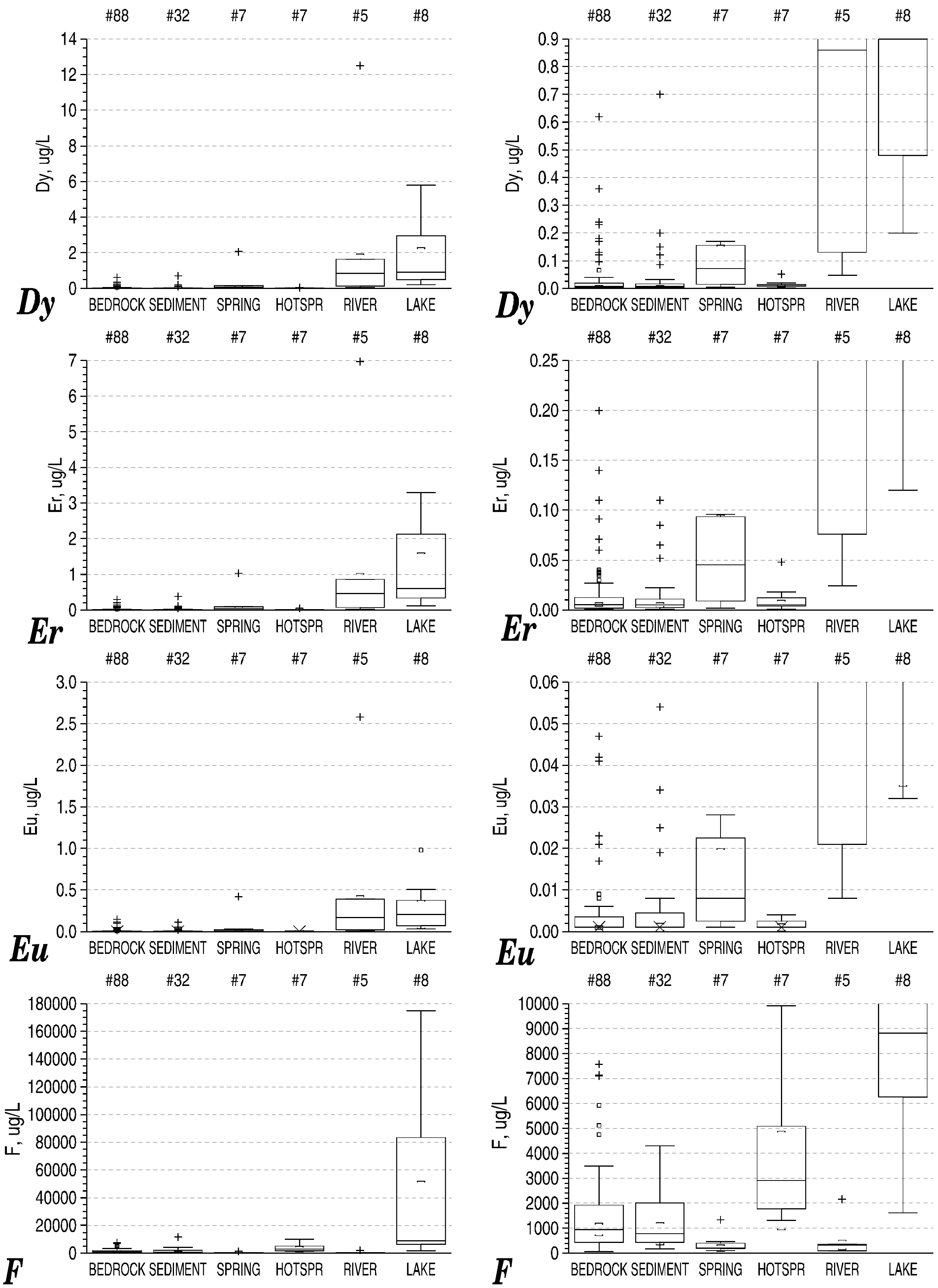


Figure 8 (continued – 5 of 14: Fe-Hf)

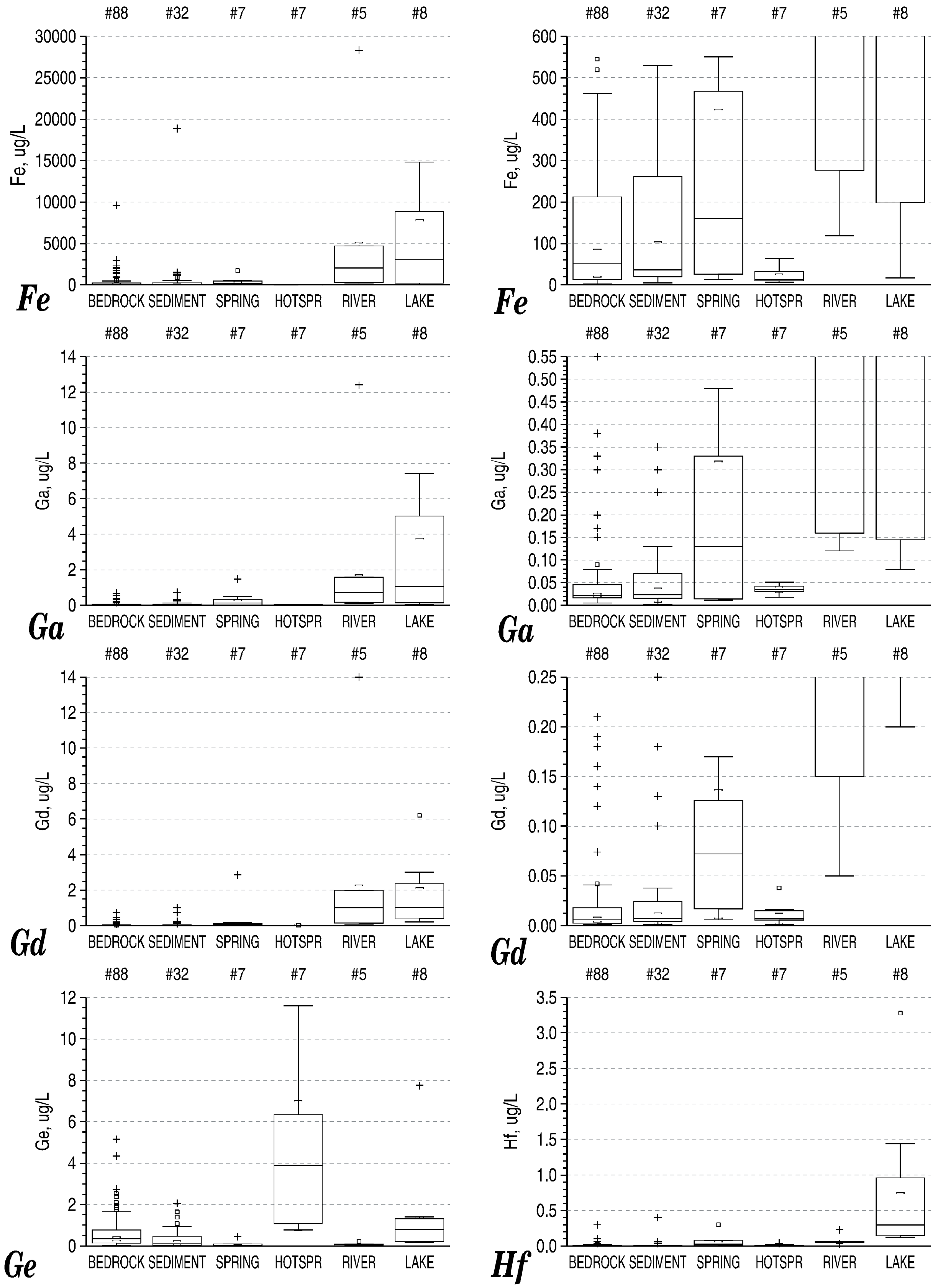


Figure 8 (continued – 6 of 14: Hg-K)

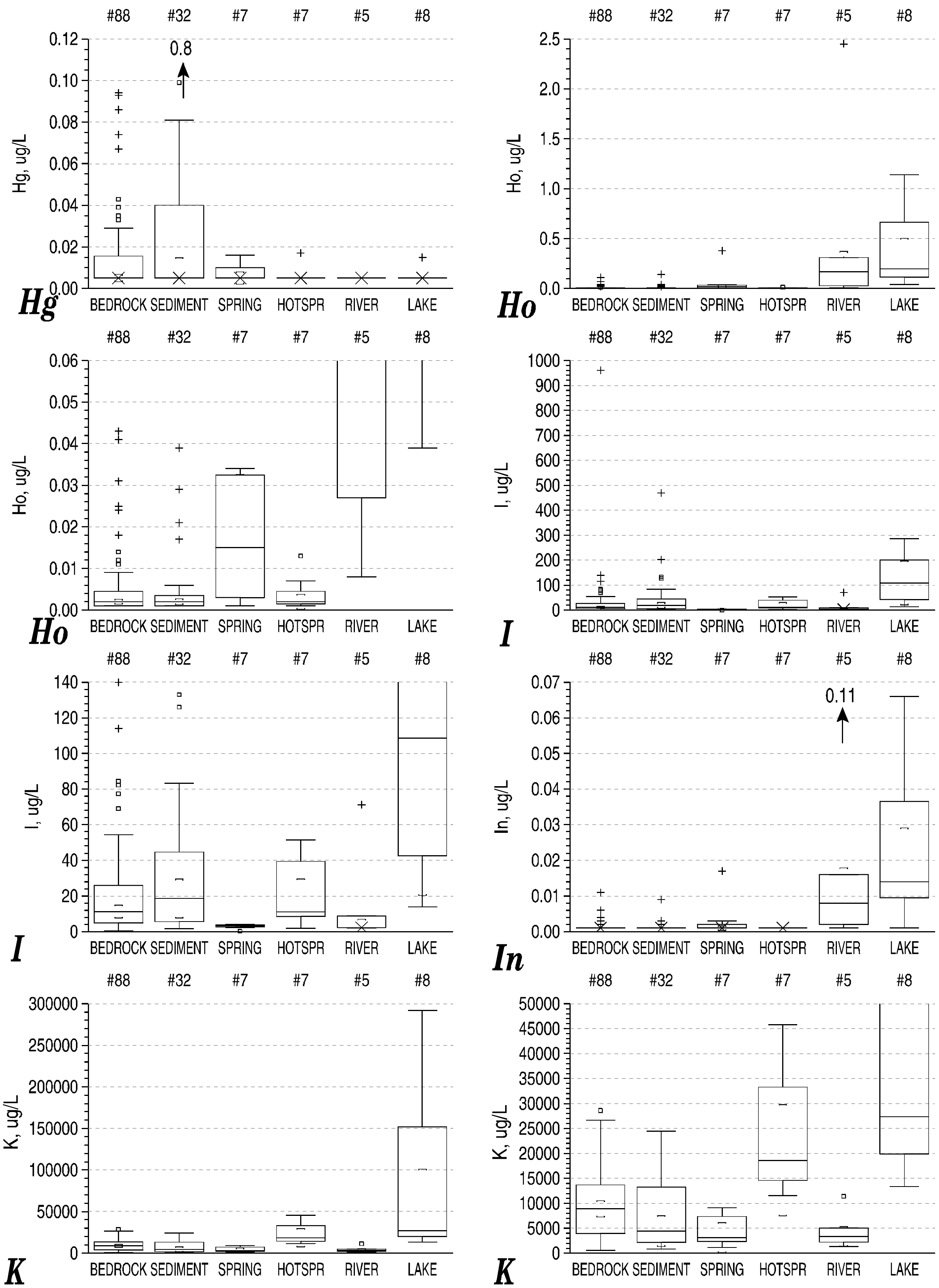


Figure 8 (continued – 7 of 14: La-Mn)

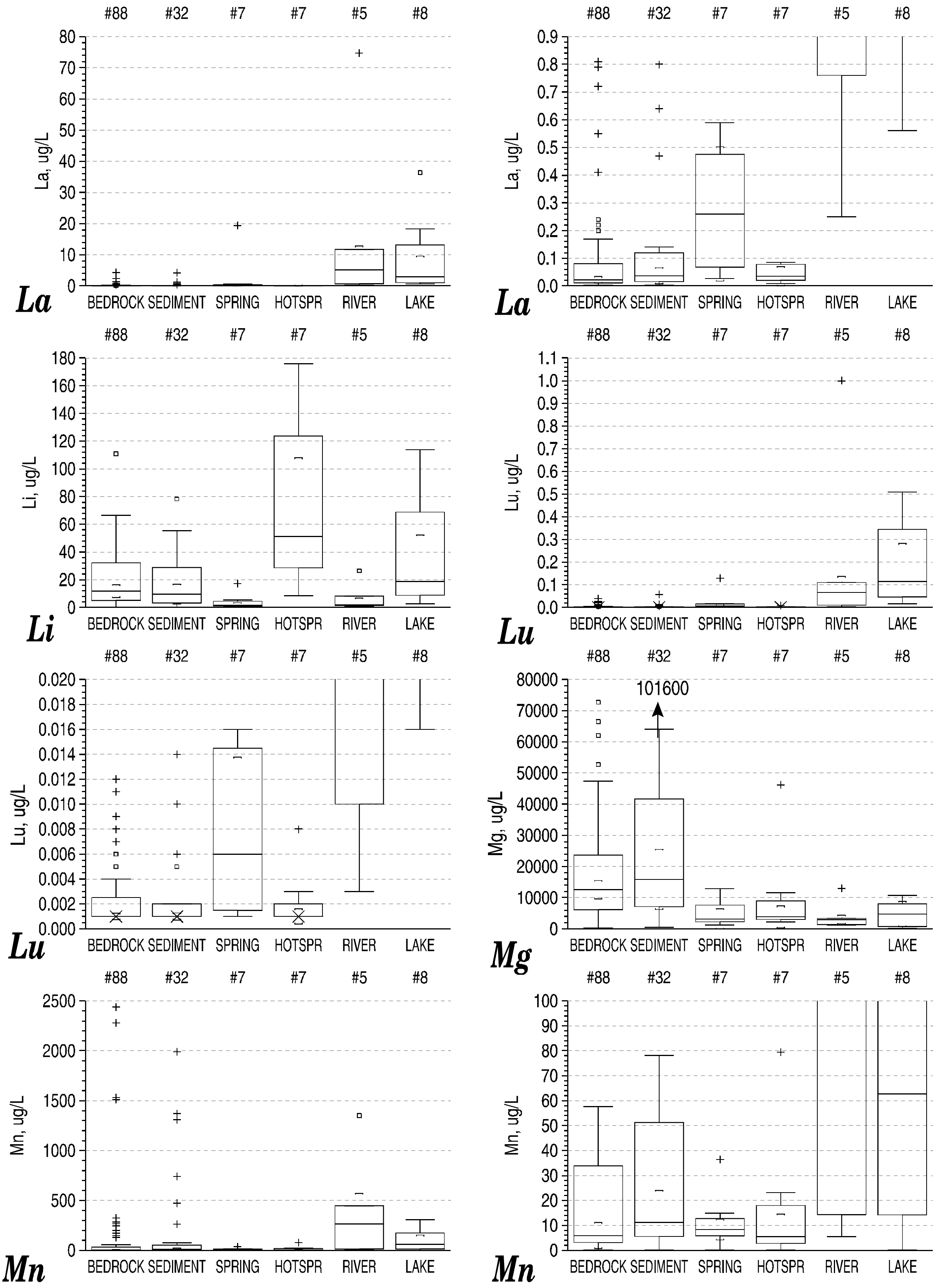


Figure 8 (continued – 8 of 14: Mo-Nd)

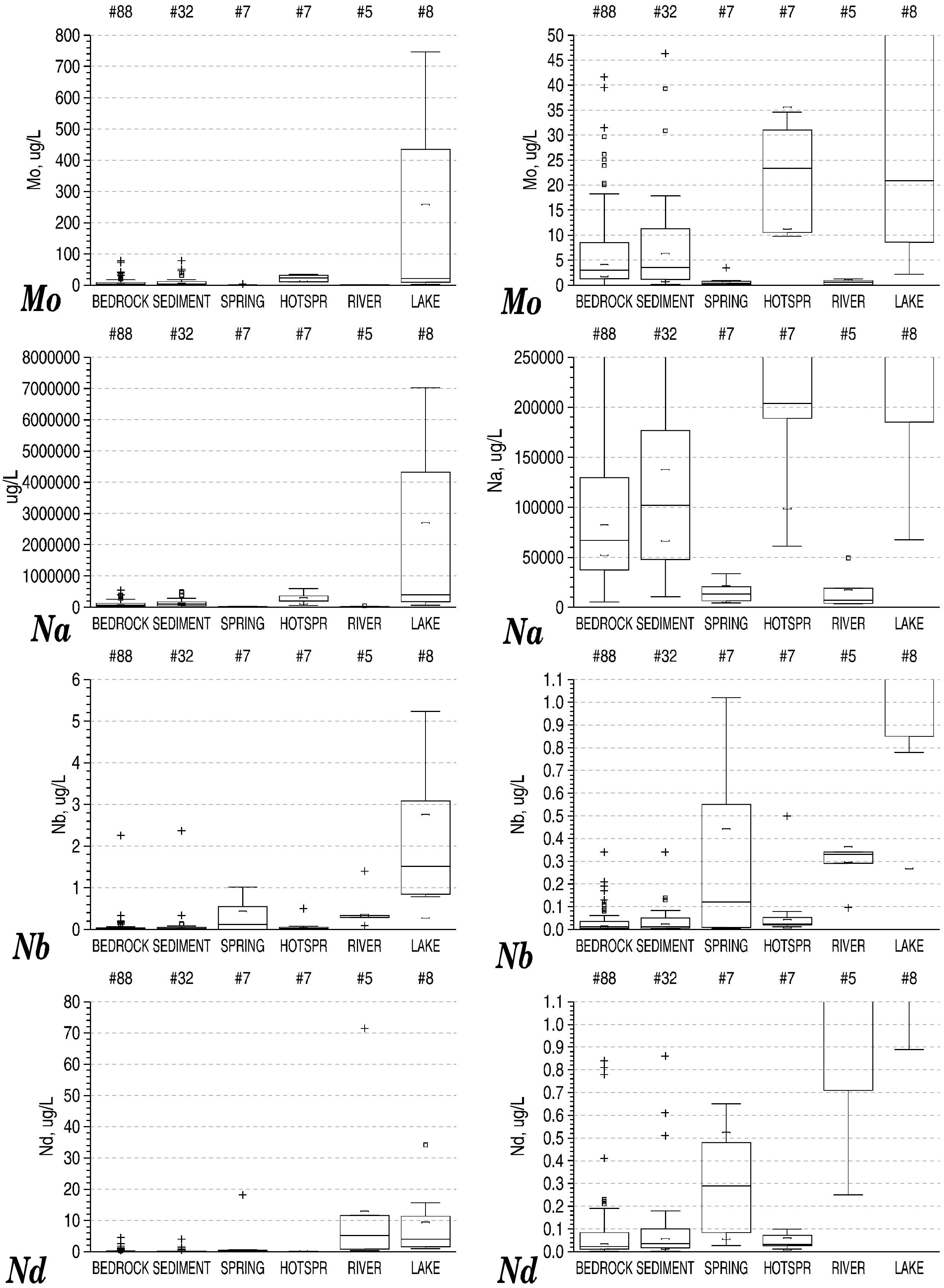


Figure 8 (continued – 9 of 14: Ni-Sb)

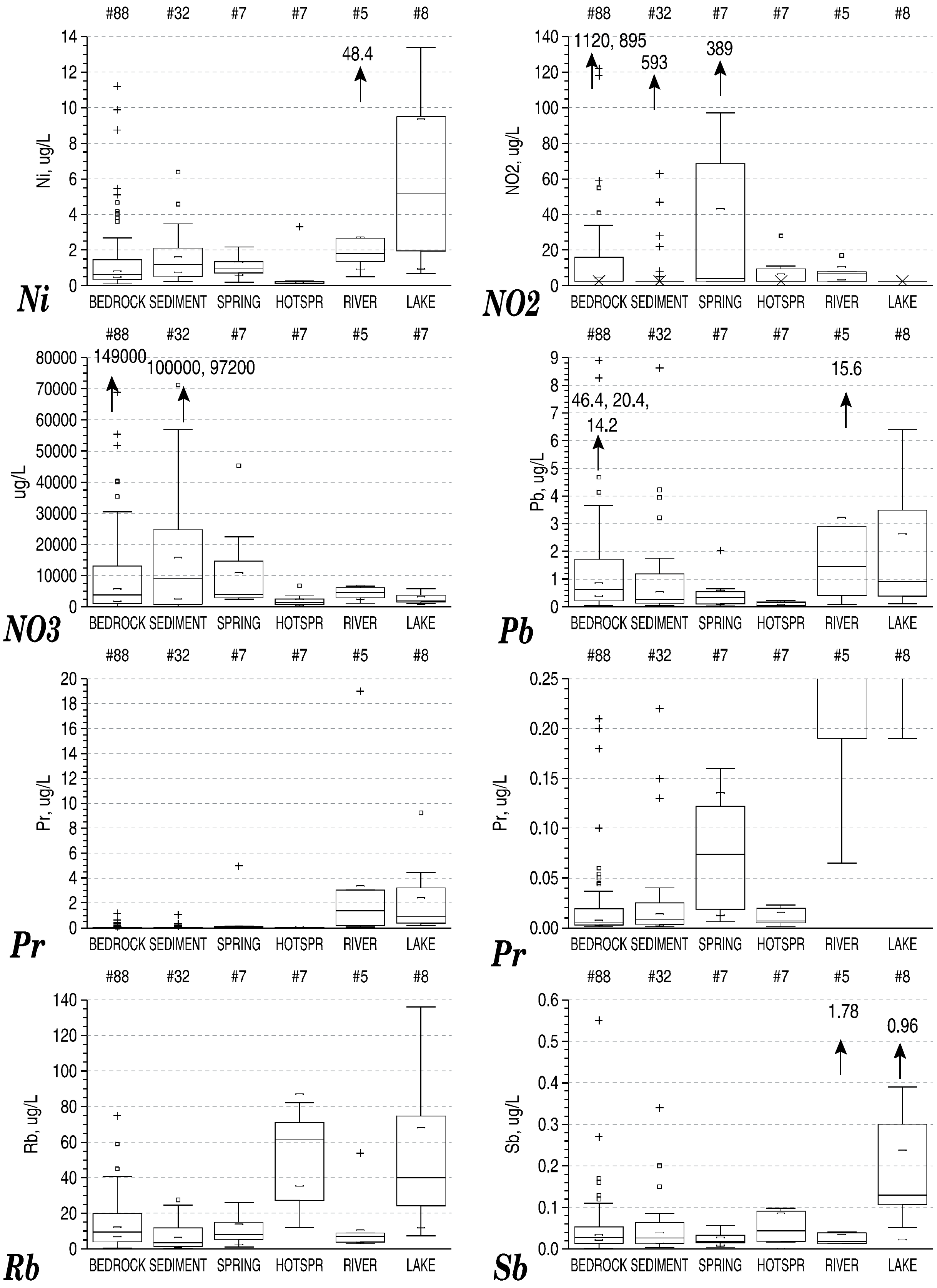


Figure 8 (continued – 10 of 14: Se-SO_4)

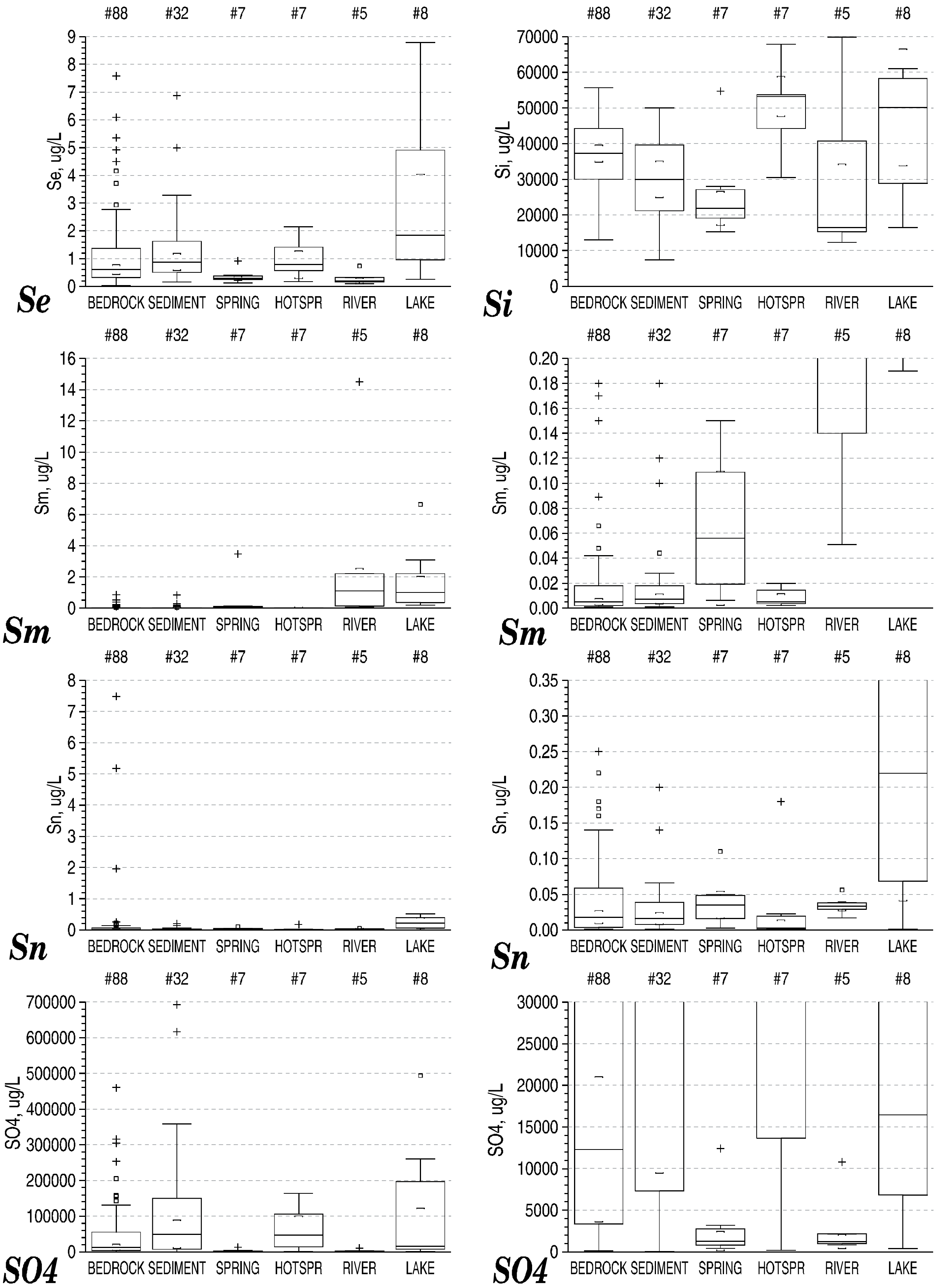


Figure 8 (continued – 11 of 14: Sr-Th)

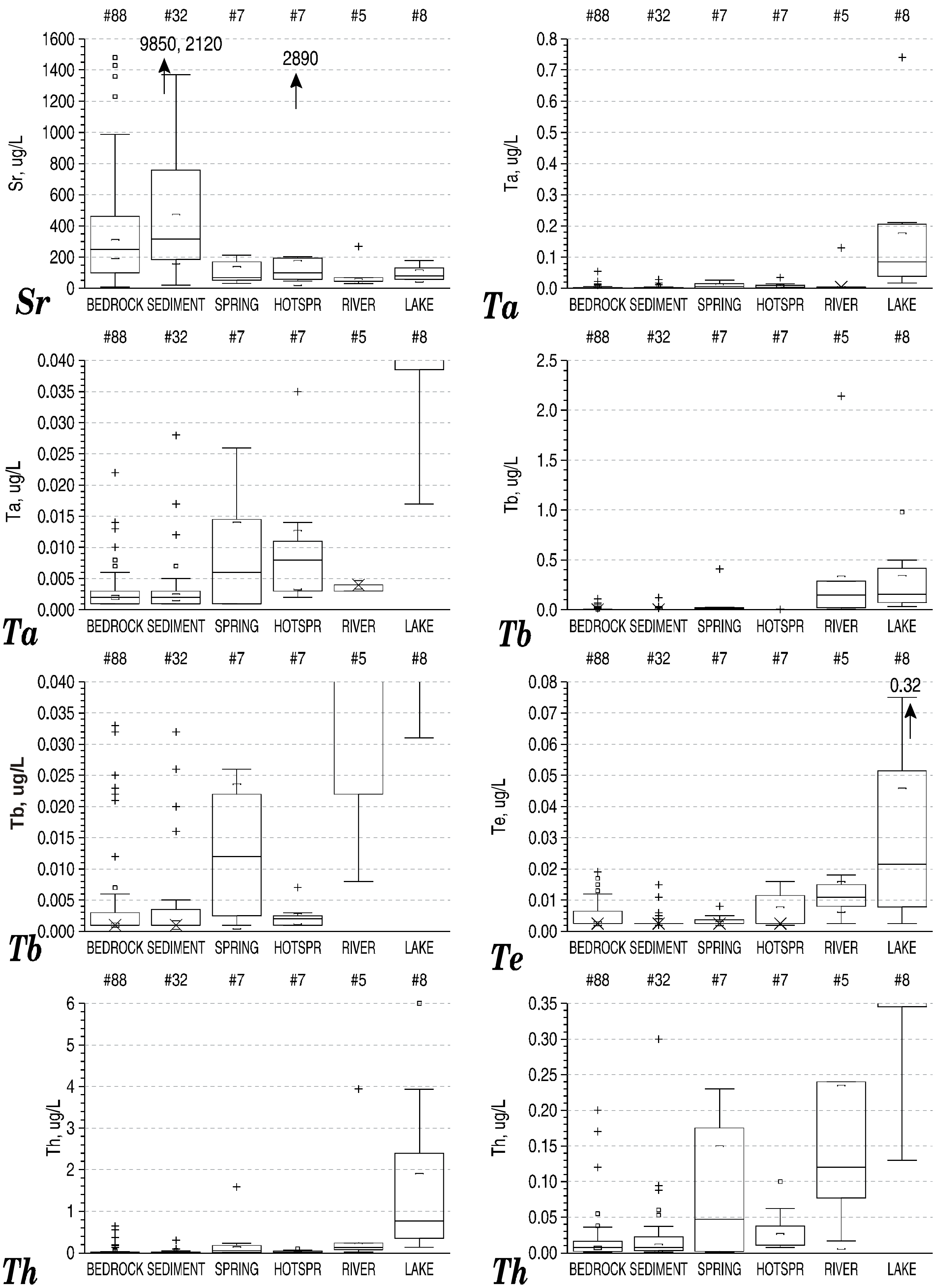


Figure 8 (continued – 12 of 14: Ti-W)

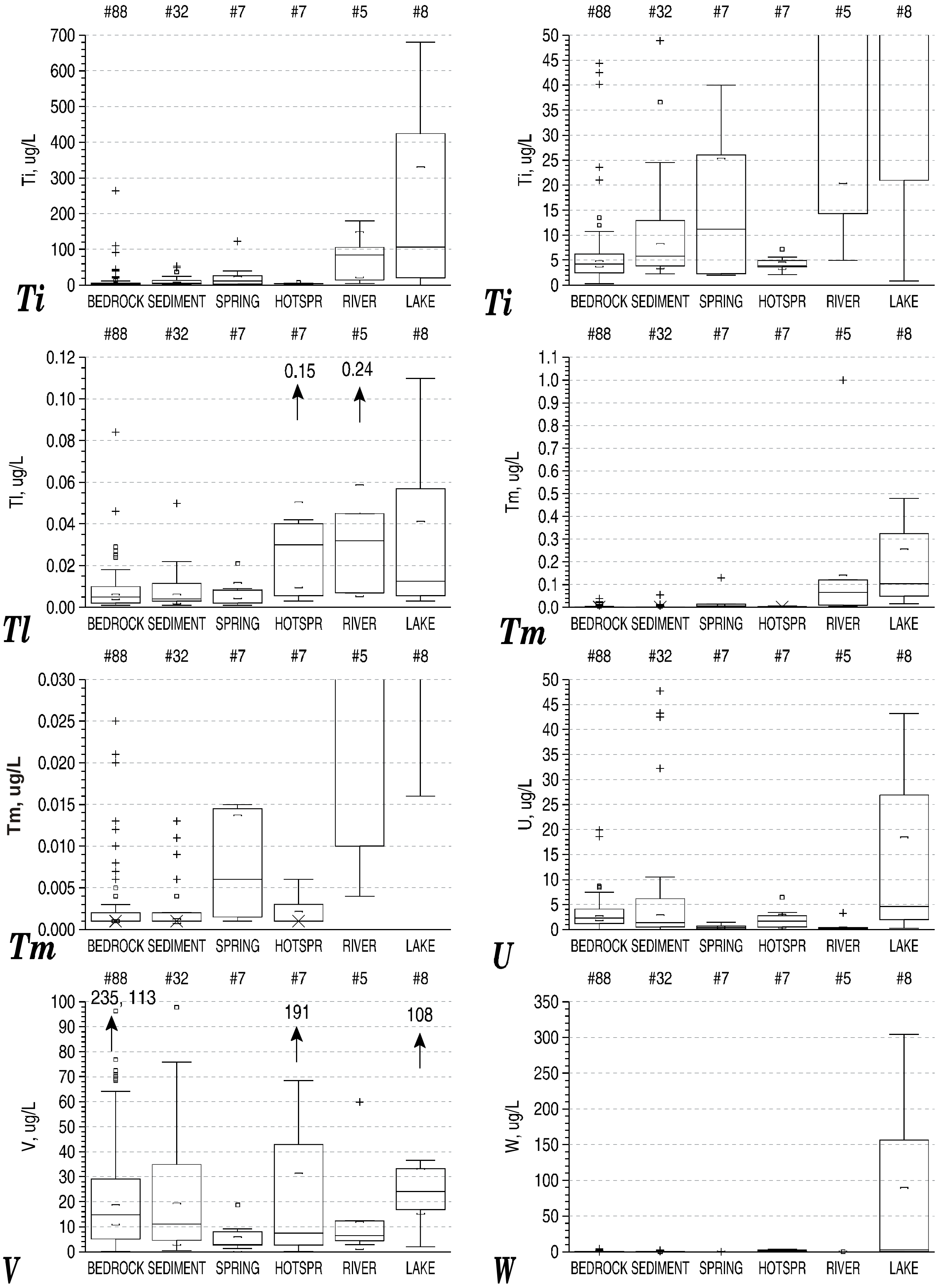


Figure 8 (continued – 13 of 14: W-Zn)

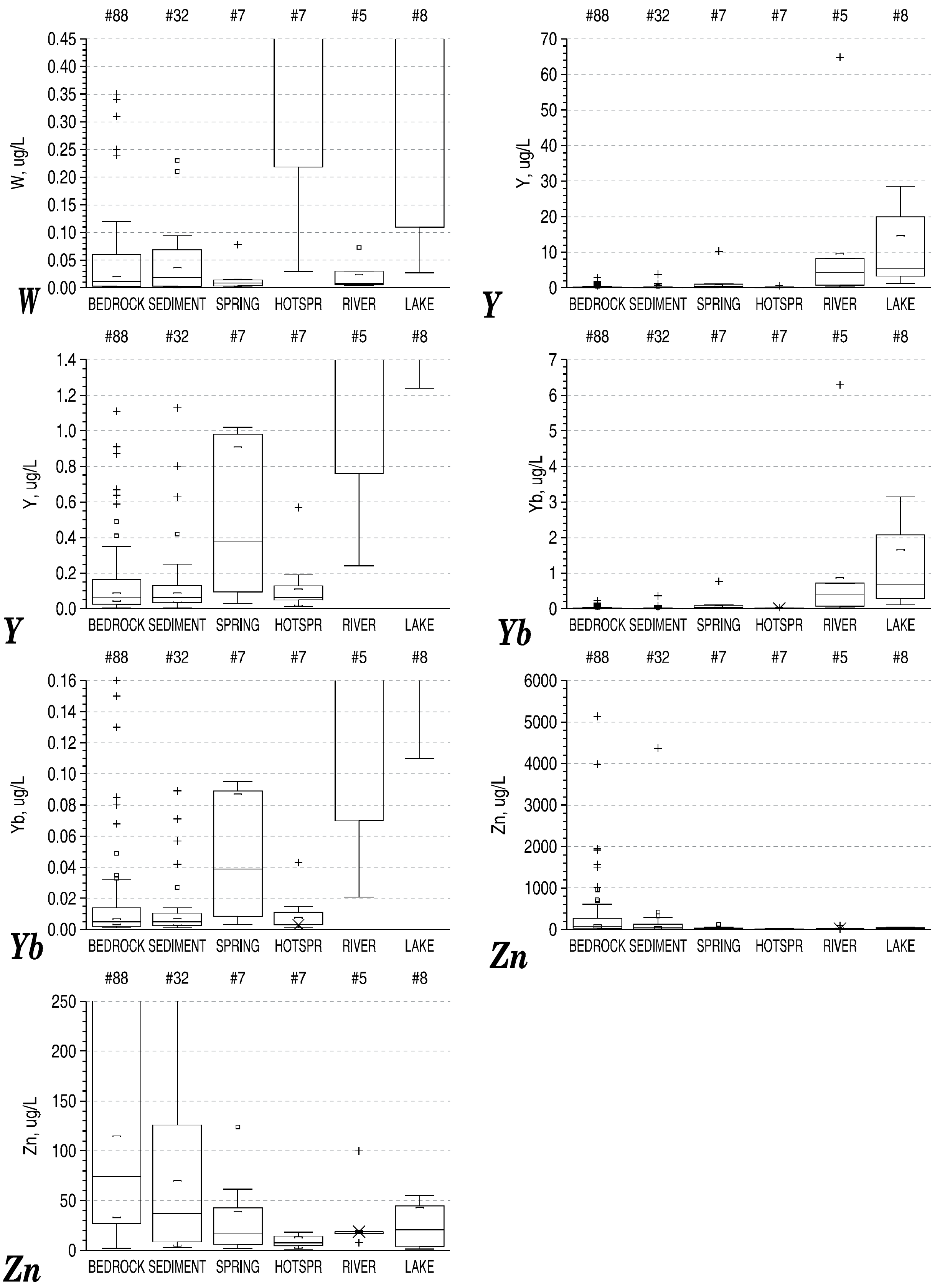


Figure 8 (continued – 14 of 14: Zr, temperature, pH, electrical conductivity and alkalinity)

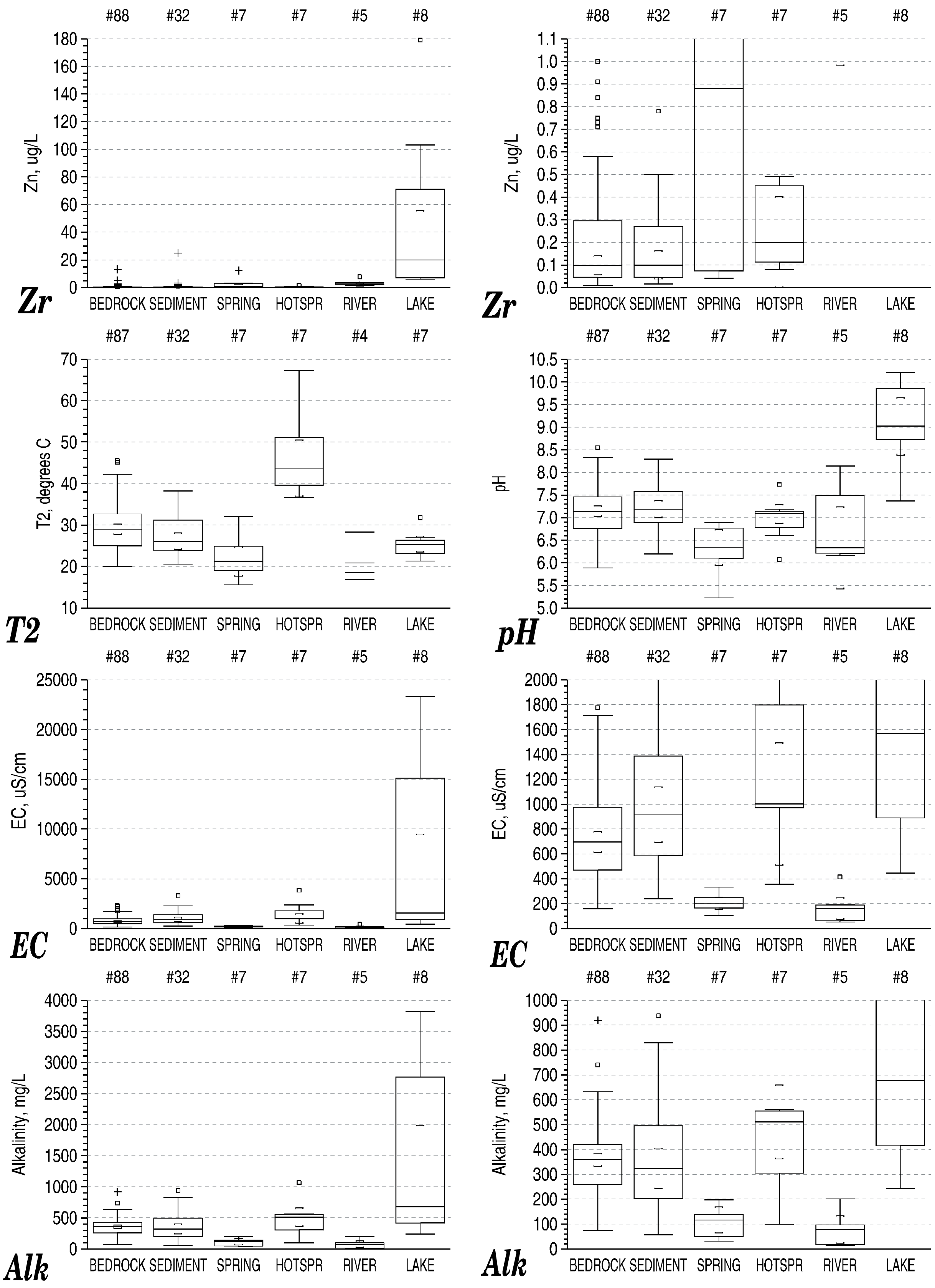


Figure 9 shows maps of the geographical distribution of the results for all elements for the drinking water subset.

Figure 9: Geochemical distribution maps for all elements. Class selection according to boxplot. For geology, location and sample numbers compare with figures 3-5). 1 of 13 - Ag-Be

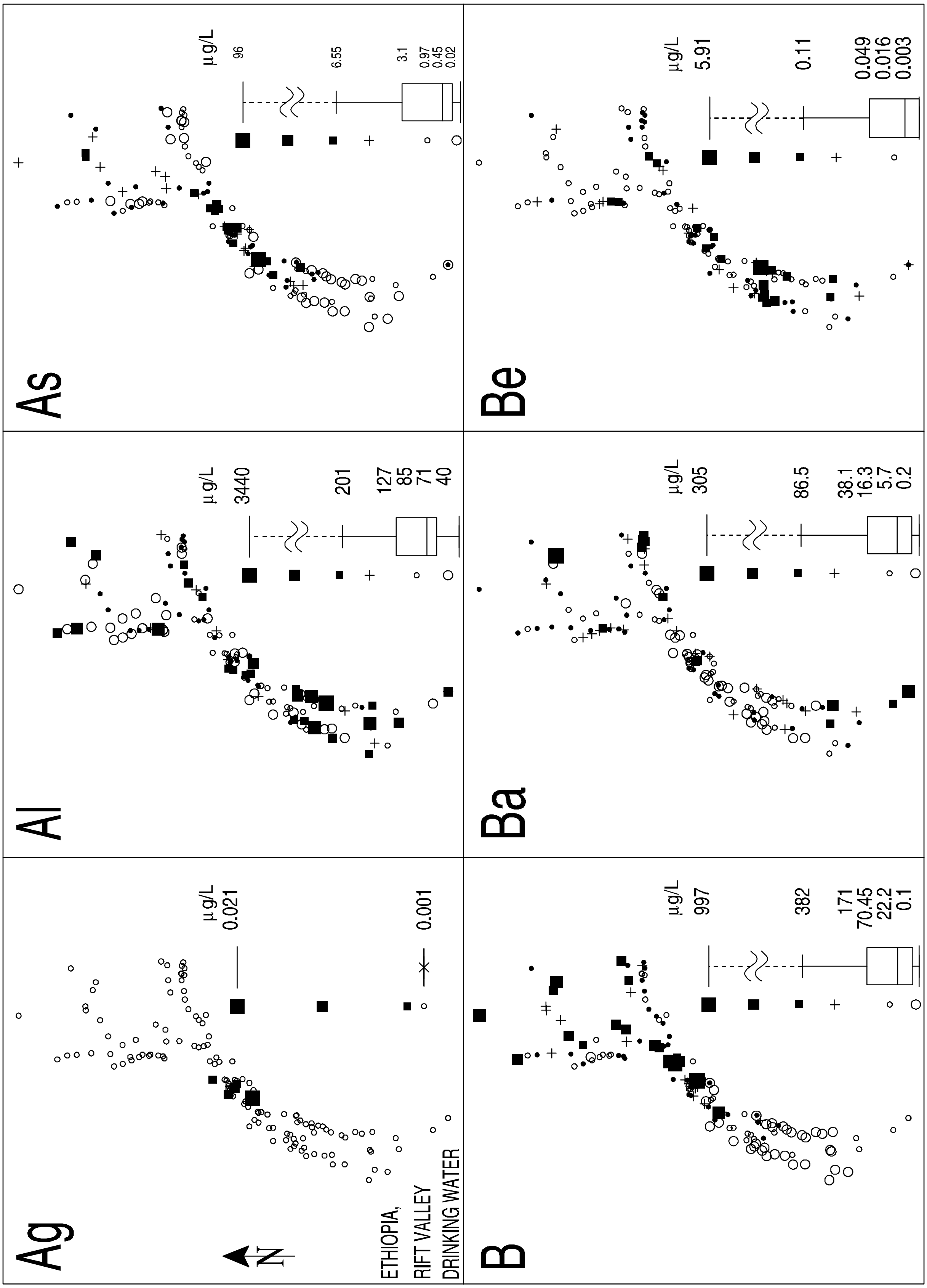


Figure 9 (continued – 2 of 13: Bi-Cl)

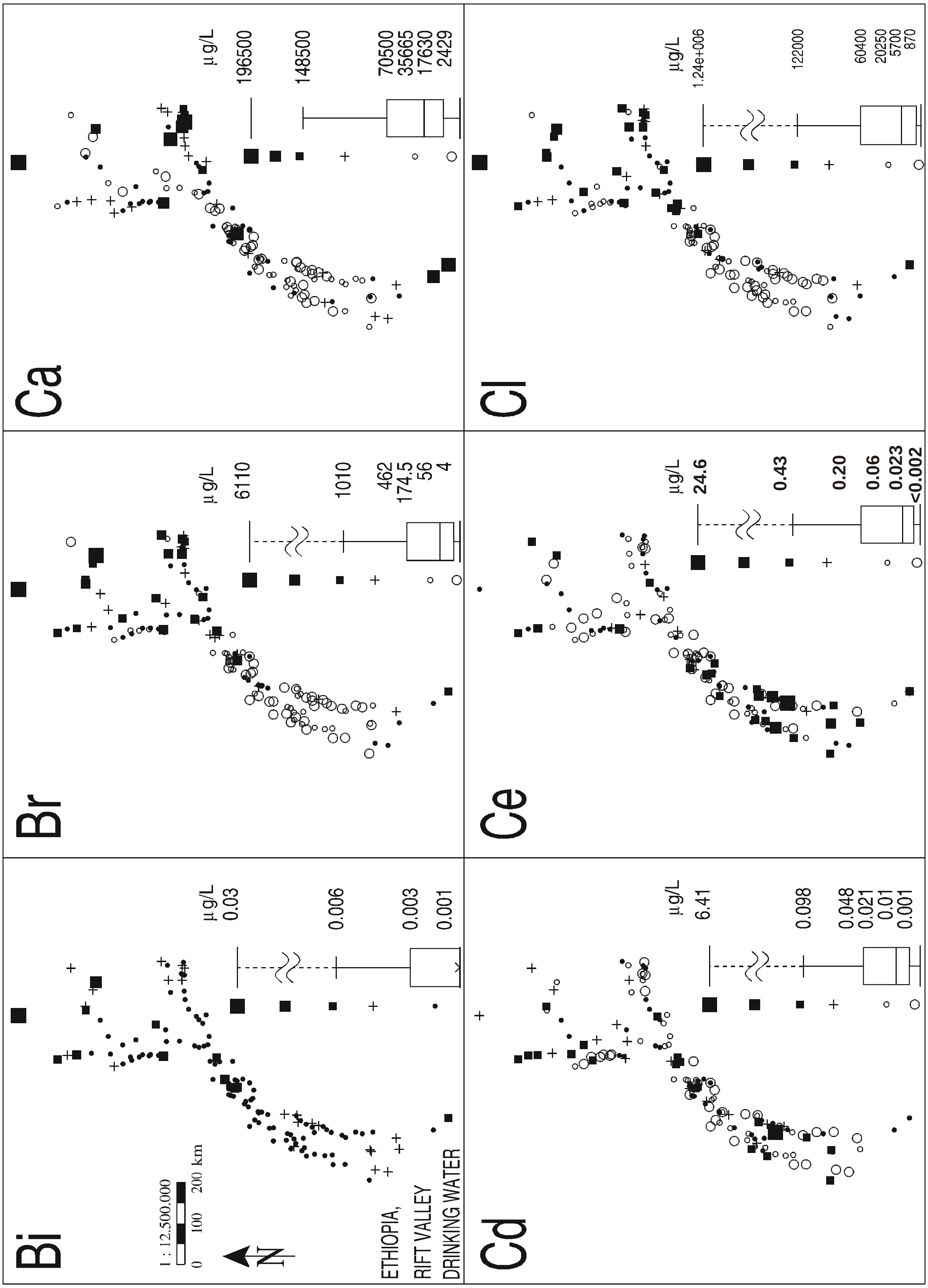


Figure 9 (continued – 3 of 13: Co-Er)

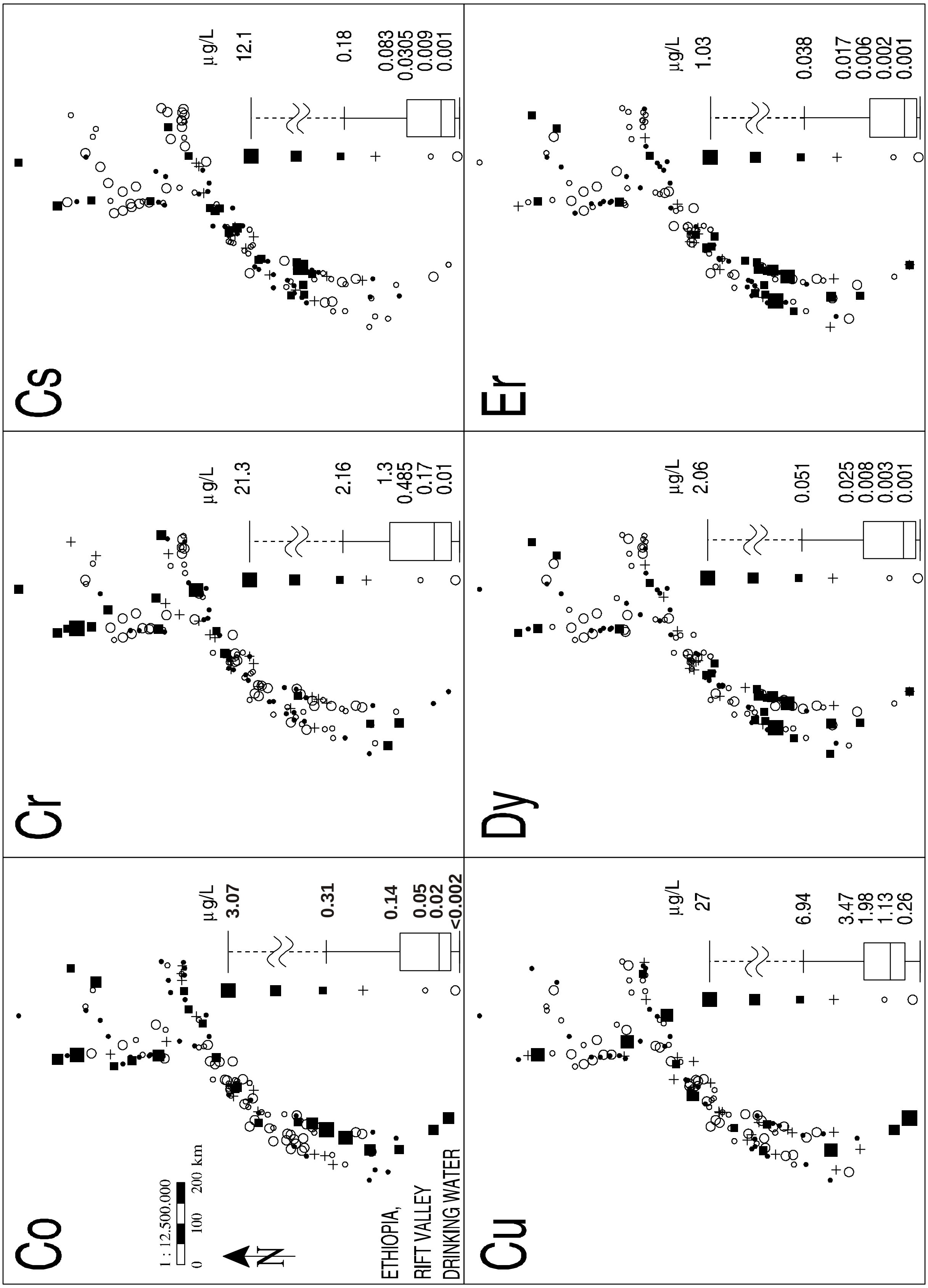


Figure 9 (continued – 4 of 13: Eu-Hf)

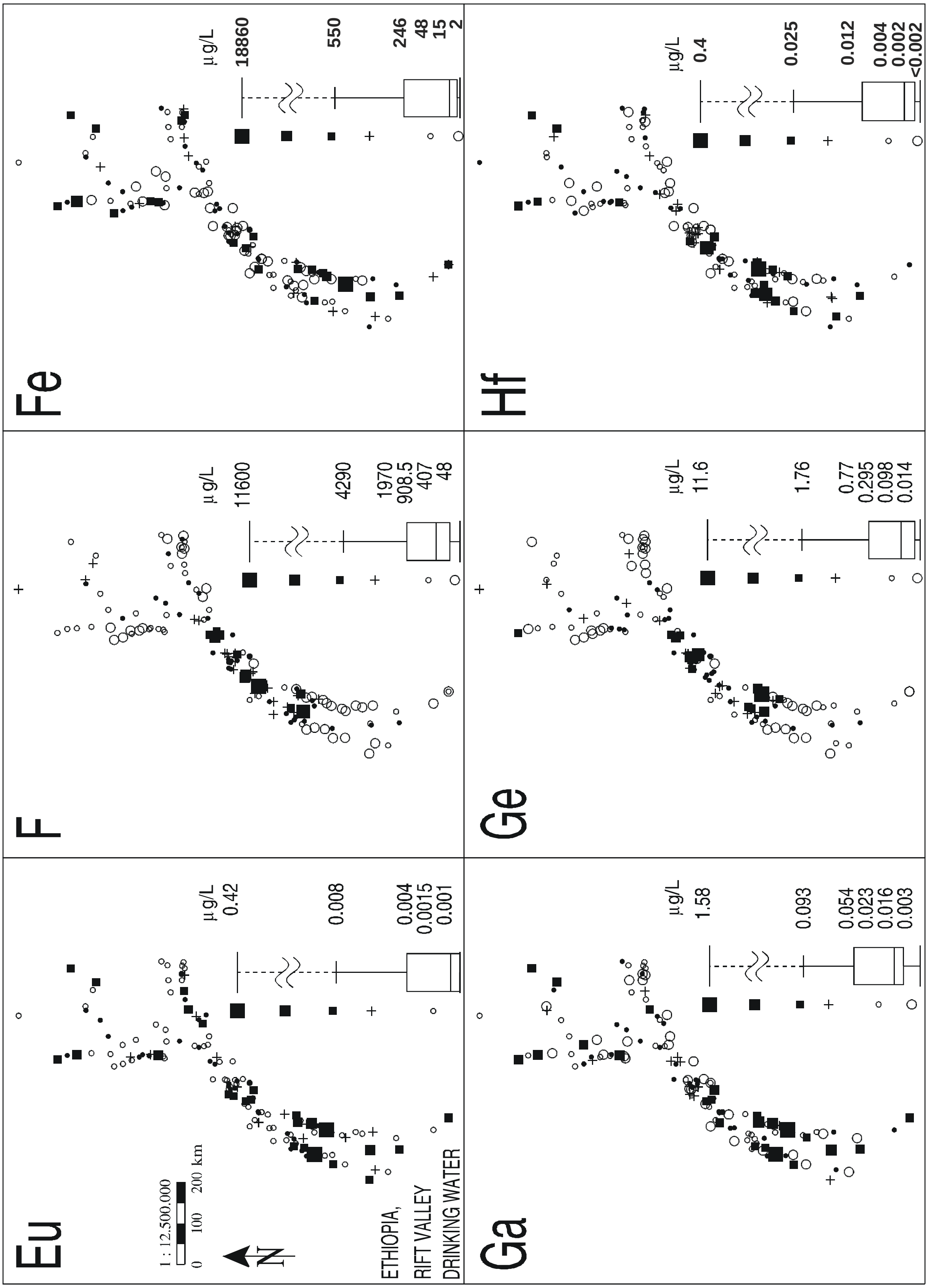


Figure 9 (continued – 5 of 13: Hg-La)

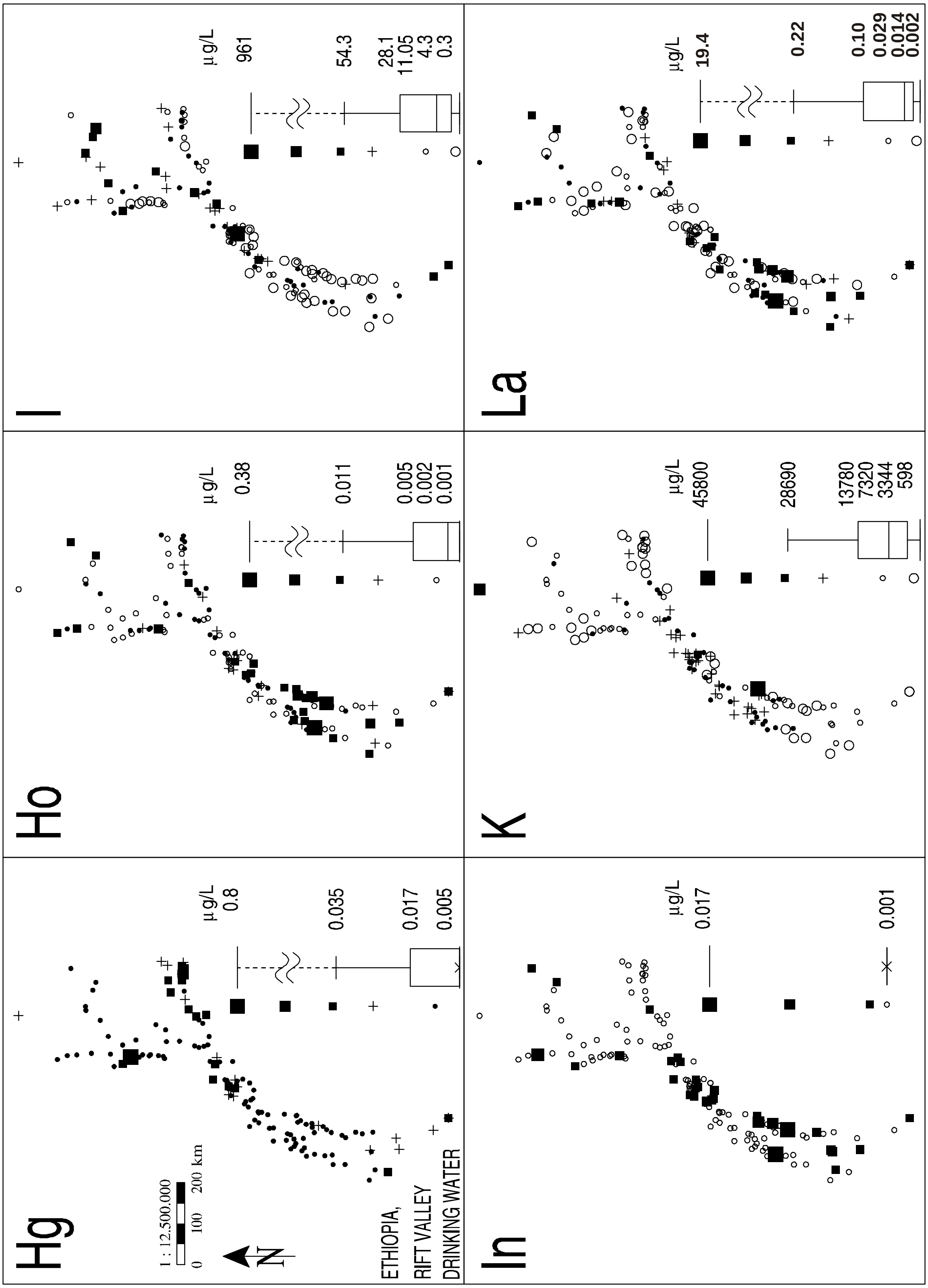


Figure 9 (continued – 6 of 13: Li-Na)

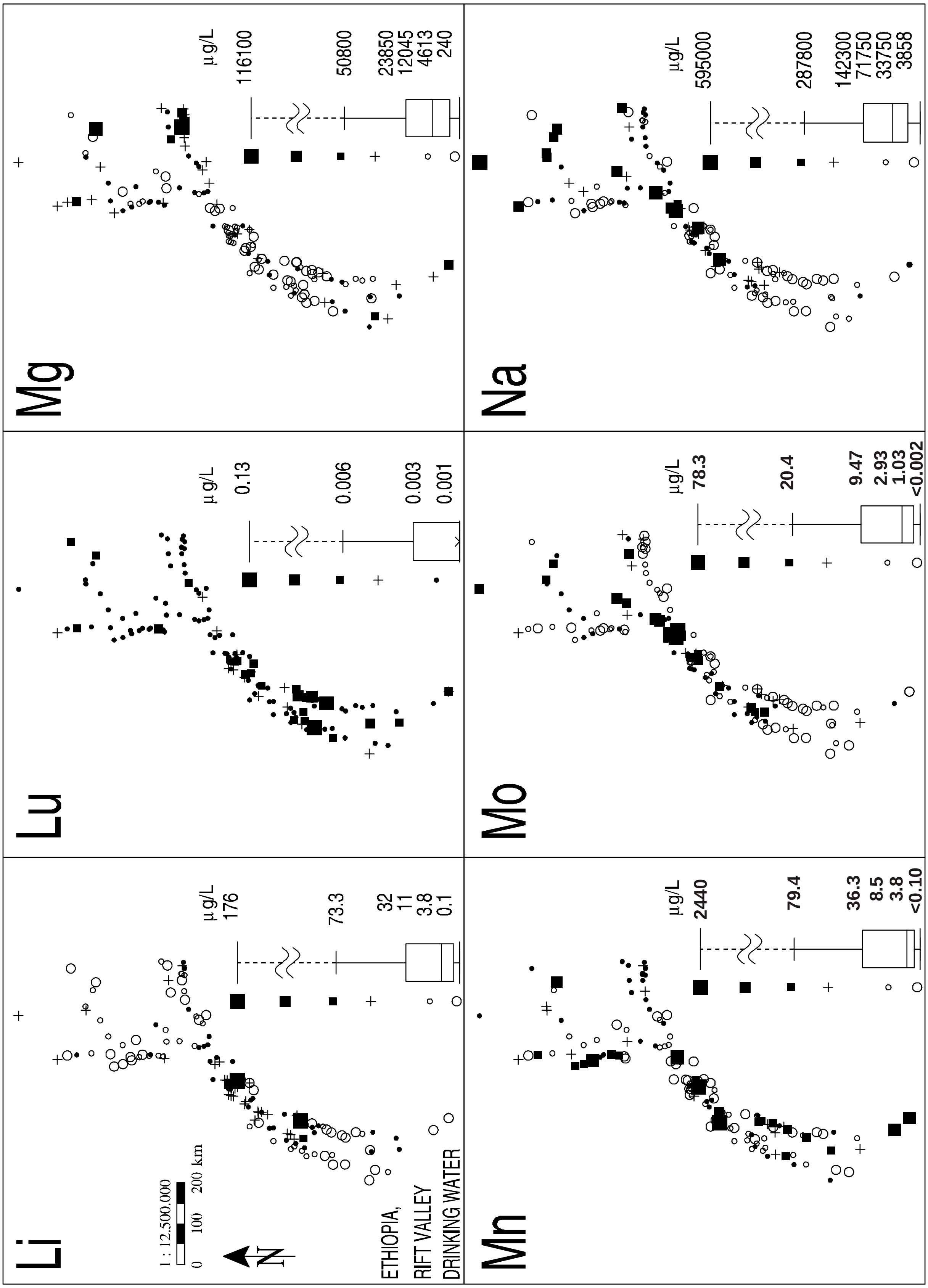


Figure 9 (continued – 7 of 13: Nb-Pb)

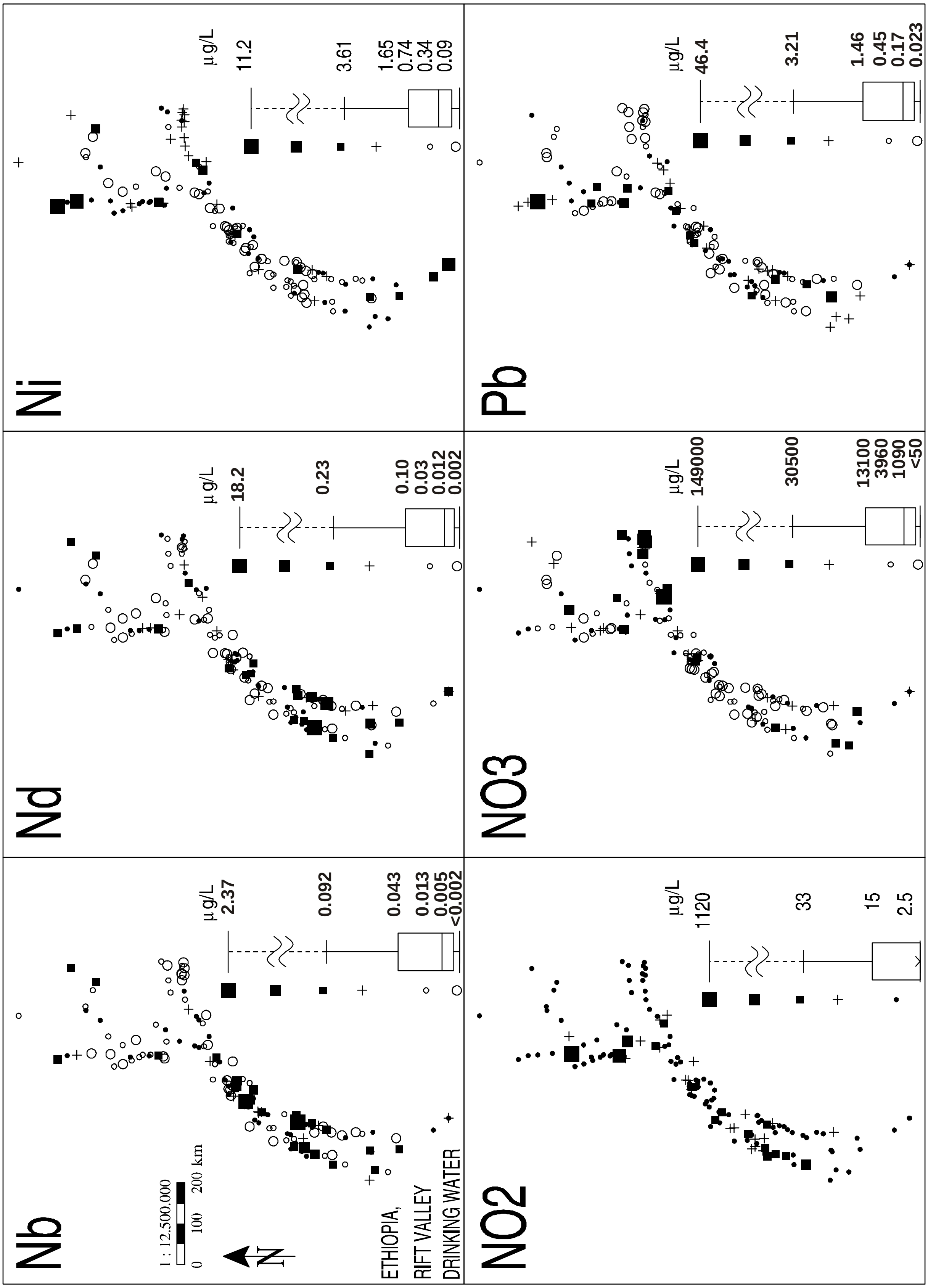


Figure 9 (continued – 8 of 13: Pr-Sm)

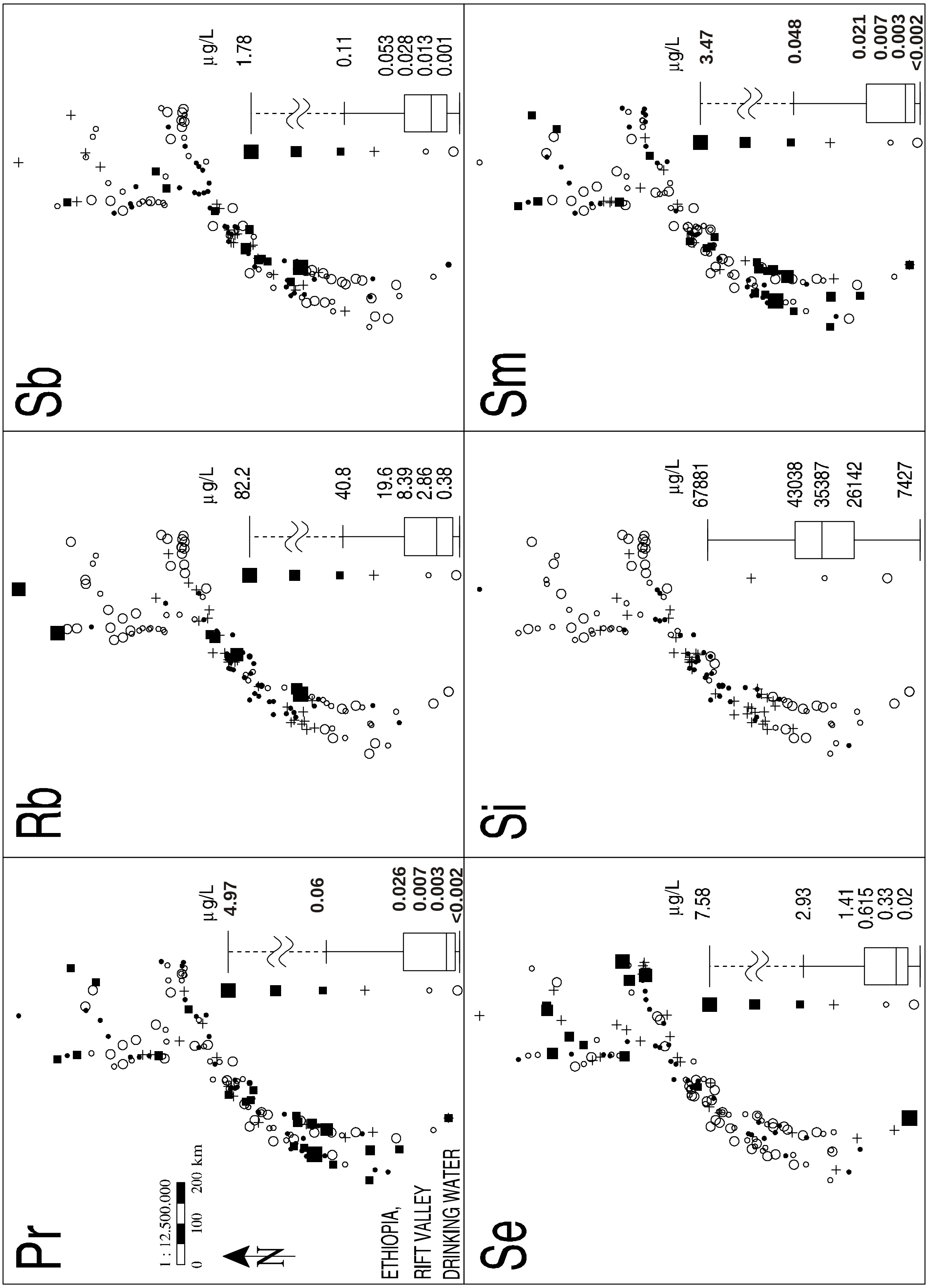


Figure 9 (continued – 9 of 13: Sn-Te)

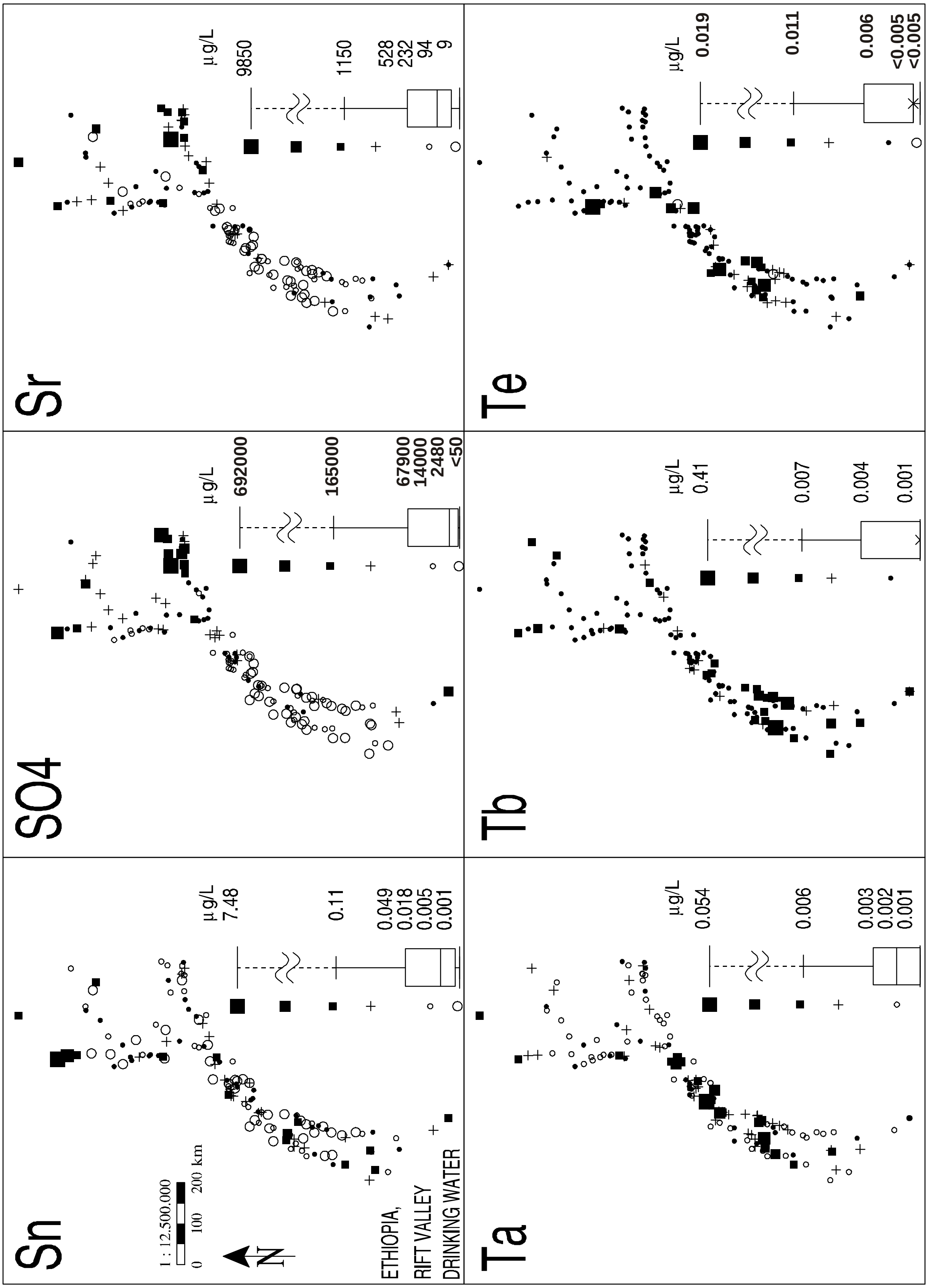


Figure 9 (continued – 10 of 13: Th-V)

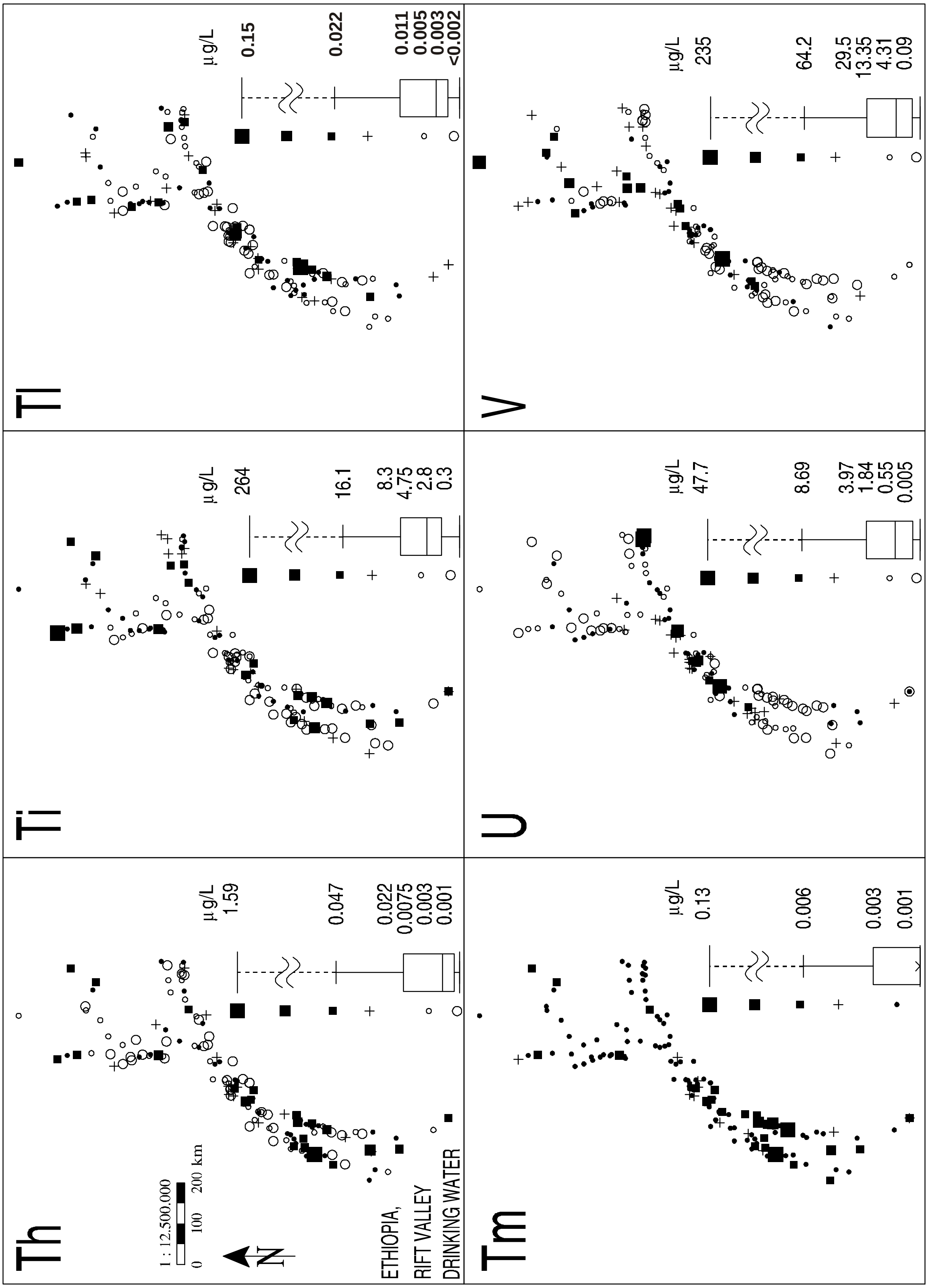


Figure 9 (continued – 11 of 13: W-Zr)

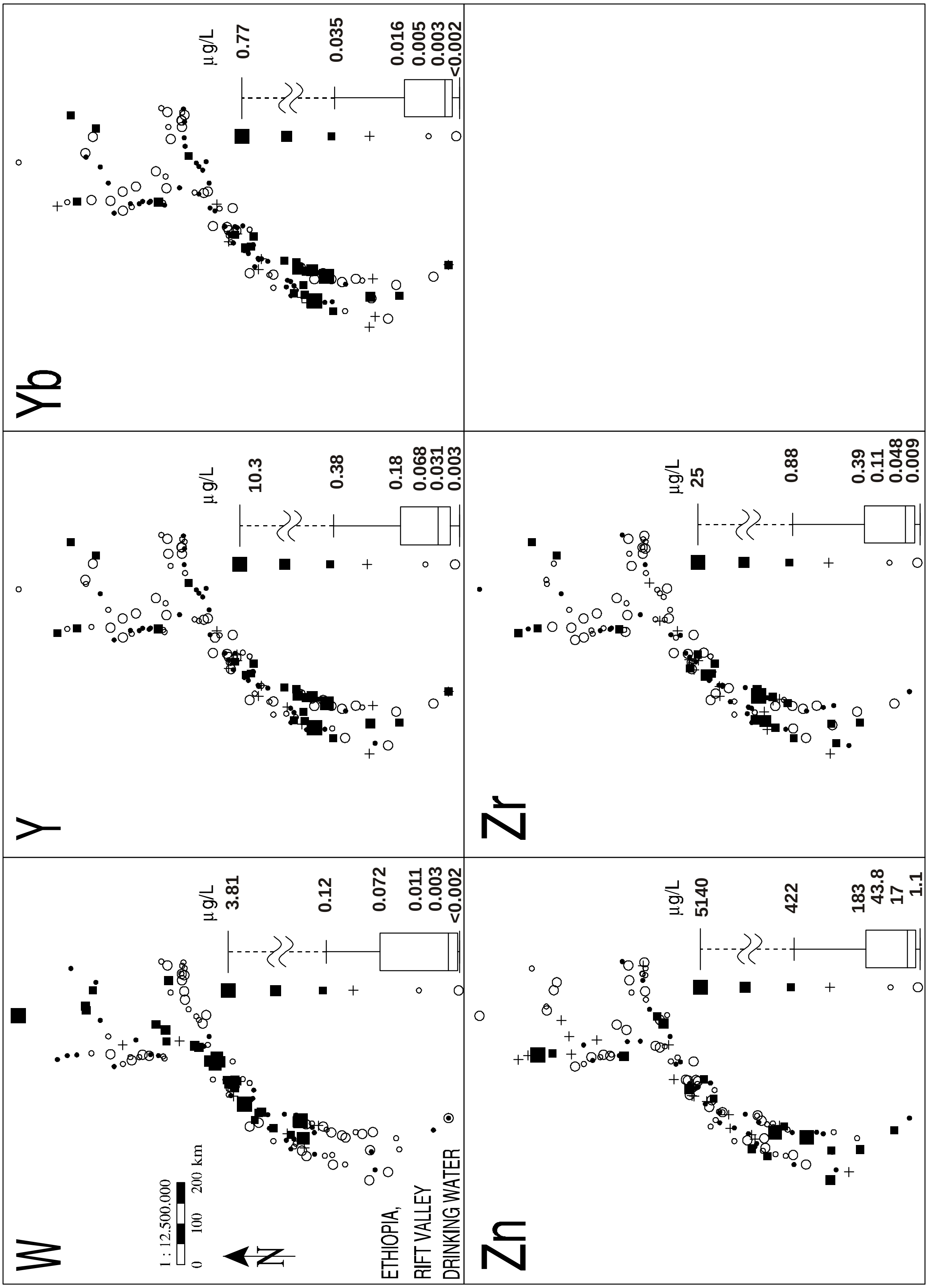


Figure 9 (continued – 12 of 13: temperature, pH, alkalinity, electrical conductivity and well depth)

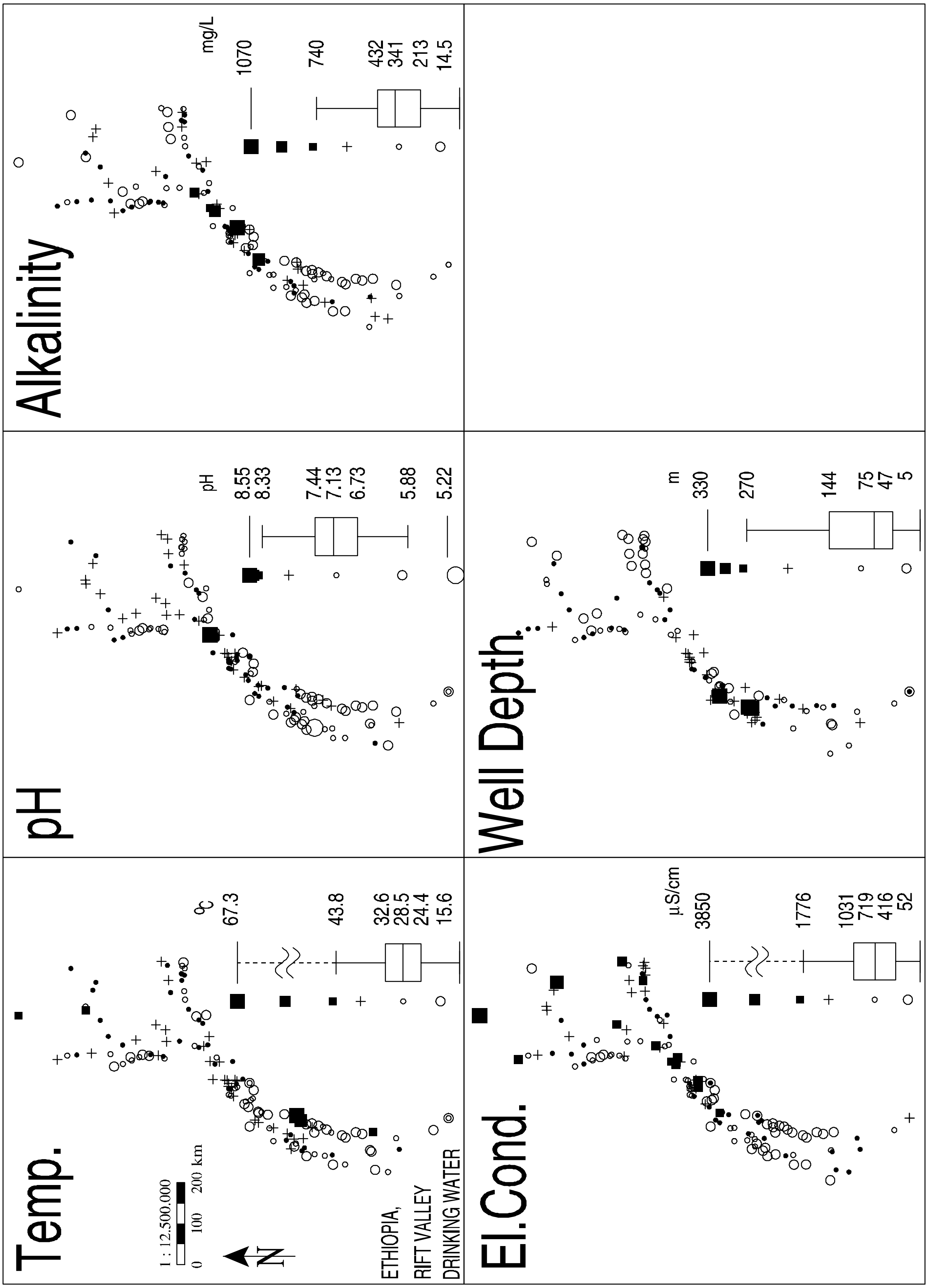


Figure 9 (continued – 13 of 13: sum dissolved solids, total hardness and carbonate hardness)

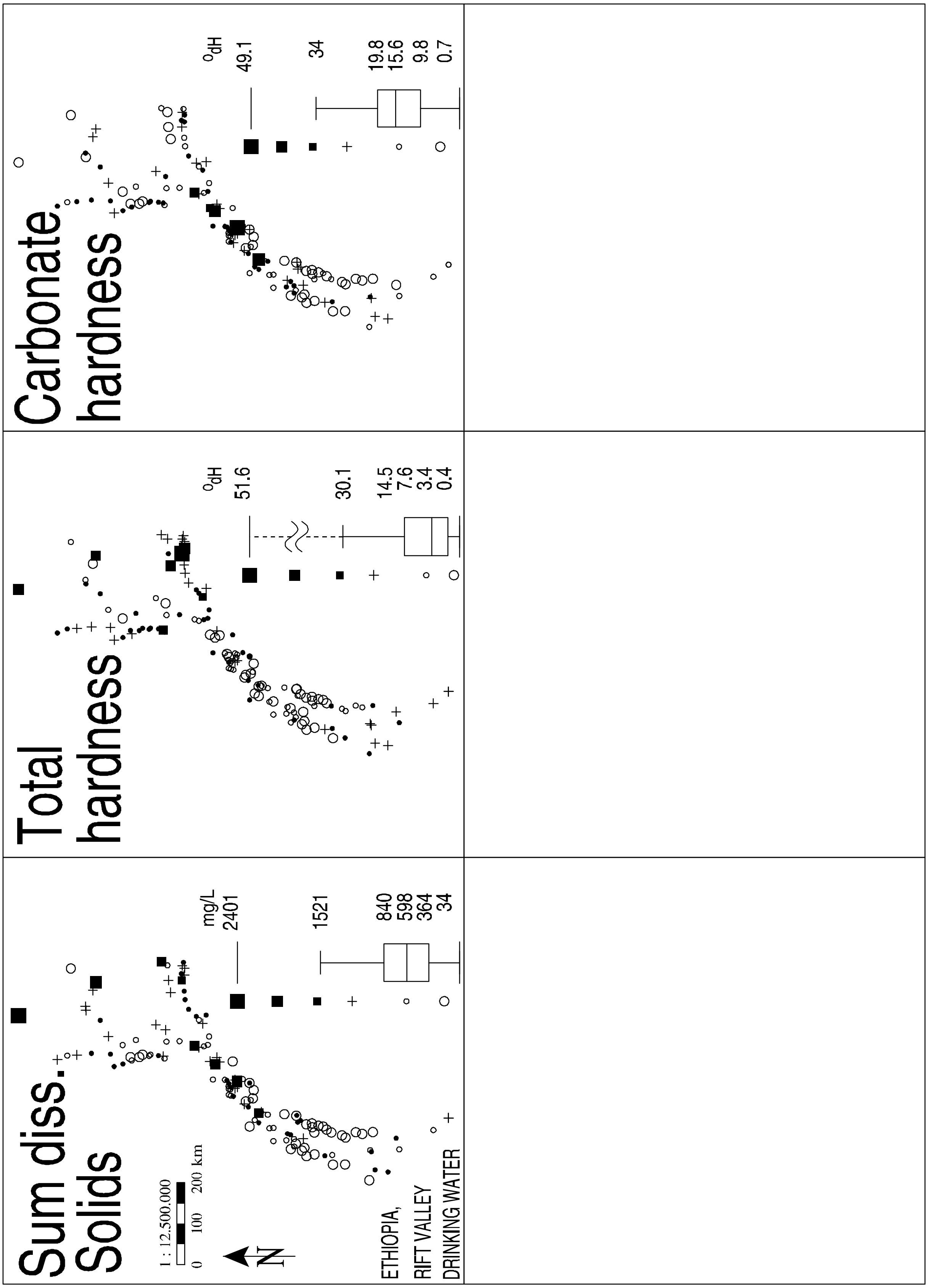
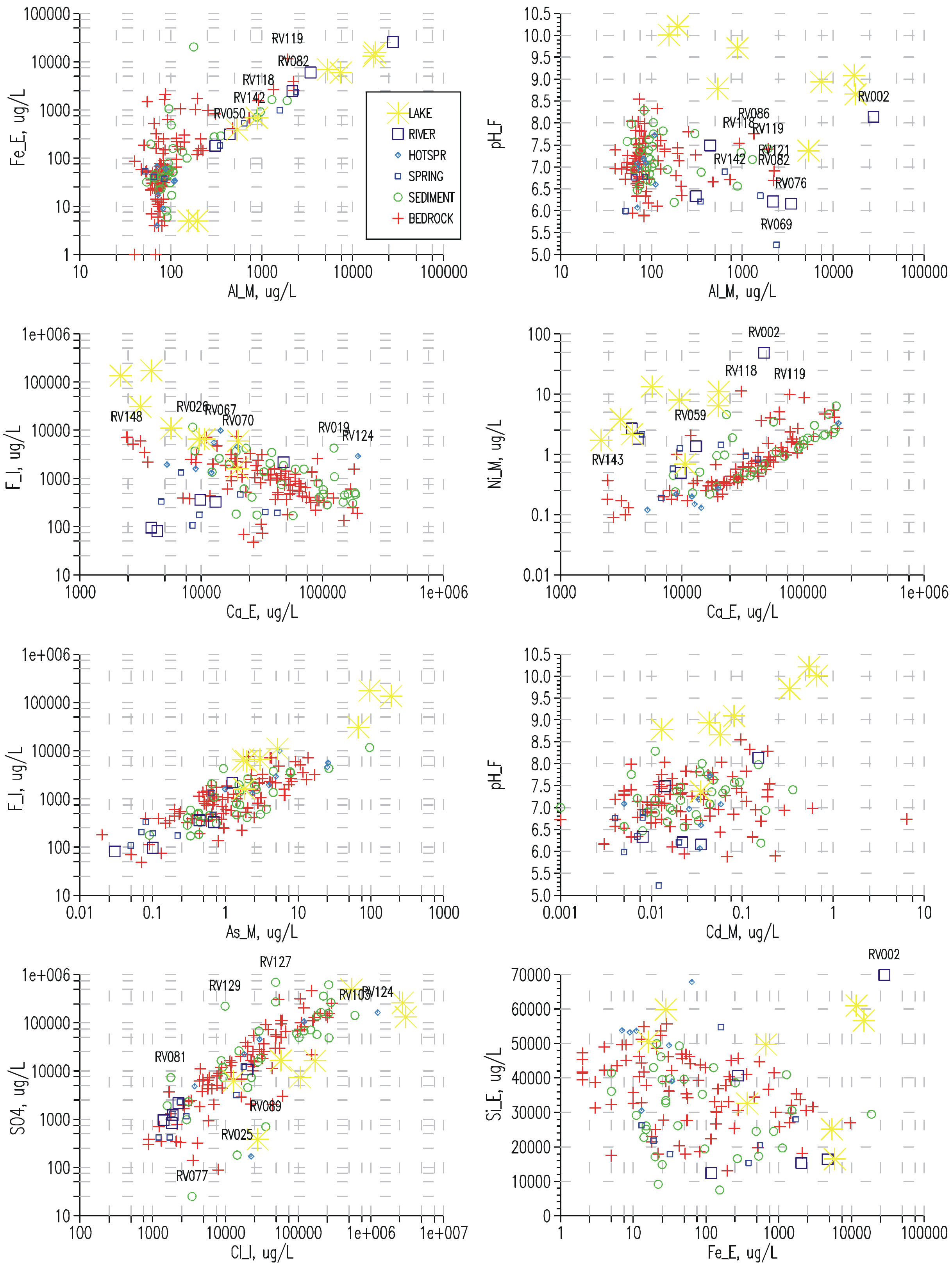


Figure 10 presents eight XY-diagrams that were used for a first interpretation of some remarkable features (see 7. Discussions).

Figure 10: selected XY-Diagramms. Hotspr= hot spring, Sediment= shallow well, BEDROCK= deep well). _M: analysed by ICP-MS, _E: analysed by ICP-OES, _I analysed by IC, _F: analysed in the field.



7. DISCUSSION

78 % of all drinking water samples from the Ethiopian Rift Valley would fail to pass the current EU drinking water directive. This number raises to 86% if the WHO-proposed MAC for U is also used. This result demonstrates the necessity of documenting natural element concentration and variation in drinking water on a regional scale. In the following all elements and parameters will be discussed separately.

7.1 Elements (alphabetically sorted)

7.1.1 Ag - Silver

No biological role of Ag is known. Silver is considered to be less toxic to humans. Silver is, however, highly toxic to many micro-organisms and fish.

Formerly the maximum acceptable concentration (MAC) of Ag in drinking water was 10 µg/L, this values was removed from the most recent EU water directive. Silver occurs in trace amounts in various silicates. The main natural source of Ag is sulphidic ores. Its mobility is high under acidic conditions, medium under oxidising conditions and very low under reducing and neutral to alkaline conditions. In the Rift Valley data set about 95% of all samples returned values below the detection limit of 0.002 µg/L. The highest value of 0.021 µg/L occurs in sample RV022 (a shallow well). All high values occur in the central part of the Rift Valley (Figure 9, map Ag).

No correlation coefficients could be calculated due to the high number of samples with concentrations below detection.

7.1.2 Al – Aluminium

Aluminium is essential to all organisms. It is considered less toxic. It has been speculated on a connection between high Al in drinking water and the development of Alzheimer's disease (e.g. Martyn et al., 1989).

The MAC of Al in drinking water (200 µg/L) is not primarily set for health reasons but rather a compromise between aesthetic problems and the efficiency of water treatment (Al-salts used to clarify water in drinking water plants). The solubility of Al is strongly pH dependent. The presence of F and SO_4 may also increase the solubility of Al (May et al., 1979). The labile, monomeric forms of Al are probably directly health-relevant. High values of "total" Al in drinking water should only be taken as a first warning of possible problems. For the Rift Valley drinking waters 26% of all samples fall above the MAC. The maximum concentration of 3440 µg/L was observed at sample RV076 (river water). It must, however, be noted that in this study the waters were not filtered. Particulates in the water can give rise to an excessive Al-concentration in some samples. This can be clearly seen for the samples from rivers and lakes (Table 11 or Figure 8). The Al/Fe and Al/pH-diagrams (Figure 10) provide an easy means to identify the samples with a possible particulate-problem. These are mostly lake and river waters and a few deep and shallow wells. The diagrams prove that the median concentration of the deep and shallow wells should not be influenced by particulates.

Aluminium-median concentrations in the Rift Valley drinking waters are by about a factor 6-10 higher than in European mineral waters or Norwegian bedrock groundwater (Table 11).

In the wells (deep and shallow) Al shows the highest correlation with Ce, Co, Fe, Ga, La, Nb, Nd, Ti, Y and Zr (Table 14).

7.1.3 As – Arsenic

Arsenic is essential in ultra-trace quantities. Arsenic is toxic and carcinogenic. Chatterjee et al. (1995) and Das et al. (1995) have recently reported dramatic health effects of too high As in drinking water.

The MAC of As in drinking water has recently been set to 10 µg/L (from 50 µg/L, a value of 2 µg/L as MAC has also been discussed). Usually As-levels in drinking water are low (less than 1 µg/L). Most cases of high values of As in water are related to the occurrence of sulphide minerals such as arsenopyrite and pyrite. Arsenic can also be expected in volcanic exhalations. In aqueous systems As is highly soluble over a wide pH/Eh-range. Fe and Eh both have an important influence on the observed concentration of As in groundwater (e.g. Matisoff et al., 1989; Varsanyi et al., 1991). Arsenic is also readily sorbed onto aluminium hydroxide. In the Rift Valley data set 9 samples are above the MAC of 10 µg/L. The highest concentration of 96 µg/L occurs in sample RV026 (shallow well), which also shows an excessive F-concentration (11.6 mg/L). Even higher values were observed in the lake waters, which are (fortunately) non-potable (up to 189 µg/L). The highest median As-concentration is observed in the hot springs (4.94 µg/L), followed by the lakes (4.1 µg/L). Arsenic concentrations in the Rift Valley waters are by a factor of 2-5 higher than those of European mineral waters and Norwegian bedrock groundwater (Table 11). Most high As-values occur in the central part of the Rift Valley (Figure 9, map As).

In the wells, As is highly correlated with B, F, Ge, I, Mo, Na, Sb, and pH (Table 14). Figure 10 shows the very good correlation of As and F, suggesting a common origin (volcanic emanations?).

7.1.4 B – Boron

Boron may be essential to some organisms. Elemental B and borates are considered non-toxic to humans. High B-concentrations may pose a problem in irrigation waters because B is toxic to some plants at high levels.

The EU-MAC for B in drinking water is 1000 µg/L. TheWHO suggests a MAC of 500 µg/L. The median concentration of the Rift Valley drinking water (70 µg/L) is well below the MAC. No sample reaches the EU-MAC of 1000 µg/L, although the observed maximum concentration of 997 µg/L in sample RV005 (a hot spring) is very close to the MAC. 14 samples fall above the WHO-MAC. Waters with a B-concentration above 300 µg/L (9 samples) should not be used for irrigation. Naturally B is a typical element in evaporites. Higher concentrations can also be found in pegmatites, skarns and greisens. Feldspars and mica may contain some B. The mobility of B is very low under reducing conditions and very high under all other conditions. The shallow wells return about double as high B-concentrations than the deep wells. River waters have the lowest B-concentration and, not surprisingly, B reaches maximum levels in the alkaline lakes (median 505 µg/L). Values from the Rift Valley are close to those observed in European mineral waters and about 3 times as high as in Norwegian bedrock groundwater. The high B-values occur in the central and northernmost part of the survey area (Figure 9, map B).

Boron correlates well with Br, Cl, I, Mo, Na, SO_4, pH and electrical conductivity (EC) (Table 14).

7.1.5 Ba – Barium

No biological role of Ba is known. Ba is toxic, however its solubility is limited under most natural conditions and in the presence of sulphate. Barium has a possible association with cardiovascular disease (WHO, 1993).

The previous GL for Ba in drinking water (100 µg/L – e.g. European Union, 1980) has been removed from the current EU-directive. The WHO suggests a MAC of 700 µg/L. The United States Environmental Protection Agency (US-EPA) has set a MAC of 2000 µg/L, in Canada the MAC is 1000 µg/L and in Russia this value is 100 µg/L (Reimann and Caritat, 1998). These large differences demonstrate that there are still discussions about the possible health effects of Ba. Usually the concentration of Ba in drinking water is well below 1000 µg/L (Edmunds et al., 1989). Although Ba is readily released during weathering, its solubility in water is controlled by the solubility of barite ($BaSO_4$). High Ba-concentrations can be expected in waters with low SO_4-concentration (less than 10 mg/L). In the Rift Valley drinking waters the median concentration is 16 µg/L (minimum 0.23 µg/L) and the maximum concentration is 305 µg/L in sample RV103 (a shallow well) (followed by RV091 (shallow well)). About 10% of all wells deliver water above the Russian MAC or previous EU-GL. Barium concentrations are lower in springs and hot springs and higher in river and lake water. The values reported from the Rift Valley compare very well with European mineral water and Norwegian bedrock groundwater.

Barium does not correlate especially well with any other element/parameter measured (Table 14).

7.1.6 Be – Beryllium

Beryllium has no known biological role. It is known to be toxic and carcinogenic. The WHO considers the toxicological data available for Be as insufficient to set a GL or MAC, and assumes that its concentrations in drinking water must be very low (WHO, 1993).
The US EPA, using a MAC of 4 µg/L, suggests that drinking water exceeding the MAC can lead to damage to bones and lung, and to cancer in the long term.

No MAC or GL is given in the European regulations. The US EPA has set a MAC of 4 µg/L, while Russian authorities use a MAC of 0.2 µg/L (Kirjuhin et al., 1993). Beryllium is especially concentrated in acidic waters but may also be soluble at higher pH (Edmunds and Smedley, 1996). Be-solubility may also be enhanced by the formation of F-complexes. It should thus always be analysed when high F-values or low pH are detected in drinking waters. In the Rift Valley drinking waters 13 samples fall above the Russian MAC, the maximum values observed is 5.9 µg/L in sample RV053 (hot spring). This value is also above the MAC as defined by the US EPA. Be-values in Rift Valley drinking water range between <0.005 and 5.9 µg/L, the median is 0.016 µg/L. Compared to the deep wells, Be is highly concentrated in springs, hot springs, river and lake water. Some of the high Be-values may thus be due to particulates in the samples. The median concentration in the Rift Valley wells compares well with European mineral water and is slightly lower than in Norwegian bedrock groundwater (Table 11). More than 25% of all samples returned values below the detection limit (0.005 µg/L). The high values form clear geographical clusters (Figure 9, map Be)

No correlation coefficients were calculated due to the high number of samples with concentrations below detection.

7.1.7 Bi – Bismuth

Little is known about the toxicity of Bi. Bismuth is considered non-essential and rare toxic effects to humans have been reported (Reimann and Caritat, 1998).

No action levels are set in the European Union. Only Russian authorities give a MAC of 100 µg/L. Naturally it may be incorporated in some apatites and occurs otherwise in sulphidic ores. Mobility of Bi should be generally quite low. Due to the generally very low concentrations of Bi in waters little research regarding this element has been performed. In the Rift Valley data set about 60% of all samples are below the detection limit (0.002 µg/L). The maximum value of 0.03 µg/L occurs in sample RV124 (hot spring) and is still far below the Russian MAC.

No correlation coefficients were calculated due to the high number of samples with concentrations below detection.

7.1.8 Br – Bromine

Br may be essential to some organisms. Br is highly toxic.

Considering the toxicity of Br and the fact that Br may also be an essential element for human beings it is astonishing, that no western authority has set a MAC or GL for this element. The new EU directive gives a MAC for bromate (10 µg/L), which is related to the possible formation of bromorganic compounds under water treatment. Only the Russian authorities give a MAC of 200 µg/L Br. The main source of Br in the environment is probably ocean water (67 mg/L). It is a typical element concentrated in sea spray and brines. In the natural environment the mobility of Br is high under all conditions. 67 samples or a staggering 49% of all samples of Rift Valley drinking water are above the Russian MAC of 200 µg/L. The maximum value reported is 6110 µg/L in sample RV124 (hot spring). The median of Br in Rift Valley drinking water is 175 µg/L. Median Br-concentrations in springs, hot springs and river water are considerably lower than those in the wells, while maximum concentrations (up to 14900 µg/L) are observed in the alkaline lakes. Compared to European mineral water and Norwegian bedrock groundwater Br is by a factor of 2-5 higher in the Rift Valley drinking water. In the map the high Br-values are clustered in the northern part of the survey area (Figure 9, map Br)

Bromine shows high correlation coefficients with B, Cl, I, Na, Se (deep wells), SO_4 and EC (Table 14).

7.1.9 Ca – Calcium

Ca is essential to all organisms. It is considered to be non-toxic. It has long been suspected that a causal link exists between water hardness (dissolved Ca and Mg) and cardiovascular disease (e.g. Gardner, 1976). It appears that there exists a weak inverse relationship between drinking water hardness and cardiovascular disease mortality (COMA, 1994). This would suggest that a lower, minimum acceptable concentration of Ca in drinking water would be more appropriate than an upper limit.

The old EU-drinking water directive gave a GL for Ca in drinking water at 100 mg/L. This upper limit was probably rather set to guarantee survival of the kettle and the washing machine and foaming soap than for any health related reasons. It has recently been removed from the EU-directives. Calcium is one of the major cations in water, usually occurring in concentrations of about 10-100 mg/L. The main source of Ca in water is deep weathering and dissolution. However, high Ca-concentrations in bedrock groundwater are not always related to lithologies with high Ca (Banks et al., 1998a). The carbonate system and pH may thus also control Ca-concentrations. In the Rift Valley drinking water Ca-concentration varies from 2 - 196 mg/L (Table 4). The maximum concentration of 196 mg/L occurs in sample RV124 (hot spring). About 10% of all samples return values below 10 mg/L, and these may be the more health-relevant samples. The lowest concentration of 2.5 mg/L was observed in samples RV148 (deep well) and RV143 (deep well). The wells return considerably higher median Ca-values than hot springs, springs, rivers and lakes (Table 11). The values observed in the Rift Valley drinking waters fall between European mineral water and Norwegian bedrock groundwater (Table 11).

Calcium correlates well with Mg, Ni (Figure 5 – attention: mass interference? Note that the standard reference materials returned correct Ni-values) and Sr (Table 14).

7.1.10 Cd – Cadmium

Cadmium may be essential to some organisms. Cadmium is an acute toxin, producing symptoms such as giddiness, vomiting, respiratory difficulties, cramps and loss of consciousness at high doses (Edmunds and Smedley, 1996). Chronic exposure can lead to anaemia, anosmia, cardiovascular diseases, renal problems and hypertension (Mielke et al., 1991, Robards and Worsfold, 1991). There is also evidence that increased Cd ingestion can promote Cu and Zn deficiency in humans (Petering et al., 1971). Cadmium may also be a carcinogen (Tebbutt, 1983).

The EU MAC is set at 5 µg/L. The WHO recommends 3 µg/L as the maximum concentration in drinking water and the Russian authorities have set a MAC of 1 µg/L. Although the intake of Cd is likely to be dominated by food and inhalation, water should not be neglected as a possible source. Volcanic exhalations can, for example, lead to high Cd-values in water. The affinity of Cd to organic substances can lead to increased concentrations in organic-rich waters. Cadmium solubility is limited by $CdCO_3$ (Hem, 1985). Cadmium is therefore found in higher concentrations at low pH. This is, however, not valid for the Rift Valley waters – low pH wells show also low Cd here and some of the highest Cd-values are found in the alkaline lakes at very high pH-values (Figure 5). Few data exist on cadmium concentration in drinking water. In the Rift Valley drinking water Cd-concentrations range from <0.002 - 6.4 µg/L. Only one sample falls above the MAC of 5 µg/L (RV054 (deep well)). Even if the stricter Russian MAC is used only this single sample shows a higher Cd-concentration. The Cd-median concentration is highest in the lakes and hot springs and lowest in the springs. The median value in the Rift Valley wells compares well with the value given for Norwegian bedrock groundwater but is considerably higher than the median for European mineral water.

Cd does not show high correlation with any other element. The best correlation exists with Pb and Zn (r=0.4-0.5 - Table 14).

7.1.11 Ce – Cerium (rare earth elements (REEs))

The REEs are considered to be non-essential and of general low toxicity. However, data to assess the health relevance of this group of elements are scarce. REEs taken up via drinking water will accumulate in the skeleton, teeth, lungs, liver and kidneys. Cerium is the most abundant REE. Geochemically all REEs can replace Ca in biological processes.

No MAC or GL exists for any of the elements of the REE-group. The mobility of the REEs is considered to be very low. Observed Ce-concentrations in the Rift Valley drinking waters range from <0.002 - 24.6 µg/L and thus span almost 5 orders of magnitude. The maximum concentration occurs in sample RV076 (river water). Observed Ce-concentrations are much higher in springs, river and lake water than in the wells – these high concentrations are most likely due to particulate material in these samples. Median Cd-concentrations in the Rift Valley drinking waters are about the same as in European mineral waters and by a factor of 3 lower than those reported from Norwegian bedrock groundwater (Table 11). The high REE-values cluster at the southern end of the central part of the survey area (Figure 9, map Ce, Dy, Er, La etc.).

Cerium correlates highly with Al, Co, Fe, Ga, La, Nb, Nd, Ti, Y and Zr (Table 14). This stresses again the likelihood of high Ce-values being related to particulate matter in the samples.

7.1.12 Cl – Chloride

Chloride is considered to be essential in small quantities and less toxic to human beings. Oxidised forms are highly toxic (Cl-gas, hypochloride, chlorates). Drinking water is often chlorinated to kill unwanted bacteria and micro-organisms.

The EU MAC for Cl in drinking water is 250 mg/L. Natural sources of high Cl in drinking water would include intrusion of sea water in coastal areas, sea spray (coastal areas), leaching of "fossil" salt from an aquifer and volcanic emissions. The range of Cl-concentrations observed in the Rift Valley drinking waters spans from 0.87 - 1240 mg/L with a median of 20.3 mg/L (Table 4). The highest value occurs in sample RV124 (hot spring) (second highest: RV103 (shallow well)). About 8% of all values are above the EU MAC. Chloride values are slightly higher in the shallow wells and in the hot springs than in the deep wells and much higher (factor 7) in the lake waters. The median Cl-concentration in European mineral water is slightly higher than that of the Rift Valley drinking water, while Cl-concentrations in Norwegian bedrock groundwater are much lower – despite the coastal position of many of these wells (Table 11). The map of the Cl-distribution shows a very clear trend to higher Cl-concentrations in the northern part of the study area (Figure 9, map Cl).

Chloride correlates well with B, Br, I, Na, SO_4 and EC.

7.1.13 Co – Cobalt

Cobalt is an essential element for human beings. It is toxic at high intake (>25 mg/day) and Co-dust is carcinogenic. In general it is believed that Co-deficiency problems are more widespread than Co-toxicity (Reimann and Caritat, 1998).

The mobility of Co strongly depends on the geochemical conditions. It will be mobilised under acidic or oxidising conditions and is immobile in the alkaline to neutral environment and under reducing conditions. No GL or MAC for Co is set in European regulations, the Russian authorities operate with a MAC of 100 µg/L. Cobalt-concentrations observed in the Rift Valley drinking water range from <0.002 to 3.1 µg/L (Table 4) and are thus far below the Russian MAC. The highest Co-concentration was measured in sample RV076 (river water – particulates?) (followed by RV119 (deep well)). Considering that due to a generally low intake of Co deficiency may be more widespread than toxicity, it may be more interesting to look at the lower end of the data distribution in connection with health-studies. Observed Co-concentrations are much higher in the river and lake waters (by a factor of about 26 - particulates?). The lowest values occur in the hot springs (Table 11). Cobalt in the Rift Valley waters is lower than in the European mineral waters and the Norwegian bedrock groundwater (Table 11).

Cobalt correlates rather well with Al, Ce, Fe, La, Nd, Ni and Y (Table 14).

7.1.14 Cr – Chromium

Chromium is considered to be essential for some organisms. Toxicity depends strongly on valence, Cr^{3+}-compounds are considered relatively harmless, Cr^{6+} compounds are highly toxic and some are carcinogenic (Reimann and Caritat, 1998).

The mobility of Cr is considered to be very low. The European Union operates with a MAC of 50 µg/L in drinking water. The Rift Valley waters show Cr-values between <0.01 and 21 µg/L (RV119 (deep well), followed by RV141 (deep well), with a median of 0.49 µg/L (Table 4). All values are thus well below the MAC. Median Cr-concentrations are lower in the hot springs and higher in the springs and rivers, much higher in the lakes, than in the wells. The values compare well with Norwegian bedrock groundwater and are considerably lower than the median value of European mineral water (Table 11).

Chromium does not really show a high correlation with any other element (Table 14).

7.1.15 Cs – Cesium

Cesium is considered non-essential. ^{137}Cs is radiotoxic. Otherwise little is known about the health effects of Cs.

For Cs no GL and no MAC are set. The mobility of Cs is considered to be low under all conditions. In the Rift Valley drinking water observed concentrations range from <0.002 to 12.1 µg/L and thus cover 4 orders of magnitude. The maximum value occurs in sample RV053 (hot spring). About 10% of the drinking water samples returned values below detection. The shallow wells show a clearly lower median Cs-concentration than the deep wells. The highest median Cs-values are observed in the hot springs, followed by the lakes. The values in the Rift Valley wells compare well with those observed in European mineral waters and are by a factor 3 lower than in Norwegian bedrock groundwater (Table 11).

No correlation coefficients were calculated due to the high number of samples <DL.

7.1.16 Cu – Copper

Copper is essential for all organisms. It is toxic at high concentrations and deadly Cu-poisoning of infants from drinking water has been reported.

EU directive and WHO guidelinesgive a MAC of 2000 µg/L Cu for drinking water. The EU uses the further restriction "weekly average", which allows much higher single values. The US EPA operates with a MAC of 1300 µg/L. These rather high values should also be seen in connection with economic considerations: until quite recently a lot of the water piping was made of Cu. All waters (especially soft water) are corrosive to Cu (e.g. piping) to some degree. Copper becomes quite mobile under acid conditions and high values can be expected in low pH-waters. Under reducing and alkaline conditions the mobility of Cu is very low. In the Rift Valley drinking water observed concentrations range from 0.26 - 27 µg/L (sample RV092, a deep well) with a median concentration of 1.98µg/L (Table 4). Thus all values are well below any GL or MAC. Median concentrations compare quite well in all the Rift Valley waters (hot springs lowest, lakes highest). Median values for the Rift Valley wells are about 4 times higher than those observed in European mineral water, but more than 5 times lower than those in Norwegian bedrock groundwater (Table 11). One can speculate whether these differences are due to differences in the piping used in the different countries (much stainless steel in mineral water works (high Cr), copper in Norway and zinc/iron in Ethiopia?).

Copper in the well waters does not correlate especially well with any other element/parameter (Table 14).

7.1.17 Dy – Dysprosium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.18 Er – Erbium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.19 Eu – Europium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.20 F – Fluoride

Because F is ubiquitous in the nature, health effects due to actual fluoride deficiencies are hard to prove. As demonstrated by Dean already in the 1930’es, low-fluoride drinking water is - in caries-prone populations - associated with elevated incidence of dental caries (Dean et al., 1939). Excessive intake of fluoride may result in acute as well as chronic health problems. Dental fluorosis is the most striking feature in cases of chronic fluoride intoxication. The “optimal” fluoride concentration in water is in the range of 0.5 – 1.5 mg/L. The MAC for F is set at 1.5 mg/L for a water temperature of 8 –12 ^{o}C. In high-temperature climates water intake increases, and the fluoride content of water should be reduced in order to avoid dental fluorosis (Evans and Stamm, 1991). Thus the MAC of drinking water in the Ethiopian Rift

Valley should be well below 1.0 mg F/L, perhaps as low as 0.5 mg F/L – which is the standard adopted by Hong Kong. Even below-MAC fluoride values in the drinking water may result in minute fluorotic changes in the dental enamel. Of greater significance to human health is skeletal fluorosis, which may develop with long-time intake of drinking water with a fluoride concentration above 4 mg/L. Crippling fluorosis is seen at values above 10 mg/L (Dissanayake, 1991). The effects of F-toxicity on bone and teeth are permanent and non-curable. Poor nutrition is recognised as an important additional factor.

Fluoride is quite mobile under most geochemical conditions. In water, stability is limited by the formation of Fluorite (CaF_2), high F-concentrations will thus mostly occur in low Ca-waters. The occurrence of F is often linked with volcanic activity, geothermal activity and granitic rocks. Thermal high pH waters can be expected to have especially high concentrations. 33 % of the Rift Valley samples plot above the MAC of 1.5 mg/L. The Rift Valley drinking waters show concentrations between 0.05 and 11.6 mg/L F with a median concentration of 0.9 mg/L. Thus even the median is above a reasonable MAC for these high temperature-waters. For example, 58 % of all samples show F-concentrations above 0.7 mg/L. The highest concentration (11.6 mg/L) was measured in sample RV026 (shallow well). The second highest value reported is 7.6 mg/L (RV067 – hot spring). In spring and river water lower median concentrations are observed than in the wells, they are higher in hot springs and highest in the lakes. The median concentration for the Rift Valley wells is clearly higher than that reported for European mineral water and Norwegian bedrock wells (Table 11). The very high F-values cluster clearly in the central parts of the Rift Valley (Figure 9, map F)

It is interesting to note that excessive F in drinking waters may be removed by the use of simple, low-cost methods such as filtration through – or simple contact precipitation with - local clay. In former times, before plastic cans were made available, drinking water was actually stored in clay pots, which were also able to reduce the temperature of the water.

Fluoride correlates well with As (Figure 10), Ge, K, Li, Mo, Na, Rb, Sb. There is a clear negative correlation with Ca and Mg (Table 14).

7.1.21 Fe – Iron

Iron is an essential element to all organisms. In drinking water it is toxic to humans at concentrations greater than 200 mg/L. In drinking water Fe is a trace element and reaches at most concentrations of some mg/L. Iron deficiency is widespread. Drinking water, however, is not the main source of iron to humans. Water with high Fe concentrations is usually unpalatable in terms of odour, taste, staining of laundry and discoloration of food.

The MAC for Fe in drinking water is set at 200 µg/L. It is set at this low level out of practical reasons, not because of toxicity. Under reducing conditions concentrations of dissolved iron can reach several mg/L, although much may be in colloidal rather than in truly dissolved form. The solubility of Fe is greater at low pH. High Fe-concentrations are a very common problem in groundwater world-wide. Too high Fe values in well waters are often reported from developing countries, where communities may be poorly equipped to treat the water. In the Rift Valley drinking waters Fe concentrations range from 1.5 to 18600 µg/L, the median is 48 µg/L. The highest value was observed for sample RV077 (shallow well) followed by sample RV 119 (deep well). The median Fe-concentration is lowest in the hot springs and highest in the lakes and rivers (particulates – see also Figure 10: Fe/Al indicating those samples where a particulate problem exists). It is about twice as high as in the Norwegian bedrock wells and compares well with the Fe-concentration observed in European mineral water (Table 11).

Iron correlates well with Al, Ce, Co, Ga, La, Nd, and Ni (Table 14).

7.1.22 Ga – Gallium

Gallium is not considered to be essential for human beings. Its toxicity is considered to be low.

No GL or MAC exists for Ga. Little is known about the mobility of Ga in the environment. The Ga-concentrations that are observed in Rift Valley drinking water range from 0.003 to 1.58 µg/L, the median is 0.023 µg/L (Table 4). The maximum value occurs in sample RV076 (river), followed by RV069 (spring). In terms of median-concentrations springs, rivers and lakes show much higher Ga-values than the wells or hot springs. The median Ga-concentration in Rift Valley wells is comparable to that in Norwegian bedrock wells and much higher than Ga in European mineral water (Table 11).

Gallium correlates well with Al, Ce, Fe, La, Nb, Nd, Ti, and Zr (Table 14). The high correlation of Ga with Fe and Al suggests that it may be bound to particulates.

7.1.23 Gd – Gadolinium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.24 Ge – Germanium

Germanium is considered to be non-essential for humans. The toxicity is thought to be low, it may be anti-carcinogenic.

No GL or MAC is set for Ge in drinking water. The mobility of Ge is considered to be low. In nature it occurs associated with Zn. Geochemically it has some similarity with Si. In the Rift Valley drinking water it shows astonishing high concentrations, which range from 0.014 to 11.6 µg/L. The median Ge-concentration is 0.3 µg/L (Table 4). The highest value occurs in sample RV053 (hot spring), followed by RV005 (hot spring). Median Ge-concentrations are lower in shallow wells, springs and rivers than in deep wells, higher in lakes and much higher in hot springs. Rift Valley well waters show much higher Ge-concentrations than European mineral water or Norwegian bedrock groundwater (Table 11). One can speculate on a volcanic or geothermal origin giving rise to these high Ge-concentrations in the Rift Valley waters. Two clusters of high Ge-values occur in the central parts of the Rift Valley (Figure 9, map Ge).

Germanium correlates well with As, F, K, Li, Mo, Rb and Si. It shows a remarkable negative correlation with Ca and Mg (Table 14).

7.1.25 Hf – Hafnium

Hafnium has no known biological role. It is considered to be highly toxic (Misund et al., 1999).

No MAC or GL exists for Hf. In nature Hf is associated with Zr and may occur in higher concentrations in granites and syenitic pegmatites. Concentrations in the Rift Valley drinking waters range from <0.002 to 0.4 µg/L, the median is very low with 0.004 µg/L. The highest value occurs in sample RV075 (shallow well). About 20% of all samples returned values below DL. Median Hf-concentrations are much higher in springs, rivers and lakes (particulates?) than in the wells. They are quite similar to Hf-concentrations observed in Norwegian bedrock wells and considerably lower than those reported from European mineral water.

Due to the high number of samples with a concentration below the DL, no correlation could be calculated for Hf.

7.1.26 Hg – Mercury

Mercury is so highly toxic, that up to now no data on a possible essential role or carcinogenic effect have been reported. Due to the high volatility of Hg special precautions are necessary when sampling waters for Hg-analyses. To prevent any losses the samples have to be stabilised in the field (e.g. with a solution of potassium dichromate in nitric acid). This was not done for this project and the values given can thus only be considered as minimum concentrations.

The MAC for Hg in drinking water is 0.5 µg/L in Norway, 1 µg/L in the EU, 2 µg/L in the US, 0.5 µg/L in Russia, and the WHO suggests 1 µg/L. Mercury becomes more mobile under acid conditions and will show a low mobility under reducing and neutral to alkaline conditions. For the Rift Valley drinking waters more than 60% of all samples are below the detection limit of 0.01 µg/L. The maximum value of 0.8 µg/L (RV114 – shallow well) is the only value above the Norwegian MAC. Due to the high number of samples below DL no comparison of median values in the different water samples can be reported. Both European mineral water and Norwegian bedrock groundwater show a higher median concentration (Table 11). These samples were, however, analysed with a shorter time interval between sampling and analyses than the Ethiopian samples.

Due to the very high number of samples with a concentration below the DL, no correlation could be calculated for Hg.

7.1.27 Ho – Holmium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.28 I – Iodine

Iodine is essential for many organisms. The association of I deficiency in the human diet with goitre has long been recognised. At high concentrations I is toxic.

No GL or MAC is defined for I. Probably a lower limit of I in drinking water would be of more importance in relation to health considerations than an upper limit. The principal natural source of I is sea water. High iodine concentrations occur in brines and evaporites. Fluid inclusions, formation waters and volcanic emanations are further sources of I. Iodine may be found in higher concentrations in association with organic carbon (Fuge and Johnson, 1986). Iodine is also readily adsorbed onto Fe- and Al-oxides (Whitehead, 1984). In the Rift Valley drinking waters I-concentrations range from 0.31 to 961 µg/L, the median is 11 µg/L. The highest value occurs in sample RV003 (deep well), the second highest in sample RV103 (shallow well). The lowest value occurs in sample RV094 (spring). Springs and rivers show lower median I-concentrations than the wells, the lakes have a much higher (10 times) median. Median concentrations in the Rift Valley wells are much higher than those reported from European mineral water or Norwegian bedrock wells (Table 11).

Iodine correlates well with As, B, Br, Cl, Mo (deep wells), Na, and EC (Table 14).

7.1.29 In – Indium

Indium is considered to be non-essential. Baseline data to assess toxicity are lacking.

No GL or MAC is defined for In. Indium occurs in traces in sphalerite, the main Zn-mineral. Little is known about its behaviour in the secondary environment. Values observed in the Rift Valley drinking water range form <0.002 to 0.017 µg/L. More than 75% of all values are below the DL. The highest value was measured in sample RV069 (spring), closely followed by sample RV076 (river). River and lake waters returned the highest median In-concentrations (particulates).

Due to the high number of samples below detection no correlation coefficients could be calculated.

7.1.30 K – Potassium

Potassium is essential for all organisms. It is considered non-toxic. Concentrated K-salts will, however, kill plants.

Formerly the EU was using a MAC of 12 mg/L for K. This MAC was recently removed from the regulations. Potassium is an important component of many rock-forming minerals (where it is closely related with Ba and Rb) and easily released during weathering. Its mobility in the secondary environment is low. For the Rift Valley drinking waters a range from 0.6 - 45.8 mg/L was found, the median is 7.3 mg/L (Table 4). 42 samples fall above the old MAC – maximum concentrations were observed in samples RV051 (hotspring) and RV124 (hotspring). In terms of median concentrations shallow wells, springs and rivers show lower values, while hot springs and lakes returned a higher median K-concentration. Compared to European mineral waters and Norwegian bedrock groundwater the median K-concentration in the Rift Valley wells is rather high (Table 11).

Potassium correlates well with F, Ge, Li, Rb, and Si (Table 14).

7.1.31 La – Lanthanum (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.32 Li – Lithium

Although Li has no known biological role Li is considered to be an essential element in some sources. Little is known about its toxicity – sources vary in their estimation from "highly toxic" to "toxicity low".

No EU GL or MAC exists. Russian authorities operate with a MAC of 30 µg/L for Li. 35 samples of the Rift Valley drinking waters fall above this Russian MAC. Lithium occurs at high concentrations in many brines and evaporites. It is enriched in granites and pegmatites and greisens. Several rock forming minerals may incorporate Li. The observed concentrations in the Rift Valley drinking waters range from 0.1 to 176 µg/L, with a median of 11 µg/L (Table 4). The maximum concentrations were found in samples RV005 (hot spring) and RV053 (hot spring). Median Li-values in springs and rivers are considerably lower than that for the wells while lakes and especially hot springs show clearly higher values. The median values for the Rift Valley wells compare well with the European mineral waters and are clearly higher than those observed in the Norwegian bedrock wells (Table 11).

Lithium correlates well with As (deep wells), F, Ge, K, Mo, Na, Rb (deep wells), and Si (deep wells).

7.1.33 Mg – Magnesium

Magnesium is essential for all organisms. It is practically non-toxic under normal circumstances and Mg-deficiency is much more widespread than Mg-toxicity problems.

In the old EU-regulations the MAC for Mg in drinking water was 50 mg/L. This MAC was recently removed (compare Ca). 10 samples would fall above the old MAC. Waters high in Mg-sulphate can cause stomach problems, especially for small children. In general much of what has been said about Ca is valid for Mg as well. More research into Ca/Mg-ratios in drinking waters and heart diseases would be needed to define the real culprit (too low Ca or too low Mg, or both?). The Mg-values found for the Rift Valley drinking waters range from 0.24 to 116 mg/L, with a median value of 12 mg/L (Table 4). The highest values are observed in samples RV137 (shallow well) and RV103 (shallow well), the lowest in samples RV148 (deep well) and RV107 (shallow well). Median values are highest in the wells and considerably lower in lake, hot spring, spring and river water. They are by a factor of 2 lower than the median reported for Mg in European mineral water and about 3 times higher than the median found for Norwegian bedrock groundwater (Table 11).

Magnesium correlates well with Ba (deep wells), Ca, Ni, and Sr and shows a pronounced negative correlation with F and Ge in the deep wells (Table 14).

7.1.34 Mn – Manganese

Manganese is an essential element. There exists limited evidence about its possible toxicity. Mn-deficiency has been reported in humans and animals and is probably more widespread than toxicity.

A MAC of 50 µg/L Mn in drinking water has been set. 29 of the Rift Valley drinking waters fall above this level. Manganese behaves in many ways quite similar to Fe. Under reducing conditions Mn in drinking water can reach concentrations of several mg/L. However, already concentrations of about 100 µg/L will usually prevent the use of such water as drinking water due to odour, taste and staining problems. The concentration range observed in the Rift Valley drinking waters is <0.1 to 2440 µg/L, the median is 8.52 µg/L (Table 4). About 10% of all samples returned values at or below the DL (Figure 7). Maximum concentrations occur in wells RV059 (deep well) and RV003 (deep well), minimum concentrations in well RV046 (deep well), RV048 deep well) and RV110 (deep well). The median value for Mn is slightly higher in springs and shallow wells than in deep wells and much higher in lakes and rivers (particulates?) (Fig. 8, Table 11). The median value in the Rift Valley wells compares well with the median values observed in European mineral waters and Norwegian bedrock groundwater.

Due to the high number of samples below or at the DL no correlation coefficients were calculated for Mn.

7.1.35 Mo – Molybdenum

Molybdenum is essential for all organisms except some bacteria. Its toxicity is species dependent, it is, for example, more toxic to cows and sheep than to humans.

No EU MAC or GL has been set for Mo. Russian authorities operate with a MAC of 250 µg/L (no sample falls above this MAC). The WHO has recommended a maximum concentration of 70 µg/L (GL) for Mo in drinking water (3 samples above this level: RV019 (shallow well), RV021 (deep well) and RV143 (deep well)). Molybdenum is a typical element in pegmatites and greisens and also occurs in porphyry deposits (often with Cu) and some U-deposits (sandstone type). Under reducing conditions its mobility is very low, under oxidising and acid conditions it is high and under neutral to alkaline conditions it is very high. Values observed in the Rift Valley drinking waters range from <0.002 to 78.3 µg/L, the median is 2.93 µg/L (Table 4). Median values in the Rift Valley waters are highest in lakes and hot springs and lowest in springs and rivers. The median Mo-concentration of Mo in the Rift Valley wells is very high when compared to European mineral waters and high when compared to Norwegian bedrock groundwater (Table11).

Molybdenum correlates well with As, B, F, Ge (deep wells), I (deep wells), K, Li, and Na (Table 14).

7.1.36 Na – Sodium

Sodium is essential for all organisms. It is toxic to plants and animals at high levels. High levels of Na (i.e. >1000 mg/L) in drinking water can cause high blood pressure.

The EU MAC for Na in drinking water is 200 mg/L (old regulation: 150 mg/L). 24 of the Rift Valley drinking waters returned values above 200 mg/L. Sodium levels above 200 mg/L will usually give rise to consumer complaints due to taste. The primary source of Na in drinking water is probably mineral weathering, but Na is also high in brines and evaporites and, of course, in sea water. The mobility of Na is high under all conditions. In the Rift Valley drinking waters the Na-concentrations range from 3.8 – 595 mg/L, the median is 71.7 mg/L. The highest values were found in sample RV124 (hot spring) and RV037 (shallow well). Median concentrations of Na are much lower in spring and river water than in the wells and higher in the hot springs and lakes (Fig. 8). Compared to European mineral waters and Norwegian bedrock groundwater median Na-values are much higher in the Ethiopian well waters (Table 11). No high Na-values occur in the southern part of the survey area (Figure 9, map Na).

Sodium correlates well with As, B, Ba, Cl, F, Ge, I, Li, Mo, alkalinity, pH and EC.

7.1.37 Nb – Niobium

Niobium is considered to be a non-essential element for humans and plants. Little is known about the toxicity of Nb. Some organisms are known to enrich Nb (e.g. sea squirt).

No MAC or GL is defined in the EU-regulations. Russian authorities operate with a MAC of 10 µg/L. No sample falls above this level. Niobium is a typical trace element in granites, syenitic pegmatites and carbonatites. It can also be enriched in bauxites developed on alkaline rocks. Niobium occurs invariably with Ta. In the Rift Valley drinking waters the Nb-concentration ranges between <0.002 and 2.37 µg/L, with a median of 0.013 µg/L. The maximum concentration was found in samples RV075 (shallow well) and RV148 (deep well). Niobium median concentrations are higher in hot spring and much higher in spring, river and lake water than in the wells (particulates?). Compared to European mineral water and Norwegian bedrock groundwater the Rift Valley wells show a median between these two (Table 11).

Niobium correlates well with Al, Ce, Ga, La, Nd, Y, and Zr.

7.1.38 Nd – Neodymium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.39 Ni – Nickel

Nickel is essential to some organisms. Toxicity depends on valence. Nickel-deficiency in animals has also been reported.

The EU MAC for Ni in drinking water is 20 µg/L. No sample is above this level. The US EPA and Russian authorities operate with a higher MAC of 100 µg/L, the WHO uses a GL of 20 µg/L. The solubility of most Ni-compounds is highly pH dependent and high values of Ni can be expected in waters at a pH <6.5. Under reducing and neutral to alkaline conditions Ni-mobility is very low. The concentration range reported for the Rift Valley drinking water is 0.086 – 11.2 µg/L, the median is 0.74 µg/L. The highest value occurs in sample RV118 (deep well) followed by sample RV119 (deep well) – both samples do not correlate with Ca (see discussion below). Compared to the deep wells, the Ni-median is lower in the hot springs and higher in springs, shallow wells, rivers and lakes. It is in the same range as the median of Norwegian bedrock groundwater and lower than the median reported for European mineral water (Table 11).

Nickel correlates well with Ca, Co, Mg and Sr.

ATTENTION: The high correlation of Ni with Ca (Figure 10) may be an indication of mass interference of Ca-oxides with Ni on the ICP-MS. The values for Ni should thus be viewed with great care and taken as preliminary results only. Note that Ni as determined by ICP-OES and ICP-MS did not even at the high end show a good correlation. This may be another hint that the ICP-MS data for Ni are unreliable. On the other hand, results obtained for the international reference materials are OK for Ni (Table 2).

7.1.40 NO_2 – Nitrite & NO_3 – Nitrate

Health effects (US EPA 2002): Short-term: Excessive levels of nitrate in drinking water have caused serious illness and sometimes death. The serious illness in infants is due to the conversion of nitrate to nitrite by the body, which can interfere with the oxygen-carrying capacity of the child's blood. This can be an acute condition in which health deteriorates rapidly over a period of days. Symptoms include shortness of breath and blueness of the skin. Long-term: Nitrates and nitrites have the potential to cause the following effects from a lifetime exposure at levels above the MCL: diuresis, increased starchy deposits and hemorrhaging of the spleen.

While the US EPA maximum concentration level (MCL) for nitrite is set at 1 mg/L, the EU MAC for nitrite in drinking water is 500 µg/L. 4 samples of the Rift Valley drinking water fall above this level. More than 60% of all samples returned values below DL (5 µg/L). 4 samples, RV105 (deep well), RV121 (deep well), RV109 (shallow well) and RV096 (spring) show an unusually high NO_2-concentration. It must be noted that analysis of the N-species in the non-acidified waters should be carried out as shortly after sampling as possible. This was not possible here and all NO_2/NO_3-results would definitely need checking.

The EU MAC for NO_3 is 50 mg/L and the US EPA MCL for nitrate in drinking water is 10 mg/L. The EU-MAC is set in the interests of the agricultural industry. 42 of the Rift Valley drinking waters report concentrations above the US-value, 9 are above the EU-value. Excessive nitrate concentrations in water are mainly related to pollution (agriculture as the main source). However, in arid regions natural NO_3-concentrations can also be high. The range of NO_3-concentrations found in the Rift Valley drinking water is <0.05 to 149 mg/L, the median is 3.96 mg/L. The highest value was found in sample RV033 (deep well). The location and protection of the wells returning NO_3-values above the MAC should be checked for construction and protection against contamination by a hydrogeologist in the field. A regional pattern of high NO_3 is discernible in the map (Figure 9, map NO_3). Wells with high NO_3-values should also be checked for bacteriological contamination.

Nitrate does not correlate well with any other element/parameter in the data set.

7.1.41 Pb – Lead

Lead is considered to be non-essential. It is highly toxic as well as carcinogenic and accumulates in the body. It initiates tiredness, irritability, behavioural changes and impairment of intellectual functions.

The EU MAC for Pb in drinking water is 10 µg/L (recently lowered from 50 µg/L). 4 samples fall above this MAC. The US EPA uses a MAC of 15 µg/L, the WHO uses a GL of 10 µg/L. Authorities are hard pressed with setting a meaningful MAC for Pb. Due to the use of Pb as an additive to fuel it has become ubiquitous in the environment. In addition, many old water pipes are made of Pb and too low a MAC would result in enormous costs. Lead solubility is controlled by the formation of $PbCO_3$. Low alkalinity, low pH-waters can thus have high Pb-concentrations. Especially soft water will readily take up Pb from Pb-piping. The concentration range found for the Rift Valley drinking waters is 0.023 – 46 µg/L, the median is 0.45 µg/L (Table 4). The 2 samples with the highest values are: RV119 (deep well) and RV082 (deep well). The median Pb-concentration is lower in springs, shallow wells and especially hot springs and slightly higher in river and lake water than in the deep well water

(Tab. 11). It is clearly higher than the median reported for European mineral water and Norwegian bedrock groundwater (Table 11).

Lead correlates well with Zn (deep wells).

7.1.42 Pr – Praseodymium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.43 Rb – Rubidium

Rubidium has no known biological role and is not considered toxic.

No MAC or GL is set for Rb. Geochemically Rb is invariably associated with K and can be expected to behave very similar. Concentrations in the Rift Valley drinking waters range from 0.38 - 82 µg/L, the median is 8.39 µg/L (Table 4). The highest concentration was measured in sample RV053 (hot spring). The shallow wells show a clearly lower median for Rb than the deep wells, while the median is higher in the lakes and highest in the hot springs (Fig. 8). Compared to European mineral water and Norwegian bedrock wells the median for Rb in the Rift Valley wells is high (Table 11).

Rubidium correlates highly with Ge, K, Li (deep wells), and Si.

7.1.44 Sb – Antimony

Antimony has no known biological role. It is toxic and some Sb-compounds are carcinogenic. At high concentrations Sb is more toxic than Pb or As.

The EU MAC for Sb in drinking water is 10 µg/L. The US EPA has defined a MAC of 6 µg/L, the WHO GL is 5 µg/L. All values in the Rift Valley waters are below these levels. Geochemically the mobility of Sb should be low under almost all conditions. It will readily adsorb to Fe-Mn-oxides. The concentration range observed for the Rift Valley drinking water is <0.002 – 1.78 µg/L, with a median of 0.028 µg/L. The highest value occurs in sample RV053 (hot spring). Only the lake waters return a significantly higher Sb median than the wells. The median for the Rift Valley wells compares well with the median of the Norwegian bedrock groundwater and is considerably lower than the median reported for the European mineral waters.

Antimony correlates well with As, F, and K (shallow wells).

7.1.45 Se – Selenium

Selenium trace concentrations are essential in the human and animal diet. Se-deficiency has received much attention. It causes symptoms like muscular degeneration, impeded growth, fertility disorders, anaemia and liver disease (Låg, 1984). Keshan and Kaschin-Beck diseases, reported on a regional scale from China, are caused by Se-deficiency. At ingested concentrations of 10 mg/day and higher gastro-intestinal ailments, skin-discoloration and tooth decay may occur (Tebbut, 1983).

The EU MAC for Se in drinking water is 10 µg/L. No sample exceeds this value. Selenium is again one of those elements where a lower guideline level would probably be of more importance that an upper MAC. Selenium behaves geochemically quite similar to S. Its mobility is high under acid and oxidising conditions, very high under neutral to alkaline conditions and very low under reducing conditions. Naturally if occurs in trace amounts in many sulphidic ores. In elemental form Se is insoluble and thus non-toxic. It has a strong affinity to organic matter. Concentrations observed in Rift Valley drinking water range from 0.015 – 7.58 µg/L, the median is 0.62 µg/L (Table 11). The highest value was measured in sample RV092 (deep well). Median Se-values are lower in spring and river water than in the wells and highest in the lakes. They are double as high as those reported from Norwegian bedrock water and very similar to the median of European mineral water (Table 11).

Se correlates with Br, Cl, and SO_4 (deep wells).

7.1.46 Si – Silicon

Silicon may be essential to some organisms and a Si-deficiency may lead to growth disturbances. Generally it is non-toxic, although some Si-compounds are toxic.

No MAC or GL has been set by the European Union, the US EPA or the WHO. Russian authorities operate with a surprisingly low MAC of 10 mg/L. Silicon is an important component of almost all rock forming minerals and will be released during weathering. It may also be part of volcanic emanations. Its mobility is low under all conditions. The concentration range in Rift Valley drinking water is 7.4 – 67.9 mg/L, the median is 35.4 mg/L. The highest concentration occurs in sample RV051 (hot spring). Slightly lower Si-median values occur in springs, shallow wells and river water than in the deep well. The Si/Fe-diagram (Fig. 10) suggests that these high Si-concentrations are not due to particulates in the samples. The median is slightly higher in the lakes and hot springs. Compared to European mineral water, the Si median for the Rift Valley wells is exceedingly high.

Silicon correlates with Ge, K, Li and alkalinity (shallow wells only).

7.1.47 Sm – Samarium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.48 Sn - Tin

Tin is possibly an essential element for humans. The element Sn is practically non-toxic, but some Sn-compounds are highly toxic for lower organisms.

No MAC or GL is defined for Sn in drinking water. The mobility of Sn is very low under all conditions. Naturally it occurs in pegmatites and greisens. The concentration range of Sn in the Rift Valley drinking waters is <0.002 to 7.48 µg/L, the median is 0.018 µg/L. More than 10% of all samples returned values below the DL. The maximum value was measured in RV118 (deep well). Higher tin median values than in the wells are observed in springs, rivers and especially lakes (particulates?). In the hot springs the median for Sn is very low. The median in the Rift Valley wells is much higher than the median of European mineral water or in Norwegian bedrock wells (Table 11).

Correlation coefficients were not calculated due to the high number of samples with values <DL.

7.1.49 SO_4 – Sulphate

Sulphate concentrations in drinking waters need to be limited due to taste and corrosion. Reports about stomach problems in humans due to high SO_4 concentrations (500 – 1000 mg/L) in drinking water have not been substantiated.

The EU MAC for SO_4 in drinking water is 250 mg/L. Concentrations above this level will give raise to consumer complaints due to taste and corrosion. One source of SO_4 in drinking water could be volcanic emanations. The concentration range observed in the Rift Valley drinking waters is <0.05 to 692 mg/L, the median is 14 mg/L (Table 4). 9 samples fall above the MAC, the highest values were measured in samples RV127 (shallow well), RV128 (shallow well) and RV118 (deep well). Median sulphate values are lower in spring and river water than in the deep wells (Fig. 8). They are higher in the shallow wells and in the hot springs. They compare well with Norwegian bedrock groundwater and are in the deep wells lower than in European mineral water, but higher in the shallow wells (Table 11). Sulphate shows very clear regional distribution patterns (Figure 9, map SO_4) – most of the high values occur in the northeastern and northern part of the survey area.

Sulphate correlates highly with B, Br, Cl, pH (shallow wells) and EC.

7.1.50 Sr – Strontium

Strontium has no known biological role and is considered less toxic. Strontium can replace Ca.

No EU MAC or GL is set for Sr. Russian authorities operate with a Sr-MAC of 70 mg/L. Strontium mobility is high under all conditions. Its main source will be weathering of rock forming minerals. Sea water is enriched in Sr. The Sr-concentration range for the Rift Valley drinking waters is 8.8 – 9850 µg/L, the median is 232 µg/L. The highest value was found for sample RV127 (shallow well). Strontium median concentrations are lower in springs, hot springs, rivers and lakes than in the wells (highest in the shallow wells – Fig. 8). They are higher than those of Norwegian bedrock groundwater and lower than the Sr-median reported for European mineral water. High values of Sr in the wells occur predominantly at the north-eastern border of the survey area (Figure 9, map Sr).

Strontium correlates well with Ca and Mg.

7.1.51 Ta – Tantalum

No biological role is known for Ta. It is considered to be less toxic. Some organisms, e.g. sea squirt, tend to accumulate Ta.

No MAC or GL is set for Ta. It occurs invariably together with Nb and is a typical trace element in granites, syenitic pegmatites and carbonatites. It may be enriched in bauxites developed on alkaline rocks. Its mobility is very low. The concentration range observed in Rift Valley drinking waters is <0.002 – 0.054 µg/L, the median value is 0.002 µg/L (Table 4). More than 40% of all samples had values below DL. The maximum value was measured in sample RV148, a deep well. The median Ta-concentration is higher in springs, hot springs and especially lakes (factor 43) than in the wells (Fig. 8). It is about the same as in the Norwegian bedrock waters and much lower than the median reported for European mineral water (Table 11). Two clear clusters of high Ta-values occur in the central parts of the Rift Valley (Figure 9, map Ta).

Due to the high number of samples <DL no correlation coefficients were calculated.

7.1.52 Tb – Terbium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.53 Te - Tellurium

Tellurium has no known biological role. Data to assess toxicity are sparse. Many compounds are more toxic than the element. It is known to accumulate in the bones.

No EU MAC or GL is set for Te. Russian authorities operate with a MAC of 10 µg/L. Tellurium mobility is very low under all conditions. It occurs mainly in some sulphidic ores. Tellurium-concentrations in Rift Valley drinking water range from <0.005 – 0.019 µg/L, the median is <0.005 µg/L. About 70% of all samples were below DL. The maximum value was found in sample RV113 (deep well). Median values in rivers and lakes are higher than in all other waters (particulates?). Te-concentrations found in the Ethiopian drinking waters are comparable to Norwegian bedrock groundwater and lower than the median reported for European mineral water.

No correlation coefficients could be calculated for Te due to the high number of samples <DL.

7.1.54 Th – Thorium

Thorium has no known biological role. It is highly toxic and may cause liver and bone cancer.

No MAC or GL are defined for Th. Its chemical properties are quite similar to those of the REEs. Thorium-mobility is low under all conditions. Concentrations in Rift Valley drinking waters range from <0.002 – 1.59 µg/L, the median is 0.008 µg/L. About 10% of all samples fall below the DL. The maximum concentration (by far) occurs in sample RV069 (spring). Median concentrations are higher in hot springs, springs, rivers and lakes (109 times) (particulates?). The median concentration in the Rift Valley wells compares well with the median observed in Norwegian bedrock groundwaters and is lower than that reported for European mineral water.

No correlation coefficients were calculated for Th due to the high number of samples <DL.

7.1.55 Ti – Titanium

Titanium has no known biological role. It is considered to be non-toxic.

No MAC or GL is set for Ti. Titanium is a trace component in many rock-forming minerals and weathering should be the primary source of Ti. Its mobility is considered low under all conditions. The concentration range observed in the Rift Valley drinking waters is 0.3 – 264 µg/L, the median is 4.74 µg/L (Table 4). The maximum was measured in sample RV118 (deep well). Shallow wells, springs, rivers and lakes (25 times) show a higher median than the deep wells (particulates?). The Ti median value of the Ethiopian wells is much higher than the median values of European mineral waters and Norwegian bedrock groundwaters (Table 11).

Titanium correlates well with Al, Ce, Ga, La, and Y (shallow wells).

7.1.56 Tl – Thallium

Thallium has no known biological role. It is highly toxic.

No EU MAC or GL exists for Tl. The USEPA has defiend a MAC of 4 µg/L, while Russian authorities operate with a MAC of 0.1 µg/L Tl in drinking water. One sample falls above the Russian MAC (RV053 – hot spring). Thallium may occur in trace amounts in some micas and clay minerals and is enriched in some deposits of sulphidic ores. Its mobility is considered to be low. The concentration range found in the Rift Valley waters is <0.002 – 0.15 µg/L, with a median of 0.005 µg/L (Table 4). More than 10% of all samples fall below the DL. The median Tl-concentration is highest in the hot springs, followed by river and lake water. It is in the same range as the median reported for European mineral water and Norwegian bedrock groundwater (Table 11).

No correlation coefficients were calculated for Tl due to the high number of samples <DL.

7.1.57 Tm – Thulium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.58 U – Uranium

Uranium has no known biological role. It is highly toxic and carcinogenic.

No EU MAC or GL are defined for U in drinking water. US authorities work with a MAC of 30 µg/L (USEPA 2001). 4 samples have U-concentrations above this MAC (RV134 (shallow well), RV 133 (shallow well), RV026 (shallow well) and RV019 (shallow well)).Based on health considerations the WHO has suggested a preliminary MAC of 2 µg/L U in drinking waters. 65 samples returned a U-concentration above the WHO-MAC. The chemical properties of U resemble those of the REE. The mobility is low under reducing conditions but high to very high under all other conditions. The concentration range observed for the Rift Valley waters is 0.005 – 48 µg/L, the median 1.84 µg/L. The median U-concentration is lower in the shallow wells, hot springs, springs and rivers than in the deep wells (Fig. 8). It is higher in the lakes. For European mineral waters a much lower median was reported, while the median in Norwegian bedrock groundwater is quite comparable (Table 11).

Only in the shallow wells does U show a reasonably good correlation with alkalinity.

7.1.59 V – Vanadium

Vanadium is essential to some organisms. The "right" amount of V in drinking water prevents caries (as does F). It is also toxic. The toxicity depends greatly on speciation and oxidation state.

No EU MAC of GL is set for V. Russian authorities operate with a MAC of 100 µg/L V for drinking water. 3 samples fall above this MAC (RV027 (deep well), RV124 (hot spring) and RV106 (deep well)). Vanadium is a trace constituent of some rock forming minerals and has an affinity to Fe and organic material. Its mobility is very low under reducing conditions and high to very high under all other conditions. The concentration range in the Rift Valley drinking waters is 0.093 – 235 µg/L, the median is 13.35 µg/L (Table 4). The V-median is lower in the deep wells than in all others waters but the lakes (slightly higher). Compared to the Norwegian bedrock groundwater and the European mineral waters the V-median is much higher in the Rift Valley wells (Table 11).

Vanadium does not correlate well with any other element. A weak correlation exits with As, B, Mo, Sb, SO_4, U, and alkalinity.

7.1.60 W – Tungsten

Tungsten may be essential to some organisms. There is little known about toxicity and until more knowledge is accumulated it should be considered toxic.

No EU MAC or GL exists for W in drinking water. Russian authorities have defined a MAC of 50 µg/L W in drinking water. Naturally tungsten is enriched in pegmatites, aplites and skarns. The mobility of W is very low to low under all conditions. The concentration range observed for the Rift Valley drinking waters is <0.002 to 3.81 µg/L, the median is 0.011 µg/L (Table 4). The highest concentrations are found in samples RV040 (deep well), RV124 (hot spring) and RV053 (hotspring). About 15% of all samples were below the DL. Median W-concentrations are much higher in hot springs and alkaline lakes than in all other waters (Fig. 8). Median concentrations in Rift Valley wells, European mineral water and Norwegian bedrock groundwater are in the same order of magnitude (Table 11). The regional distribution of the high W-values is interesting (Figure 9, map W). Most of the high values occur in the central parts of the Rift Valley.

No correlation coefficients were calculated for W due to the high number of samples < DL.

7.1.61 Y – Yttrium

Yttrium has no known biological role. The toxicity is considered to be low but Y appears to have a higher toxicity than the REEs. Reports about carcinogenic effects are contradictory.

No MAC or GL exists for Y. It is enriched in carbonatites, phosphorites and apatites and appears generally together with the REEs. Its mobility is very low under all conditions. The concentration range observed in the Rift Valley drinking waters is 0.003 – 10.3 µg/L, the median value is 0.068 µg/L (Table 4). The maximum concentrations were observed in samples RV069 (spring) and RV076 (river). Median concentrations are clearly higher in springs, rivers and lakes (particulates?) than in the wells (Fig. 8). The median concentration in the Rift Valley wells is higher than in European mineral water but lower than in the Norwegian bedrock wells (Table 11).

Yttrium correlates well with Al, Ce, Ga, La, Nb, Nd, and Zr.

7.1.62 Yb – Ytterbium (REE)

See Ce for general comments on REEs and Tables 4 and 11 for data.

7.1.63 Zn – Zinc

Zinc is essential for all organisms. Its toxicity is low, Zn-deficiency is probably more widespread than toxicity problems.

NO MAC for Zn is presently set in the EU. Previously the EU GL for Zn was 100 µg/L at source and 5000 µg/L after 12 hours in the network. Concentrations above 3000 µg/L may give rise to consumer complaints due to appearance and taste of the water. Sample RV119 (deep well) shows the highest Zn concentration (>5000 µg/L), followed by RV077 (shallow well) and RV054 (deep well), which both show a Zn value >4000 µg/L). Zinc mobility is high under acid and oxidising conditions and very low under reducing and neutral to alkaline conditions. Zinc is a trace component in some rock forming minerals and occurs in high concentrations in quite different types of deposits. The concentration range observed for the Rift Valley drinking waters is 1.1 – 5140 µg/L, the median is 44 µg/L (Table 4). Median concentrations are highest in the deep wells and lowest in the hot springs. Compared to European mineral water and Norwegian bedrock groundwater the median of the Rift Valley wells is very high (Table 11). It may be due to a contribution from the plumbing material.

Zinc does not correlate well with any other element.

7.1.64 Zr - Zirconium

Zirconium has no known biological role. Only scarce data on toxicity to humans exist, Zr is not considered very toxic.

No GL or MAC is set for Zr. Zirconium occurs in the form of its own mineral (zircon) in many rocks. Its mobility is considered to be very low, geochemists view Zr as one of the "immobile" trace elements. When taking this "immobility" serious the concentration range observed for Zr in the Rift Valley drinking waters is very surprising: 0.009 – 25 µg/L, with a median of 0.11 µg/L (Table 4). The highest value was measured in sampleRV075 (shallow well). Median values are much higher in springs, rivers and lakes (particulates?) than in the wells (Fig. 8). The median value of the Rift Valley wells fits reasonably well with the median values of European mineral water and Norwegian bedrock groundwater (Table 11).

Zirconium correlates well with Al, Ce, Ga, La, Nb, Nd, and Y.

7.2 Other parameters

7.2.1 pH

A pH-range (pH=-log(H^+)) of 6.5 to 9.5 is suggested for drinking water in the new EU drinking water directive. Below pH 6.5 consumer complaints may arise due to corrosion, at a pH>8.5 due to taste and soapy feel. In addition the pH should be below 8 for an effective disinfection of drinking water with Cl. The pH of the Rift Valley drinking waters ranges from 5.2 – 8.6, the median value is 7.1. A total of 18 samples lies outside the EU-drinking water range – all with a pH <6.5 (lowest: RV069 (spring)). In terms of median pH spring and river water is clearly more acidic than the well waters and the lakes are very alkaline (Fig. 8). The median pH of the Rift Valley wells is lower than the median pH reported for Norwegian bedrock groundwater.

7.2.2 EC - Electrical Conductivity

The new EU drinking water directive sets a MAC of 2500 µS/cm for the electrical conducitivity as measured in drinking water. (There old EU GL was 400 µS/cm). 2 samples fall above this new EU MAC. Electrical conductivity is a measure of the dissolved salts in the water – high values can have natural reasons but also point at contamination. The EC-range observed for the Rift Valley waters is 52 – 3850 µS/cm, the median 719 µS/cm. The maximum value was measured in well RV005 (hot spring), which is a highly mineralised hot spring. The median EC-value is lower in spring and river water and higher in the lakes than in the wells.

7.2.3 Dissolved Solids

"Dissolved Solids" is the sum of the major cations in the water. The range of this sum is 34 – 2401 mg/L in the Rift Valley drinking waters, the median is 598 mg/L. The sum of dissolved solids is highest in sample RV124 (hotspring). The median is lower in spring and river water than in the wells and higher in shallow wells, hot springs and lakes.

8. CONCLUSIONS

In total a staggering 78% of all drinking water samples from the Ethiopian Rift Valley would fail to pass the current EU drinking water directive. This number increases to 86% if the WHO-proposed MAC for U in drinking waters is also used. This result demonstrates the necessity of documenting natural element concentration and variation therein on a regional scale.

Compared to median values reported for European bottled mineral waters (Misund et al., 1999) and for Norwegian bedrock wells (Banks et al., 1998a and Frengstad et al. 2000) the Rift Valley wells resemble the mineral waters more closely than the Norwegian groundwater. For Al, As, Br, Cd, F, Fe, Ga, Ge, I, K, Mo, Na, NO_3, Pb, Rb, Si, Ti, V, Zn, and Zr the median of the Rift Valley waters is considerably higher than that of both other waters. Only Co and W show an unusually low median. There may exist several reasons for the observed higher median concentrations. High values of Al, Fe, Ga, Pb, Ti and Zr may, in part, be due to a higher content of particulate matter (a test with filtered water would be advisable) in the Rift Valley samples. The high value for NO_3 is most likely due to contamination, although natural reasons could exist as well. Well construction and protection of the wells returning high NO_3 should be checked in the field. The high values for Zn (Pb, Cd?) maybe due to contamination from piping. High median values for As, Br, F, Ge, I, K, Mo, Na, Rb, Si and V may be due to the special geological setting and volcanic emanations influencing water chemistry.

In terms of health risks associated with drinking these waters, sample RV026, showing the highest As and F-concentrations of all drinking water samples needs immediate attention. In general, the very high F-concentrations found in a substantial number of wells (58% of all wells above the MAC of 0.7 mg/L for high temperature drinking water, 35% above the MAC of 1.5 mg/L!) present probably the biggest health risk. Other interesting wells in terms of observed maximum concentrations include RV053 (Be, Cs, Ge, Li, Rb, Sb, Tl, W), RV124 (Bi, Br, Ca, Cl, K, Na, V, W), RV119 (Cr, Fe, Ni, Pb, Zn), RV019 (Mo, U), RV054 (Cd, Zn), RV033 (NO_3) and RV114 (Hg).

Furthermore, the many samples returning a high Na-concentration and the samples that returned high NO_3-values need consideration in a health-related context. High Br-concentrations were found in many Rift Valley drinking waters. Considering the toxicity of Br and the fact that Br may also be an essential element for human beings, it is astonishing, that no western authority has set a MAC or GL for this element. The unusually high V-concentrations in the Rift Valley waters may also warrant further investigations.

A special survey checking Hg-concentrations in Rift Valley waters may also be indicated. The samples reported here did not see any special conservation for Hg-analysis in the field and were stored a long time prior to analysis. Nevertheless a surprisingly high number of samples reports Hg-values above detection and the maximum value is close to the EU MAC.

Many elements show surprisingly clear regional distribution patterns in the maps (Figure 4) of the drinking water data subset. This suggests that many of the observed features have a geological control. It also means that risk-areas for high concentrations of certain elements can be outlined using the data, before new wells are put into production.

When comparing the different waters collected in the Rift Valley, the lakes show the highest or second highest median concentration for most elements. Exceptions are Ca (lowest), Hg (all below DL), Mg, NO_3, SO_4, Sr, Tl and Zn. Many of the observed high median values may at least partly be caused by particulates in the samples. This impression is substantiated by the long list of elements showing very high concentrations in the rivers as well: Al, Ba, Be, Ce, Co, Cr, Cu, Dy, Er, Eu, Fe, Ga, Gd, Hf, Ho, In, Mn, Nb, Nd, Ni, Pb, Pr, Sm, Sn, Tb, Te, Th, Ti, Tl, Tm, Y, Yb, and Zr. River and lake waters should thus definitely be filtered at the time of collection. This would give a better indication of the "solution" chemistry of these elements. Most interesting are thus the elements that show a high median in the lakes but not in the rivers: As, B, Bi, Br, Cd, Cl, Cs, F, Ge, I, K, Li, Mo, Na, Rb, Sb, Si, Ta, U, V, and W. The enrichment of these elements must be due to a special process/source – either evaporation, higher solubility in the alkaline environment or volcanic emanations.

The hot springs are clearly enriched in As, B, Cd, Cs, F, Ge, K, Li, Mo, Na, Rb, Sb, Si, SO_4, Ta, and W. Interesting is also the list of elements appearing at comparatively very low levels in the hot springs: Al, Ba, Co, Cr, Cu, Er, Fe, Ho, Lu, Mg, Mn, Nd, Ni, NO_3, Pb, Pr, Sm, Sn, Ti, Y, Yb and Zn.

The wells show the highest median for Ca, Mg, Sr, and Zn. Bromine (Br), Cl, I, NO_3, Se, SO_4, U, and V also show quite high median values in the wells. Aluminium (Al), all REEs, as well as Be, Ga, Hf, Ta, Th, Tl, Y and Zr show comparatively low median values in the wells.

The springs show some of the lowest median values for a long list of elements. This indicates that most springs have a shallow origin and are predominantly fed by precipitation. A relatively high NO_3-value demonstrates their vulnerability to contamination.

The river waters show the lowest median values for As, Br, Cl, F, Ge, I, K, Mg, Na, Se, and Sr.

This report demonstrates that there are many elements that need consideration in the drinking water context. Most of the elements reported here show a very wide range of concentrations, covering three, four or even five orders of magnitude. It may not be sufficiently realised that health risks may not only occur from too high concentrations of elements but may also relate to deficiency (e.g. I, Se). For some elements health depends upon a delicate balance between too little and too much (e.g. F, I, Se) in a concentration range that is quite normal in drinking waters. It must be realised, however, that the relationship between trace elements in water and health is very complex. Drinking water is not the only, and in many cases not even the most important source of the elements in the dietary intake. Furthermore the complex interplay between the elements is not sufficiently understood at present. Nevertheless, water is rather easy to sample and analyse and will give a fairly good reflection of the local geochemical environment. High or low levels in the water will most often be reflected in local soils and plants and thus give a rather good reflection of the dietary intake of these elements in developing countries, where the people mostly live of local sources.

Further work on natural baseline concentrations of all these elements in natural waters and their geographical distribution is still urgently needed. It is much easier to establish the existence of a geochemical province (Reimann and Melezhik, 2001) than to establish its relationship with health effects. Developing countries are especially well suited to study the relationship between the regional distribution of chemical elements and health. Independently of these considerations drinking water of good quality must be of the highest priority in any country – regional geochemical studies are needed to document this good quality.

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ATTACHMENTS (VEDLEGG)

Table 12: Water samples, Rift Valley Ethiopia: analytical results.

Table 14: Correlation coefficients for deep and shallow wells. All values except pH were ln-transformed prior to calculatios. Elements with more than 10% of all samples < detection not used. Not all rare earth elements included.

				TABLE 12: WATER SAMPLES, RIFT VALLEY ETHIOPIA, ANALYTICAL RESULTS.											
				SHALL: shallow well, well depth <60m, _M: ICP-MS, _E: ICP-OES, _I: IC, _F: field measurement,											
				_L: laboratory, underline: no drinking water											
*NR	*ID	*DW	*TYPE	Ag_M	Al_M	As_M	B_M	Ba_M	Be_M	Bi_M	Br_M	Ca_E	Cd_M	Ce_M	Cl_I
1	**RV001**	YES	DEEP	0.006	61	2.25	171	118	0.042	0.009	314	90900	0.29	0.22	33900
2	**RV002**	NO	river	0.018	27760	1.24	101	358	4.720	0.016	154	47740	0.15	147	20100
3	**RV003**	YES	DEEP	<0.002	118	6.43	197	120	0.006	0.009	2450	181700	0.11	0.18	201000
4	**RV004**	YES	DEEP	0.003	72	4.36	300	7.8	0.044	0.004	224	23440	0.005	0.016	32500
5	**RV005**	YES	hspring	<0.002	82	25.1	997	0.3	0.410	0.002	462	19920	0.033	0.040	120000
6	**RV006**	YES	DEEP	<0.002	69	8.12	333	45.4	0.009	<0.002	314	29450	0.017	0.056	49000
7	**RV007**	YES	DEEP	0.002	76	0.69	102	4.8	<0.005	0.002	116	37130	0.011	0.021	8810
8	**RV008**	YES	DEEP	0.003	201	1.60	85.5	21.7	0.018	<0.002	47	45460	0.007	0.54	4890
10	**RV009**	YES	DEEP	<0.002	76	3.10	120	56.2	<0.005	<0.002	193	52500	0.021	0.017	24000
11	**RV010**	YES	spring	<0.002	85	0.67	17.2	7.0	0.020	<0.002	24	21030	0.008	0.060	1860
12	**RV011**	YES	DEEP	<0.002	68	0.55	49.1	27.5	0.010	<0.002	59	48660	0.024	0.014	5890
13	**RV012**	NO	river	<0.002	307	0.69	14.2	10.1	0.027	<0.002	38	13130	0.008	0.42	2260
14	**RV013**	YES	DEEP	<0.002	80	0.58	54.1	9.1	<0.005	<0.002	58	37630	0.087	0.023	5710
15	**RV014**	YES	DEEP	<0.002	71	13.1	162	0.3	0.007	<0.002	164	8200	0.014	0.008	7660
16	**RV015**	YES	spring	<0.002	1580	0.22	9.3	6.6	0.160	<0.002	37	9660	0.007	1.68	2370
18	**RV016**	YES	DEEP	<0.002	83	4.07	222	12.3	<0.005	0.010	103	19120	0.017	0.024	11500
19	**RV017**	YES	DEEP	<0.002	71	0.71	39.9	5.7	0.049	<0.002	66	42640	0.009	0.004	6500
20	**RV018**	NO	lake	<0.002	882	67.3	3550	17.9	0.033	0.014	2600	3145	0.33	5.41	542000
21	**RV019**	YES	SHALL	<0.002	150	26.4	382	76.1	0.036	0.008	1880	124400	0.18	0.28	259000
22	**RV020**	YES	DEEP	<0.002	83	9.18	621	4.0	<0.005	0.002	498	3164	0.19	0.039	98400
24	**RV021**	YES	DEEP	<0.002	73	10.7	866	2.0	<0.005	<0.002	542	2733	0.096	0.026	122000
25	**RV022**	YES	SHALL	0.021	98	1.53	29.8	8.3	0.036	<0.002	20	17030	0.015	0.086	1580
26	**RV023**	YES	SHALL	0.008	353	2.03	29.4	6.5	0.040	<0.002	34	14090	0.011	1.29	3100
27	**RV024**	NO	lake	0.007	5330	1.82	92.6	54.9	0.700	0.006	196	19940	0.035	17.6	13000
28	**RV025**	YES	SHALL	<0.002	97	2.65	127	35.3	<0.005	<0.002	217	60000	0.021	0.094	14500
29	**RV026**	YES	SHALL	<0.002	105	96.0	734	5.6	<0.005	<0.002	694	8510	0.036	0.093	103000
30	**RV027**	YES	DEEP	<0.002	84	11.7	159	2.8	<0.005	<0.002	104	3417	0.006	0.012	9040
31	**RV028**	YES	DEEP	<0.002	72	2.06	227	1.4	0.160	<0.002	304	19490	0.013	0.013	44500
32	**RV029**	YES	DEEP	<0.002	75	2.35	94.5	6.3	<0.005	<0.002	63	40240	0.037	0.015	8180
33	**RV030**	YES	DEEP	<0.002	86	16.9	248	1.4	<0.005	<0.002	135	9130	0.022	0.032	20200
36	**RV031**	YES	DEEP	<0.002	86	1.20	125	23.9	0.019	<0.002	245	56700	0.013	0.034	34100
37	**RV032**	YES	DEEP	<0.002	94	1.49	163	30.1	0.010	<0.002	439	68400	0.013	0.043	58100
38	**RV033**	YES	DEEP	<0.002	213	0.79	94.7	110	0.052	<0.002	1440	151300	0.016	0.27	154000
39	**RV034**	YES	DEEP	<0.002	67	6.45	590	21.1	<0.005	0.006	1570	21930	0.048	0.009	264000
40	**RV035**	YES	hspring	<0.002	108	3.95	547	1.1	<0.005	0.002	712	5210	0.044	0.042	120000
41	**RV036**	YES	SHALL	<0.002	105	4.56	507	6.3	<0.005	<0.002	508	8850	0.042	0.076	95600
42	**RV037**	YES	SHALL	<0.002	74	7.79	638	5.9	<0.005	0.002	1600	19410	0.046	0.009	206000
43	**RV038**	YES	DEEP	<0.002	70	1.43	141	42.5	0.007	<0.002	277	41900	0.010	0.002	31500
44	**RV039**	YES	SHALL	<0.002	93	1.68	118	3.2	0.010	<0.002	243	70500	0.007	0.044	28000
45	**RV040**	YES	DEEP	<0.002	74	4.30	205	1.6	<0.005	<0.002	397	11060	0.024	0.017	60800
47	**RV041**	YES	SHALL	<0.002	78	7.86	135	2.4	0.003	<0.002	281	38170	0.065	0.011	20200
48	**RV042**	YES	DEEP	<0.002	74	7.9	46.3	12.1	0.007	<0.002	30	17630	0.022	0.015	3340
49	**RV043**	NO	lake	<0.002	17000	5.2	735	40.7	1.720	0.010	870	5670	0.081	52.7	170000
50	**RV044**	NO	lake	<0.002	195	189	10700	11.1	0.200	0.013	14900	2167	0.54	2.86	2740000
51	**RV045**	NO	lake	<0.002	156	95.8	11700	27.5	0.040	0.002	14100	3884	0.66	10.8	3012000
53	**RV046**	YES	DEEP	<0.002	74	1.44	39.4	2.8	<0.005	0.004	22	17790	0.005	0.19	2150
54	**RV047**	YES	DEEP	<0.002	78	2.29	53.6	6.9	0.031	0.002	145	31860	0.016	0.10	16200
55	**RV048**	YES	DEEP	<0.002	68	3.25	47.2	21.3	0.007	<0.002	56	25250	0.028	0.025	4390
56	**RV049**	YES	DEEP	<0.002	77	5.41	57.1	11.7	<0.005	<0.002	82	13450	0.031	0.041	5990
57	**RV050**	YES	river	<0.002	443	0.44	10.2	11.3	0.098	<0.002	16	9820	0.014	1.42	1840
59	**RV051**	YES	hspring	<0.002	87	2.34	82	79.6	0.039	0.005	146	12140	0.005	0.14	22600
60	**RV052**	NO	lake	<0.002	534	1.74	149	14.6	0.059	0.006	218	10630	0.013	1.93	27800
61	**RV053**	YES	hspring	<0.002	70	25.8	183	13.0	5.910	0.002	115	12750	0.034	0.018	29400
62	**RV054**	YES	DEEP	<0.002	73	2.49	40.8	9.3	<0.005	0.002	25	28930	6.41	0.014	1210
63	**RV055**	YES	hspring	<0.002	111	0.99	17.8	0.4	0.088	0.002	22	9010	0.035	0.18	3760
64	**RV056**	YES	river	<0.002	2170	0.03	2.2	37.1	0.270	0.003	17	4334	0.022	10.3	1410
65	**RV057**	YES	DEEP	<0.002	116	2.90	79.1	6.3	<0.005	0.003	790	9070	0.017	0.19	106000
66	**RV058**	YES	DEEP	<0.002	66	3.23	77.5	16.7	0.012	<0.002	81	19810	0.004	<0.002	7900
67	**RV059**	YES	DEEP	<0.002	195	0.20	3.15	32.9	0.079	<0.002	23	11840	0.019	0.43	870
68	**RV060**	YES	DEEP	<0.002	74	1.09	26.6	3.2	0.007	<0.002	33	21780	0.010	0.035	3170

*NR	*ID	*DW	*TYPE	Ag_M	Al_M	As_M	B_M	Ba_M	Be_M	Bi_M	Br_M	Ca_E	Cd_M	Ce_M	Cl_I
71	**RV061**	YES	DEEP	<0.002	69	0.41	10.7	7.0	0.028	<0.002	35	42980	0.006	0.006	2620
72	**RV062**	YES	SHALL	<0.002	70	0.65	16.0	67.3	0.072	<0.002	47	36890	0.008	0.008	2920
73	**RV063**	YES	DEEP	<0.002	78	1.04	22.2	5.1	0.009	<0.002	44	28290	0.010	0.051	4430
74	**RV064**	YES	DEEP	<0.002	86	0.74	11.8	0.7	0.040	<0.002	17	17630	0.13	0.17	1790
75	**RV065**	YES	DEEP	<0.002	475	0.67	14.1	28.7	0.092	0.003	95	59500	0.011	1.83	16500
76	**RV066**	YES	DEEP	<0.002	88	0.76	15.5	4.6	0.038	<0.002	23	19530	0.057	0.084	2730
77	**RV067**	YES	hspring	<0.002	72	5.58	103	1.8	1.560	0.002	128	14470	0.026	0.085	18200
78	**RV068**	YES	spring	<0.002	347	0.64	12.4	0.3	1.150	0.002	29	6810	0.020	2.6	1710
79	**RV069**	YES	spring	<0.002	2380	0.08	6.2	9.1	1.550	0.002	74	4671	0.012	12.7	14100
80	**RV070**	NO	lake	<0.002	17600	1.94	153	62.7	2.180	0.008	465	20180	0.057	87	57700
82	**RV071**	YES	DEEP	<0.002	63	0.17	15.2	45.3	0.018	<0.002	153	90200	0.010	0.042	8870
83	**RV072**	YES	DEEP	<0.002	83	0.12	6.1	1.0	0.390	<0.002	18	7050	0.23	0.14	880
84	**RV073**	YES	DEEP	<0.002	62	0.20	9.7	3.6	0.300	<0.002	76	16480	0.023	0.040	4130
85	**RV074**	YES	DEEP	<0.002	83	0.88	11.7	0.4	0.079	<0.002	51	7970	0.068	0.28	6940
86	**RV075**	YES	SHALL	<0.002	1900	0.94	155	16	0.210	0.003	147	23390	0.36	9.39	22700
88	**RV076**	YES	river	<0.002	3440	0.10	7.4	74.5	0.630	<0.002	26	3868	0.035	24.6	1890
89	**RV077**	YES	SHALL	<0.002	178	0.43	4.0	57.9	<0.005	<0.002	73	19430	0.16	0.26	3470
90	**RV078**	YES	DEEP	<0.002	82	0.07	2.8	17.8	<0.005	<0.002	11	26970	<0.002	0.054	2390
91	**RV079**	YES	DEEP	<0.002	80	0.09	6.8	15.2	<0.005	<0.002	31	31160	0.012	0.005	2110
92	**RV080**	YES	DEEP	<0.002	85	0.08	8.4	38.1	<0.005	<0.002	26	74000	0.078	0.027	4480
94	**RV081**	YES	SHALL	<0.002	91	0.09	6.2	16.5	<0.005	<0.002	10	28850	0.033	0.063	1770
95	**RV082**	YES	DEEP	<0.002	2220	0.24	12.8	102	0.180	0.005	174	64500	0.16	9.31	22200
96	**RV083**	YES	DEEP	<0.002	69	0.64	10.7	35.7	0.007	0.004	17	15830	0.01	0.023	1310
97	**RV084**	YES	DEEP	<0.002	71	0.05	3.1	5.1	<0.005	0.002	20	22400	0.004	0.018	3570
98	**RV085**	YES	DEEP	<0.002	72	0.58	26.7	49.4	0.031	0.005	921	88500	0.005	0.01	111000
99	**RV086**	YES	DEEP	<0.002	1340	0.43	47.0	28.6	0.064	0.003	272	45210	0.013	3.11	38600
100	**RV087**	YES	DEEP	<0.002	140	0.55	17.9	12.3	<0.005	0.003	381	93800	0.006	0.13	43700
101	**RV088**	YES	DEEP	<0.002	225	0.13	4.6	13.6	0.010	<0.002	20	32070	0.51	0.80	5850
102	**RV089**	YES	SHALL	<0.002	74	0.33	17.8	16.3	0.019	0.003	248	101400	0.005	0.063	35900
103	**RV090**	YES	DEEP	<0.002	65	0.95	29.8	86.5	<0.005	<0.002	299	179100	0.044	0.037	55300
106	**RV091**	YES	SHALL	<0.002	880	1.43	62.9	226	0.067	0.007	1180	187900	0.023	2.69	265000
107	**RV092**	YES	DEEP	<0.002	186	0.30	41.5	43.6	0.020	<0.002	392	102700	0.044	0.20	54200
108	**RV093**	YES	DEEP	<0.002	215	0.66	6.5	188	0.260	<0.002	148	40680	0.007	0.43	23700
109	**RV094**	YES	spring	<0.002	640	0.05	0.1	2.4	0.044	<0.002	4	8460	0.008	1.36	1200
110	**RV095**	NO	lake	<0.002	7370	3.00	275	45.5	0.250	0.003	888	9550	0.043	8.02	106000
111	**RV096**	YES	spring	<0.002	65	0.07	6.4	1.7	0.009	<0.002	17	33720	0.004	0.050	2900
112	**RV097**	YES	DEEP	<0.002	54	0.55	31.6	34.6	0.019	<0.002	78	49650	0.014	0.003	8680
113	**RV098**	YES	DEEP	<0.002	116	3.47	266	31.0	<0.005	<0.002	510	52500	0.042	0.14	57900
114	**RV099**	YES	DEEP	<0.002	127	6.55	344	56.8	0.006	0.006	2170	35780	0.012	0.13	290000
115	**RV100**	YES	DEEP	<0.002	67	7.50	333	27.9	<0.005	0.004	1610	12450	0.11	0.018	241000
117	**RV101**	YES	SHALL	<0.002	968	1.98	102	18	0.016	0.003	53	26180	0.061	1.19	8740
118	**RV102**	YES	DEEP	<0.002	61	4.89	474	0.2	<0.005	0.004	1190	3625	0.059	0.008	166000
119	**RV103**	YES	SHALL	<0.002	1290	3.03	760	305	0.057	0.019	6010	163000	0.011	1.96	602000
120	**RV104**	YES	DEEP	<0.002	60	2.03	333	32.8	0.020	<0.002	554	72400	0.080	0.032	60400
121	**RV105**	YES	DEEP	<0.002	53	0.15	71.9	18.4	<0.005	<0.002	201	79800	0.59	0.004	24000
123	**RV106**	YES	DEEP	<0.002	86	1.92	584	9.8	<0.005	<0.002	791	23470	0.038	0.067	57700
124	**RV107**	YES	SHALL	<0.002	60	4.54	439	7.4	<0.005	0.002	1500	12290	0.15	0.006	182000
125	**RV108**	YES	SHALL	<0.002	54	1.57	60.1	8.6	<0.005	<0.002	210	45900	0.093	0.004	15300
126	**RV109**	YES	SHALL	<0.002	66	3.66	185	25.5	<0.005	<0.002	236	22580	0.082	0.027	28900
127	**RV110**	YES	DEEP	<0.002	40	0.67	94.5	16.3	<0.005	<0.002	174	54100	0.055	0.002	18900
129	**RV111**	YES	DEEP	<0.002	127	0.51	59.6	43.6	0.340	<0.002	257	59700	0.008	0.21	22700
130	**RV112**	YES	DEEP	<0.002	92	0.02	43.9	54.1	0.075	<0.002	170	51600	0.003	0.17	12200
131	**RV113**	YES	DEEP	<0.002	47	2.47	63.3	38.4	0.005	<0.002	175	78300	0.14	0.040	11800
132	**RV114**	YES	SHALL	<0.002	87	0.33	13.4	18.4	<0.005	0.002	73	57200	0.009	0.16	9330
133	**RV115**	YES	DEEP	<0.002	40	0.47	157	46.4	<0.005	<0.002	269	50600	0.005	0.011	24400
134	**RV116**	YES	DEEP	<0.002	55	1.68	38	9.4	0.008	0.004	99	88000	0.012	0.046	7630
135	**RV117**	YES	DEEP	<0.002	69	0.94	66.6	6.1	0.008	0.004	211	42730	0.19	0.10	20300
136	**RV118**	YES	DEEP	<0.002	919	2.79	625	22.8	0.010	0.008	1490	30910	0.20	1.41	153000
137	**RV119**	YES	DEEP	<0.002	1920	0.75	144	26.2	0.066	0.009	1010	77900	0.19	3.76	119000
138	**RV120**	YES	DEEP	<0.002	51	1.02	133	85.3	0.022	0.011	2120	171400	0.024	0.031	254000
141	**RV121**	YES	DEEP	<0.002	2250	0.52	162	36.3	0.130	0.002	305	64000	0.021	5.57	35900
142	**RV122**	YES	DEEP	<0.002	92	0.90	53.9	18.2	0.016	<0.002	159	66300	0.009	0.16	11900
143	**RV123**	YES	spring	<0.002	52	0.10	52.3	104	0.051	<0.002	221	42360	0.005	0.11	17800

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144	**RV124**	YES	hspring	<0.002	70	4.94	780	17.1	0.014	0.030	6110	196500	0.058	0.075	1240000
145	**RV125**	YES	DEEP	<0.002	116	3.05	159	8.9	0.014	<0.002	334	27760	0.013	0.20	29300
146	**RV126**	YES	SHALL	<0.002	94	2.52	443	6.3	0.019	0.004	2130	47770	0.048	0.023	282000
147	**RV127**	YES	SHALL	<0.002	93	0.43	242	20.8	0.029	<0.002	414	185200	0.019	0.023	48900
148	**RV128**	YES	SHALL	<0.002	134	1.41	556	26.0	<0.005	0.003	2120	91800	0.034	0.089	263000
149	**RV129**	YES	SHALL	<0.002	83	0.30	88.9	46.0	<0.005	<0.002	123	93800	0.011	0.024	9900
150	**RV130**	YES	DEEP	<0.002	87	0.35	67.4	128	0.018	<0.002	675	123200	0.004	0.032	66700
152	**RV131**	YES	DEEP	<0.002	73	0.44	69.0	46.4	0.035	<0.002	950	193000	0.007	0.016	106000
153	**RV132**	YES	SHALL	<0.002	95	0.60	90.2	120	0.034	0.004	1180	152300	0.031	0.024	149000
154	**RV133**	YES	SHALL	<0.002	101	0.45	98.3	135	0.014	0.002	973	148500	<0.002	0.060	120000
155	**RV134**	YES	SHALL	<0.002	106	0.70	174	103	0.016	0.003	1550	125900	0.044	0.064	181000
156	**RV135**	YES	Infi	<0.002	113	0.49	56.2	30.5	0.011	<0.002	462	88700	0.030	0.13	65500
158	**RV136**	YES	SHALL	<0.002	300	0.42	124	58.4	0.010	<0.002	333	101500	0.006	0.34	48900
159	**RV137**	YES	SHALL	<0.002	65	0.75	147	0.9	0.021	0.003	2330	177900	0.017	0.084	222000
160	**RV138**	YES	DEEP	<0.002	63	0.23	60.2	117	0.016	<0.002	446	108700	0.019	0.007	49800
161	**RV139**	YES	DEEP	<0.002	72	0.91	42.5	0.6	0.051	<0.002	122	49170	0.022	0.031	13000
162	**RV140**	YES	SHALL	<0.002	89	0.30	43.2	28.2	0.028	<0.002	229	109600	0.016	0.15	30900
164	**RV141**	YES	DEEP	<0.002	140	0.65	139	2.5	0.110	<0.002	218	53800	0.098	0.17	24700
165	**RV142**	YES	DEEP	<0.002	729	0.49	110	16.2	0.420	0.002	405	82300	0.035	1.55	48100
166	**RV143**	YES	DEEP	<0.002	115	13.7	898	2.0	0.004	<0.002	818	2448	0.12	0.060	159000
167	**RV144**	YES	SHALL	<0.002	102	1.56	108	9.3	0.030	<0.002	161	32850	0.021	0.060	9200
168	**RV145**	YES	DEEP	<0.002	194	1.29	59.8	7.6	0.062	<0.002	67	31970	0.021	0.38	5700
169	**RV146**	YES	DEEP	<0.002	85	0.61	62.0	0.8	0.043	<0.002	51	35550	0.012	0.057	4780
170	**RV147**	YES	DEEP	<0.002	256	7.94	270	27.4	0.047	<0.002	99	19090	0.047	0.33	16700
171	**RV148**	YES	DEEP	<0.002	308	4.09	21.9	2.0	0.200	0.002	17	2429	0.065	4.10	1690

*ID	*DW	*TYPE	Co_M	Cr_M	Cs _M	Cu_M	Dy_M	Er_M	Eu_M	F_I	Fe_E	Ga_M	Gd_M	Ge_M	Hf_M
RV001	YES	DEEP	0.62	0.07	0.093	1.23	0.036	0.038	0.002	2570	10	0.02	0.014	0.71	0.012
RV002	NO	river	13.9	40.9	0.70	25.7	12.5	6.97	2.58	2170	28290	12.4	14	0.22	0.230
RV003	YES	DEEP	0.80	0.15	0.042	2.27	0.027	0.027	0.004	1570	146	0.055	0.02	0.21	0.012
RV004	YES	DEEP	0.036	0.40	0.12	1.59	0.002	0.003	<0.002	2180	5	0.032	0.003	2.54	0.003
RV005	YES	hspring	0.022	0.30	2.24	0.73	0.019	0.018	0.002	4580	9	0.045	0.007	7.83	0.016
RV006	YES	DEEP	0.033	0.01	0.083	0.67	0.012	0.009	<0.002	2340	280	0.046	0.007	1.18	0.002
RV007	YES	DEEP	0.023	0.27	0.06	3.47	0.003	<0.002	<0.002	923	6	0.024	<0.002	0.73	<0.002
RV008	YES	DEEP	0.075	1.23	0.009	2.80	0.038	0.021	0.009	1270	97	0.059	0.042	1.29	0.025
RV009	YES	DEEP	0.024	1.30	0.020	5.08	0.004	0.002	<0.002	1070	49	0.010	0.004	0.41	<0.002
RV010	YES	spring	0.025	0.61	0.029	5.09	0.005	0.002	0.003	467	19	0.016	0.006	0.098	<0.002
RV011	YES	DEEP	0.010	0.26	0.036	1.00	0.006	0.004	<0.002	744	<3	0.008	0.005	0.46	<0.002
RV012	NO	river	0.27	0.59	0.010	1.67	0.047	0.024	0.008	329	118	0.12	0.050	0.038	0.031
RV013	YES	DEEP	0.029	0.33	0.049	2.32	0.005	0.002	<0.002	1220	12	0.014	0.005	0.59	0.002
RV014	YES	DEEP	0.016	4.06	0.023	2.92	0.002	<0.002	<0.002	2530	<3	0.013	<0.002	1.62	<0.002
RV015	YES	spring	0.16	1.59	0.11	1.65	0.17	0.096	0.028	175	550	0.48	0.17	0.046	0.077
RV016	YES	DEEP	0.012	5.28	0.055	2.77	0.006	0.005	<0.002	2300	223	0.019	0.004	0.90	0.003
RV017	YES	DEEP	0.016	0.14	0.054	4.79	0.003	<0.002	<0.002	920	<3	0.007	0.002	0.57	<0.002
RV018	NO	lake	0.57	1.92	0.14	8.28	0.55	0.37	0.096	30800	663	0.31	0.53	1.06	0.210
RV019	YES	SHALL	0.66	3.05	0.02	3.49	0.031	0.022	0.004	4290	89	0.082	0.028	0.16	0.015
RV020	YES	DEEP	<0.002	1.19	0.56	1.24	0.005	0.002	<0.002	5920	79	0.080	0.004	2.10	0.006
RV021	YES	DEEP	0.003	1.59	0.56	0.76	0.014	0.011	0.002	5120	10	0.066	0.007	2.39	0.005
RV022	YES	SHALL	0.004	0.31	0.015	1.67	0.011	0.006	<0.002	1970	28	0.023	0.007	0.46	0.005
RV023	YES	SHALL	0.087	0.44	0.028	1.16	0.12	0.065	0.019	2620	253	0.13	0.13	0.36	0.058
RV024	NO	lake	1.41	4.95	0.26	5.63	1.24	0.72	0.24	1610	5400	2.62	1.35	0.21	0.480
RV025	YES	SHALL	0.17	0.10	0.025	5.13	0.013	0.008	0.002	1570	50	0.052	0.009	0.30	0.006
RV026	YES	SHALL	0.054	1.47	0.62	5.25	0.01	0.008	0.002	11600	127	0.038	1.008	1.40	0.011
RV027	YES	DEEP	0.042	0.08	0.033	1.56	0.005	0.003	<0.002	3490	3	0.039	<0.002	0.94	<0.002
RV028	YES	DEEP	0.032	0.18	0.40	4.67	0.022	0.030	<0.002	7570	4	0.022	0.007	1.10	0.004
RV029	YES	DEEP	0.035	2.04	0.026	13.7	0.003	<0.002	<0.002	1580	47	0.018	0.004	1.95	<0.002
RV030	YES	DEEP	0.034	0.83	1.27	0.85	0.005	0.002	0.002	3140	24	0.027	0.003	5.15	0.003
RV031	YES	DEEP	0.032	0.99	0.084	2.00	0.003	<0.002	<0.002	569	14	0.021	0.005	0.56	<0.002
RV032	YES	DEEP	0.063	0.60	0.074	2.93	0.013	0.008	<0.002	434	24	0.015	0.006	0.69	<0.002
RV033	YES	DEEP	0.31	0.34	0.031	1.71	0.025	0.013	0.009	135	206	0.035	0.029	0.26	0.002
RV034	YES	DEEP	0.020	5.38	0.051	1.84	0.004	<0.002	<0.002	1200	<3	0.025	<0.002	0.31	0.006
RV035	YES	hspring	0.032	1.86	0.035	0.82	0.009	0.006	<0.002	1950	13	0.039	0.004	1.16	0.008
RV036	YES	SHALL	0.030	2.03	0.032	0.68	0.012	0.005	0.002	3740	32	0.035	0.008	1.08	0.015
RV037	YES	SHALL	0.058	0.10	0.019	1.06	0.005	0.003	<0.002	3640	5	0.017	0.003	0.13	0.004
RV038	YES	DEEP	0.019	1.05	0.071	1.14	<0.002	<0.002	<0.002	1010	<3	0.009	<0.002	0.55	<0.002
RV039	YES	SHALL	0.048	0.50	0.009	1.24	0.008	0.004	<0.002	1570	28	0.019	0.004	0.46	0.003
RV040	YES	DEEP	0.017	0.47	0.014	2.90	0.011	0.011	<0.002	7100	3	0.012	0.004	0.40	0.007
RV041	YES	SHALL	0.039	0.09	0.051	1.13	0.005	0.006	<0.002	3460	5	0.006	0.002	0.41	<0.002
RV042	YES	DEEP	0.025	0.50	0.033	6.94	<0.002	<0.002	<0.002	3140	21	0.024	0.004	1.66	0.002
RV043	NO	lake	2.25	11.2	0.57	5.48	3.09	1.94	0.51	11000	11740	7.42	3.02	1.42	3.280
RV044	NO	lake	0.42	33	0.14	5.13	0.41	0.49	0.045	136000	28	0.10	0.24	1.22	0.130
RV045	NO	lake	0.47	32	0.66	6.65	2.82	2.31	0.24	175000	16	0.08	1.72	7.75	0.120
RV046	YES	DEEP	0.028	1.18	0.008	0.87	0.040	0.040	0.004	897	15	0.017	0.031	0.25	0.004
RV047	YES	DEEP	0.016	0.46	0.081	0.93	0.017	0.014	0.002	3100	14	0.022	0.015	2.74	0.006
RV048	YES	DEEP	0.014	0.67	0.033	3.23	0.005	0.007	0.002	3270	4	0.016	0.006	1.14	0.002
RV049	YES	DEEP	0.012	1.80	0.030	4.91	0.007	0.007	<0.002	4750	29	0.022	0.007	1.76	0.003
RV050	YES	river	0.064	0.58	0.036	2.02	0.13	0.076	0.021	359	277	0.16	0.15	0.10	0.060
RV051	YES	hspring	0.011	0.08	0.43	0.76	0.007	0.005	<0.002	1320	64	0.051	0.014	3.89	0.015
RV052	NO	lake	0.17	0.38	0.21	1.76	0.20	0.12	0.032	6510	368	0.19	0.20	0.23	0.160
RV053	YES	hspring	0.029	0.08	12.1	0.69	<0.002	<0.002	<0.002	5590	7	0.035	<0.002	11.6	0.008
RV054	YES	DEEP	0.038	0.09	0.013	1.36	<0.002	0.002	<0.002	1470	7	0.02	0.005	0.55	0.002
RV055	YES	hspring	0.017	0.06	0.21	0.88	0.009	0.005	0.003	1590	31	0.03	0.016	1.01	0.009
RV056	YES	river	1.81	1.45	0.077	2.91	0.86	0.47	0.17	81	2044	0.72	1.00	0.048	0.053
RV057	YES	DEEP	0.038	1.61	0.035	2.98	0.015	0.009	0.003	436	216	0.06	0.014	1.86	0.014
RV058	YES	DEEP	0.008	0.07	0.031	0.96	0.002	0.004	<0.002	2600	8	0.021	<0.002	1.49	0.002
RV059	YES	DEEP	0.49	0.02	0.054	0.75	0.034	0.018	0.006	2140	1747	0.30	0.041	0.21	0.014
RV060	YES	DEEP	0.004	0.68	0.10	1.28	0.007	0.005	<0.002	1060	31	0.037	0.005	0.38	0.004

*ID	*DW	*TYPE	Co_M	Cr_M	Cs _M	Cu_M	Dy_M	Er_M	Eu_M	F_I	Fe_E	Ga_M	Gd_M	Ge_M	Hf_M
RV061	YES	DEEP	0.004	0.32	0.006	0.83	0.004	<0.002	<0.002	462	12	0.011	0.002	0.14	<0.002
RV062	YES	SHALL	0.016	0.20	0.042	1.29	0.003	0.005	<0.002	2060	19	0.014	<0.002	0.20	0.002
RV063	YES	DEEP	0.018	0.78	0.025	6.46	0.007	0.006	<0.002	1850	53	0.021	0.005	0.88	0.003
RV064	YES	DEEP	0.018	0.11	0.32	3.30	0.012	0.009	0.003	1100	30	0.017	0.015	0.36	0.009
RV065	YES	DEEP	0.13	0.88	0.041	2.13	0.13	0.071	0.021	1240	361	0.15	0.14	0.18	0.100
RV066	YES	DEEP	0.012	0.17	0.094	1.20	0.008	0.005	<0.002	1730	34	0.018	0.006	0.38	0.011
RV067	YES	hspring	0.006	0.31	1.01	0.43	0.051	0.048	0.004	9920	11	0.031	0.038	4.85	0.038
RV068	YES	spring	0.017	0.84	0.43	0.55	0.14	0.091	0.008	1330	160	0.13	0.082	0.45	0.300
RV069	YES	spring	0.21	1.56	0.15	3.90	2.06	1.03	0.42	333	1706	1.47	2.86	0.094	0.078
RV070	NO	lake	3.36	9.12	0.47	5.69	5.81	3.29	0.98	6020	14820	7.42	6.21	0.55	1.440
RV071	YES	DEEP	0.18	0.18	<0.002	0.80	0.007	0.006	<0.002	351	20	0.030	0.007	0.042	0.003
RV072	YES	DEEP	0.06	0.16	0.042	3.01	0.017	0.011	0.003	393	59	0.024	0.011	0.094	0.012
RV073	YES	DEEP	0.007	0.21	0.062	8.59	0.028	0.020	0.002	605	13	0.011	0.017	0.21	0.007
RV074	YES	DEEP	0.009	0.70	0.010	8.25	0.18	0.14	0.006	381	13	0.021	0.12	0.29	0.002
RV075	YES	SHALL	0.59	3.48	0.13	3.79	0.70	0.38	0.11	4260	1283	0.74	0.74	2.07	0.400
RV076	YES	river	3.07	2.03	0.098	4.04	1.64	0.86	0.39	96	4705	1.58	1.99	0.056	0.054
RV077	YES	SHALL	2.46	0.24	0.020	0.92	0.019	0.009	0.005	183	18860	0.093	0.021	0.031	0.005
RV078	YES	DEEP	0.046	0.46	<0.002	2.46	<0.002	0.002	<0.002	48	117	0.019	<0.002	0.036	0.002
RV079	YES	DEEP	0.023	0.12	0.011	4.90	<0.002	<0.002	<0.002	112	5	0.017	<0.002	0.046	<0.002
RV080	YES	DEEP	0.13	0.18	0.016	0.80	<0.002	0.002	<0.002	1870	1494	0.016	0.002	0.29	0.002
RV081	YES	SHALL	0.013	0.10	0.092	2.58	0.004	0.004	<0.002	176	14	0.015	0.005	0.10	0.002
RV082	YES	DEEP	1.56	3.16	0.063	21.9	0.62	0.29	0.15	536	2949	0.67	0.75	0.13	0.022
RV083	YES	DEEP	0.016	0.36	0.023	1.52	0.002	<0.002	<0.002	398	162	0.027	0.003	0.62	0.018
RV084	YES	DEEP	0.006	0.09	<0.002	0.75	<0.002	<0.002	<0.002	70	18	0.019	<0.002	0.023	<0.002
RV085	YES	DEEP	0.053	0.32	0.010	2.98	<0.002	<0.002	<0.002	897	54	0.012	<0.002	0.18	0.004
RV086	YES	DEEP	0.84	6.46	0.048	4.92	0.17	0.091	0.041	1140	2387	0.33	0.21	0.32	0.037
RV087	YES	DEEP	0.10	0.35	0.009	5.13	0.021	0.012	0.005	348	276	0.046	0.019	0.11	0.033
RV088	YES	DEEP	0.12	0.78	0.010	2.89	0.066	0.035	0.017	74	131	0.07	0.074	0.080	0.010
RV089	YES	SHALL	0.051	4.88	0.013	0.46	0.003	<0.002	<0.002	585	25	0.015	0.005	0.16	0.003
RV090	YES	DEEP	1.31	1.28	<0.002	14.1	0.003	0.002	<0.002	249	519	0.042	0.002	0.13	0.002
RV091	YES	SHALL	1.66	1.16	0.011	15.4	0.20	0.11	0.054	468	490	0.25	0.25	0.043	0.004
RV092	YES	DEEP	0.14	0.87	0.019	27.0	0.035	0.021	0.008	319	1033	0.045	0.033	0.031	0.006
RV093	YES	DEEP	0.098	0.69	0.047	3.91	0.032	0.017	0.006	366	138	0.049	0.038	0.24	0.005
RV094	YES	spring	0.17	0.33	0.011	1.95	0.072	0.045	0.017	107	385	0.18	0.072	0.037	0.025
RV095	NO	lake	3.29	5.20	0.082	5.78	0.56	0.30	0.17	6620	5930	1.79	0.72	0.17	0.380
RV096	YES	spring	0.045	0.86	0.009	2.07	0.006	0.003	<0.002	204	32	0.012	0.006	0.032	<0.002
RV097	YES	DEEP	0.033	0.44	0.003	0.73	0.006	0.004	<0.002	1440	46	0.005	0.003	0.31	<0.002
RV098	YES	DEEP	0.064	1.28	0.005	1.69	0.010	0.006	0.003	718	246	0.022	0.016	0.11	0.004
RV099	YES	DEEP	0.071	0.22	0.031	1.30	0.012	0.008	0.003	1190	137	0.090	0.013	1.03	0.002
RV100	YES	DEEP	0.031	0.06	<0.002	1.36	<0.002	0.002	<0.002	1980	26	0.013	<0.002	0.13	0.002
RV101	YES	SHALL	0.46	1.77	0.025	2.36	0.086	0.052	0.025	411	852	0.25	0.1	0.086	0.035
RV102	YES	DEEP	0.030	0.17	0.011	0.96	<0.002	<0.002	<0.002	2180	18	0.031	<0.002	0.28	0.016
RV103	YES	SHALL	1.50	1.97	0.029	2.62	0.15	0.085	0.034	479	1522	0.30	0.18	0.11	0.062
RV104	YES	DEEP	0.016	5.80	0.24	1.14	0.003	0.003	<0.002	648	13	0.005	0.004	0.25	0.003
RV105	YES	DEEP	0.24	<0.01	0.015	0.26	<0.002	<0.002	<0.002	314	43	0.018	<0.002	0.15	<0.002
RV106	YES	DEEP	0.064	4.82	<0.002	2.26	0.007	0.003	0.002	525	140	0.019	0.006	0.33	<0.002
RV107	YES	SHALL	0.019	0.15	<0.002	1.92	0.002	<0.002	<0.002	1360	154	0.35	<0.002	0.91	0.004
RV108	YES	SHALL	0.024	0.03	<0.002	0.32	<0.002	<0.002	<0.002	750	11	0.003	0.002	0.12	<0.002
RV109	YES	SHALL	0.17	0.01	0.003	21.6	0.002	0.002	<0.002	608	24	0.014	0.003	0.63	0.002
RV110	YES	DEEP	0.019	0.83	0.032	2.93	0.002	0.003	<0.002	768	5	0.007	<0.002	0.28	0.002
RV111	YES	DEEP	0.056	0.13	0.18	0.68	0.014	0.009	0.004	872	915	0.037	0.019	0.57	0.010
RV112	YES	DEEP	0.12	1.12	0.008	3.03	0.016	0.007	0.002	179	545	0.022	0.014	0.067	0.003
RV113	YES	DEEP	0.68	0.03	0.005	0.98	0.002	0.005	<0.002	407	54	0.055	0.002	0.055	0.002
RV114	YES	SHALL	0.075	0.58	0.008	1.98	0.014	0.012	0.007	170	41	0.027	0.016	0.025	0.002
RV115	YES	DEEP	0.10	0.01	0.003	0.35	<0.002	<0.002	<0.002	365	82	0.023	<0.002	0.051	<0.002
RV116	YES	DEEP	0.39	0.21	0.003	1.5	0.004	0.008	<0.002	221	1417	0.019	0.007	0.089	0.004
RV117	YES	DEEP	0.091	2.16	0.006	3.78	0.009	0.003	0.003	508	52	0.016	0.012	0.081	0.007
RV118	YES	DEEP	1.45	7.10	2.25	3.46	0.096	0.037	0.047	819	1461	0.38	0.16	1.97	0.065
RV119	YES	DEEP	2.66	21.3	0.033	22.3	0.24	0.11	0.097	414	9580	0.55	0.34	0.25	0.035
RV120	YES	DEEP	0.095	0.19	0.013	4.04	0.002	0.004	<0.002	605	188	0.006	0.002	0.31	0.003
RV121	YES	DEEP	1.76	6.46	0.057	3.14	0.36	0.20	0.11	785	1962	0.56	0.47	0.55	0.042
RV122	YES	DEEP	0.059	0.10	0.006	2.35	0.011	0.010	0.002	701	56	0.016	0.012	0.16	0.005
RV123	YES	spring	0.033	0.08	0.014	0.32	0.024	0.015	0.002	194	13	0.011	0.028	0.021	0.004

*ID	*DW	*TYPE	Co_M	Cr_M	Cs _M	Cu_M	Dy_M	Er_M	Eu_M	F_I	Fe_E	Ga_M	Gd_M	Ge_M	Hf_M
RV124	YES	hspring	0.062	4.93	0.57	2.14	0.008	0.003	<0.002	2910	34	0.018	0.007	0.77	0.010
RV125	YES	DEEP	0.081	1.45	0.015	2.12	0.017	0.009	0.003	1050	55	0.027	0.020	0.14	0.006
RV126	YES	SHALL	0.050	1.77	0.56	1.95	0.004	0.002	<0.002	1870	43	0.013	0.003	1.65	0.003
RV127	YES	SHALL	0.11	0.34	<0.002	1.83	0.003	0.002	<0.002	506	25	0.017	0.004	0.091	0.002
RV128	YES	SHALL	0.056	7.36	0.007	1.59	0.007	0.002	<0.002	806	96	0.024	0.005	0.2	0.004
RV129	YES	SHALL	0.046	0.69	<0.002	0.85	0.002	0.002	<0.002	402	22	0.017	0.004	0.034	<0.002
RV130	YES	DEEP	0.17	0.26	0.003	1.15	0.005	0.002	0.002	389	2105	0.035	0.003	0.11	0.003
RV131	YES	DEEP	0.075	0.12	0.015	1.77	0.009	0.004	0.004	190	196	0.015	0.007	0.034	<0.002
RV132	YES	SHALL	0.11	0.61	0.003	2.47	0.005	0.003	<0.002	451	1124	0.018	0.008	0.030	0.012
RV133	YES	SHALL	0.099	0.39	<0.002	3.50	0.007	0.006	<0.002	324	530	0.016	0.010	0.035	0.005
RV134	YES	SHALL	0.28	0.13	<0.002	2.82	0.006	0.003	<0.002	1090	20	0.022	0.007	0.051	0.008
RV135	YES	Infi	0.084	0.45	<0.002	3.52	0.015	0.006	0.002	574	55	0.019	0.015	0.062	0.003
RV136	YES	SHALL	0.40	0.24	0.012	1.31	0.030	0.018	0.008	476	270	0.060	0.038	0.014	0.008
RV137	YES	SHALL	0.21	0.08	0.003	1.25	0.002	0.003	<0.002	306	15	0.009	0.004	0.076	0.003
RV138	YES	DEEP	0.031	0.03	<0.002	7.16	<0.002	0.002	<0.002	487	22	0.009	0.002	0.064	0.002
RV139	YES	DEEP	0.025	0.12	0.13	1.31	0.008	0.009	0.002	969	28	0.018	0.006	0.15	0.003
RV140	YES	SHALL	0.063	1.25	<0.002	19.5	0.010	0.010	0.002	284	15	0.008	0.008	0.014	<0.002
RV141	YES	DEEP	0.17	18.1	0.10	2.80	0.018	0.009	0.004	479	209	0.026	0.018	0.37	0.003
RV142	YES	DEEP	0.33	0.66	0.26	1.98	0.12	0.060	0.042	1370	463	0.17	0.18	0.44	0.017
RV143	YES	DEEP	0.015	1.51	1.51	8.12	0.005	0.003	0.002	7130	61	0.028	0.008	4.35	0.014
RV144	YES	SHALL	0.035	1.58	0.065	1.74	0.004	0.004	<0.002	1380	21	0.023	0.007	0.94	0.002
RV145	YES	DEEP	0.046	0.56	0.20	0.63	0.016	0.008	0.003	1250	83	0.054	0.018	0.83	0.021
RV146	YES	DEEP	0.021	0.38	0.094	1.22	0.005	0.005	0.002	1210	8	0.010	0.005	0.67	0.002
RV147	YES	DEEP	0.26	1.24	0.022	10.8	0.029	0.017	0.009	2600	866	0.058	0.036	0.48	0.014
RV148	YES	DEEP	0.047	0.88	0.13	0.77	0.23	0.14	0.023	7130	724	0.20	0.19	0.66	0.300

*ID	*DW	*TYPE	Hg_M	Ho_M	I_M	In_M	K_E	La_M	Li_M	Lu_M	Mg_E	Mn_M	Mo_M	Na_E	Nb_M
RV001	YES	DEEP	0.067	0.012	69.0	0.002	21110	0.057	32.6	0.009	19670	326	7.99	124600	0.17
RV002	NO	river	<0.01	2.450	71.1	0.110	11390	74.700	26.5	1.00	13000	1350	0.57	49430	1.4
RV003	YES	DEEP	0.033	0.007	961	0.002	26660	0.081	61.7	0.006	41010	2280	29.7	251300	0.13
RV004	YES	DEEP	<0.01	<0.002	49.1	<0.002	12160	0.011	47.5	<0.002	9960	<0.1	4.09	134800	0.008
RV005	YES	hspring	<0.01	0.007	30.3	<0.002	28690	0.021	176	0.003	11670	<0.1	23.4	473300	0.50
RV006	YES	DEEP	0.017	0.003	24.4	0.002	16720	0.028	55.6	0.002	9590	169	12.6	187600	0.036
RV007	YES	DEEP	0.039	<0.002	21.2	0.002	15740	0.010	21.7	<0.002	12740	<0.1	4.31	62500	0.005
RV008	YES	DEEP	0.021	0.007	8.5	0.002	11190	0.240	54.3	0.004	9640	<0.1	4.23	65300	0.030
RV009	YES	DEEP	<0.01	<0.002	10.8	<0.002	15150	0.015	44.7	<0.002	30290	<0.1	2.69	70700	0.005
RV010	YES	spring	<0.01	<0.002	4.0	<0.002	3121	0.028	3.6	<0.002	7960	<0.1	0.85	8470	0.005
RV011	YES	DEEP	0.009	<0.002	7.7	<0.002	10610	0.012	9.1	<0.002	14640	<0.1	1.52	36150	0.008
RV012	NO	river	<0.01	0.008	8.8	<0.002	3324	0.250	1.0	0.003	3383	14.4	1.20	7060	0.096
RV013	YES	DEEP	0.008	<0.002	7.1	<0.002	11440	0.016	19.7	<0.002	11330	<0.1	2.85	33060	0.004
RV014	YES	DEEP	<0.01	<0.002	36.3	<0.002	14090	0.005	34.7	<0.002	5700	<0.1	9.45	142300	0.004
RV015	YES	spring	0.016	0.034	3.2	0.003	2696	0.590	1.4	0.016	3211	5.9	0.29	4501	0.47
RV016	YES	DEEP	<0.01	0.002	17.8	<0.002	16100	0.012	33.0	<0.002	6790	<0.1	18.2	100200	0.018
RV017	YES	DEEP	<0.01	<0.002	5.0	<0.002	9740	0.002	11.0	<0.002	7890	<0.1	1.77	30490	0.004
RV018	NO	lake	<0.01	0.120	206	0.010	63800	2.200	40.9	0.049	701	28.4	250	1740000	1.20
RV019	YES	SHALL	0.028	0.006	126	0.002	12370	0.130	21.9	0.005	29470	1990	78.3	287800	0.14
RV020	YES	DEEP	<0.01	<0.002	29.7	0.002	19630	0.025	34.8	<0.002	2768	5.0	39.5	281800	0.032
RV021	YES	DEEP	<0.01	0.004	29.1	0.002	26640	0.014	27.9	0.002	2393	0.5	77.4	406600	0.062
RV022	YES	SHALL	<0.01	0.002	3.6	0.003	5080	0.043	16.8	<0.002	5430	0.9	2.91	31250	0.011
RV023	YES	SHALL	<0.01	0.021	5.4	0.003	14110	0.640	29.7	0.010	4260	23.8	4.71	66600	0.34
RV024	NO	lake	<0.01	0.250	30.1	0.021	13400	8.020	6.7	0.12	9840	158	2.21	67700	2.94
RV025	YES	SHALL	<0.01	0.003	43.0	<0.002	18590	0.048	34.7	<0.002	25580	742	1.97	100600	0.068
RV026	YES	SHALL	<0.01	0.002	83.2	<0.002	24400	0.042	49.0	0.002	6210	5.4	30.9	472800	0.084
RV027	YES	DEEP	<0.01	<0.002	16.5	<0.002	9730	0.008	13.3	<0.002	3885	5.1	5.01	192900	0.047
RV028	YES	DEEP	<0.01	0.009	33.6	<0.002	10330	0.011	66.4	0.006	2723	4.1	11.0	206000	0.19
RV029	YES	DEEP	<0.01	<0.002	13.7	<0.002	14290	0.008	46.8	<0.002	7720	5.6	4.86	78400	0.004
RV030	YES	DEEP	<0.01	<0.002	13.0	<0.002	18710	0.016	111	<0.002	1665	5.5	23.9	158800	0.009
RV031	YES	DEEP	<0.01	<0.002	21.3	<0.002	8460	0.019	11.1	<0.002	17800	5.1	2.93	57000	0.005
RV032	YES	DEEP	<0.01	0.003	18.4	<0.002	18490	0.031	19.9	0.002	23850	6.1	2.89	91700	0.023
RV033	YES	DEEP	<0.01	0.005	10.0	<0.002	4785	0.140	4.6	0.003	39070	14.8	0.28	74900	0.009
RV034	YES	DEEP	<0.01	<0.002	54.3	<0.002	16150	0.009	11.0	<0.002	8190	3.3	41.6	408000	0.005
RV035	YES	hspring	<0.01	0.002	48.5	<0.002	11970	0.019	8.6	<0.002	2227	3.8	32.0	259400	0.025
RV036	YES	SHALL	<0.01	0.002	36.8	<0.002	15140	0.037	15.3	<0.002	9460	4.6	46.3	243600	0.018
RV037	YES	SHALL	<0.01	0.002	202	<0.002	6140	0.005	8.2	<0.002	15320	9.0	51.1	507000	0.015
RV038	YES	DEEP	0.007	<0.002	25.6	<0.002	8870	0.004	12.5	<0.002	12420	3.8	4.40	89900	0.003
RV039	YES	SHALL	<0.01	0.002	18.8	<0.002	6330	0.020	27.7	<0.002	12770	17.6	2.84	99100	0.039
RV040	YES	DEEP	<0.01	0.004	38.1	<0.002	9190	0.009	57.5	0.003	2428	4.3	8.33	238500	0.053
RV041	YES	SHALL	<0.01	0.002	41.2	<0.002	12080	0.008	34.6	0.002	12920	6.8	5.80	119900	0.029
RV042	YES	DEEP	<0.01	<0.002	7.8	<0.002	14000	0.015	23.8	<0.002	2261	0.4	8.20	105400	0.005
RV043	NO	lake	<0.01	0.620	55.0	0.052	23520	18.300	24.7	0.35	3371	190	19.7	415000	5.24
RV044	NO	lake	<0.01	0.140	285	0.015	292000	0.560	10.6	0.11	195	<0.1	619	6900000	1.83
RV045	NO	lake	<0.01	0.710	195	0.013	240000	1.340	96.6	0.34	812	<0.1	746	7030000	0.78
RV046	YES	DEEP	0.015	0.011	4.2	<0.002	3944	0.046	11.8	0.005	4385	<0.1	1.71	38220	0.006
RV047	YES	DEEP	<0.01	0.004	12.6	<0.002	20150	0.030	66.3	0.003	2417	4.9	20.1	142800	0.016
RV048	YES	DEEP	<0.01	0.002	13.1	<0.002	13030	0.010	38.9	<0.002	7030	<0.1	20.4	124600	0.008
RV049	YES	DEEP	<0.01	0.002	14.7	<0.002	14810	0.019	46.0	<0.002	844	8.8	31.5	149100	0.018
RV050	YES	river	<0.01	0.027	2.3	0.002	5040	0.760	8.2	0.010	2971	5.5	0.90	18990	0.33
RV051	YES	hspring	<0.01	0.002	10.4	<0.002	45800	0.071	51.2	<0.002	3804	23.1	10.3	180700	0.023
RV052	NO	lake	<0.01	0.039	13.9	<0.002	31210	0.880	114	0.016	6200	33.3	7.84	161300	0.82
RV053	YES	hspring	<0.01	<0.002	6.6	<0.002	17170	0.009	174	<0.002	6270	79.4	9.74	197300	0.019
RV054	YES	DEEP	<0.01	<0.002	10.8	<0.002	5470	0.016	16.6	<0.002	6310	36.8	4.81	37000	0.002
RV055	YES	hspring	<0.01	0.002	1.8	<0.002	11540	0.085	16.8	<0.002	3024	1.7	10.8	60900	0.026
RV056	YES	river	<0.01	0.170	2.3	0.008	1346	5.090	1.2	0.066	1367	265	0.065	3983	0.34
RV057	YES	DEEP	0.017	0.003	12.2	<0.002	11730	0.090	22.2	<0.002	1451	31.1	9.96	214300	0.043
RV058	YES	DEEP	<0.01	<0.002	11.1	<0.002	16170	0.004	41.7	<0.002	4000	3.6	5.41	151700	0.023
RV059	YES	DEEP	<0.01	0.008	7.6	<0.002	6220	0.220	2.2	0.003	4280	2440	1.26	24970	0.039
RV060	YES	DEEP	<0.01	<0.002	4.3	<0.002	9300	0.021	21.1	<0.002	15950	4.0	2.82	44550	0.009

*ID	*DW	*TYPE	Hg_M	Ho_M	I_M	In_M	K_E	La_M	Li_M	Lu_M	Mg_E	Mn_M	Mo_M	Na_E	Nb_M
RV061	YES	DEEP	<0.01	<0.002	2.3	<0.002	10470	0.005	6.0	<0.002	11410	3.2	0.43	21330	0.004
RV062	YES	SHALL	<0.01	<0.002	2.2	<0.002	16820	0.008	9.3	<0.002	5510	3.9	4.00	64400	0.004
RV063	YES	DEEP	<0.01	<0.002	9.6	<0.002	13780	0.022	20.3	<0.002	9620	4.1	9.09	74400	0.010
RV064	YES	DEEP	<0.01	0.003	3.2	<0.002	10000	0.089	9.7	0.002	8470	5.4	4.15	31050	0.033
RV065	YES	DEEP	<0.01	0.025	4.9	<0.002	19380	0.810	6.5	0.008	18090	18.6	1.41	50900	0.21
RV066	YES	DEEP	<0.01	0.002	4.8	<0.002	13610	0.050	11.6	<0.002	6280	5.2	8.04	50800	0.019
RV067	YES	hspring	<0.01	0.013	11.1	<0.002	18600	0.085	73.3	0.008	3062	5.4	30.1	204100	0.08
RV068	YES	spring	<0.01	0.031	2.3	<0.002	7850	0.360	17.2	0.013	1771	8.3	3.48	33750	1.02
RV069	YES	spring	<0.01	0.380	3.8	0.017	9130	19.400	5.4	0.13	1266	36.3	0.052	27340	0.63
RV070	NO	lake	0.015	1.140	113	0.066	17970	36.400	12.8	0.51	6220	309	9.38	208900	3.23
RV071	YES	DEEP	0.012	<0.002	13.7	<0.002	1651	0.025	0.5	<0.002	42660	285	1.18	39780	0.008
RV072	YES	DEEP	<0.01	0.003	3.4	<0.002	9060	0.060	6.5	0.002	1869	8.7	0.45	12810	0.019
RV073	YES	DEEP	<0.01	0.008	2.1	<0.002	10380	0.052	9.2	0.003	4098	5.7	0.49	21490	0.008
RV074	YES	DEEP	0.008	0.043	2.5	<0.002	7160	0.170	12.4	0.025	2050	55.6	2.40	24340	0.016
RV075	YES	SHALL	<0.01	0.140	15.1	0.009	15000	4.160	78.4	0.057	16430	262	6.64	168300	2.37
RV076	YES	river	<0.01	0.310	2.2	0.016	2241	11.700	1.9	0.11	1160	448	0.035	3858	0.29
RV077	YES	SHALL	0.008	0.004	51.2	<0.002	2277	0.100	0.2	0.002	8680	472	0.25	10520	0.023
RV078	YES	DEEP	<0.01	<0.002	2.5	<0.002	1761	0.022	0.1	<0.002	14420	4.9	0.02	5560	0.004
RV079	YES	DEEP	<0.01	<0.002	2.5	<0.002	3935	0.003	0.2	<0.002	23530	0.7	0.056	17390	<0.002
RV080	YES	DEEP	<0.01	<0.002	0.7	<0.002	3344	0.009	6.5	<0.002	47370	57.6	0.19	33910	0.002
RV081	YES	SHALL	<0.01	<0.002	1.7	<0.002	3780	0.030	6.1	<0.002	8100	0.3	1.65	15350	0.006
RV082	YES	DEEP	0.018	0.110	27.7	0.004	4673	4.350	1.6	0.038	23750	130	0.28	54500	0.11
RV083	YES	DEEP	<0.01	<0.002	2.4	0.004	3621	0.014	15.5	<0.002	3738	27.8	2.85	68600	0.011
RV084	YES	DEEP	<0.01	<0.002	1.0	0.003	2275	0.008	0.5	<0.002	11220	0.1	0.01	6870	0.002
RV085	YES	DEEP	0.017	<0.002	8.4	<0.002	3906	0.005	11.8	<0.002	26440	5.8	1.03	59600	0.002
RV086	YES	DEEP	0.029	0.031	23.0	0.003	5680	1.290	17.0	0.012	18760	51.1	10.0	87900	0.12
RV087	YES	DEEP	<0.01	0.005	17.6	0.002	3415	0.062	1.7	0.002	52800	3.1	1.36	47590	0.092
RV088	YES	DEEP	0.006	0.014	3.9	<0.002	1687	0.410	1.2	0.004	17750	9.9	0.035	13800	0.081
RV089	YES	SHALL	0.069	<0.002	3.2	<0.002	3207	0.110	4.1	<0.002	35810	<0.1	0.11	51900	0.006
RV090	YES	DEEP	0.018	<0.002	140	<0.002	5840	0.017	1.4	<0.002	41700	1510	3.20	29070	0.036
RV091	YES	SHALL	0.042	0.039	133	0.002	3019	1.180	2.3	0.014	53600	1370	0.57	130600	0.064
RV092	YES	DEEP	0.018	0.008	6.7	<0.002	1990	0.160	1.7	0.003	66500	20.8	0.60	58200	0.024
RV093	YES	DEEP	<0.01	0.006	3.6	<0.002	4812	0.200	16.0	0.002	11640	10.6	0.031	24410	0.041
RV094	YES	spring	<0.01	0.015	0.3	<0.002	1111	0.260	0.8	0.006	2778	14.9	<0.002	4166	0.12
RV095	NO	lake	<0.01	0.110	104	0.009	21780	3.520	<5	0.043	10780	92.1	22.1	395200	0.88
RV096	YES	spring	<0.01	<0.002	3.7	<0.002	1960	0.026	0.6	<0.002	12850	5.7	0.42	12950	0.008
RV097	YES	DEEP	0.007	<0.002	25.0	<0.002	8380	0.007	4.5	<0.002	13170	5.6	11.7	64500	0.004
RV098	YES	DEEP	<0.01	0.002	34.0	<0.002	4148	0.061	4.7	<0.002	25230	8.9	7.03	109700	0.025
RV099	YES	DEEP	0.014	0.002	34.4	<0.002	5310	0.061	46.0	<0.002	12420	50.8	8.55	330200	0.014
RV100	YES	DEEP	<0.01	<0.002	84.5	<0.002	4001	0.013	7.3	<0.002	9720	36.7	25.1	342700	0.009
RV101	YES	SHALL	0.010	0.017	10.9	0.002	2078	0.470	1.2	0.006	4613	20.8	1.46	16830	0.13
RV102	YES	DEEP	<0.01	<0.002	114	<0.002	8910	0.003	5.5	<0.002	3740	5.3	26.2	351900	0.008
RV103	YES	SHALL	<0.01	0.029	469	0.002	7270	0.800	3.3	0.010	101600	1310	6.63	391400	0.13
RV104	YES	DEEP	<0.01	<0.002	47.4	<0.002	6540	0.015	9.4	<0.002	34180	5.6	2.58	86500	0.002
RV105	YES	DEEP	<0.01	<0.002	9.3	<0.002	598	0.004	2.6	<0.002	22710	48.7	0.34	49470	0.003
RV106	YES	DEEP	<0.01	<0.002	77.4	<0.002	3663	0.033	6.1	<0.002	17520	7.1	8.56	209300	0.007
RV107	YES	SHALL	<0.01	<0.002	12.8	<0.002	1459	0.003	10.0	<0.002	445	8.1	3.05	185300	0.005
RV108	YES	SHALL	<0.01	<0.002	21.7	<0.002	3694	0.003	3.2	<0.002	19540	5.7	1.20	43960	0.003
RV109	YES	SHALL	<0.01	<0.002	46.3	<0.002	6800	0.017	5.6	<0.002	3426	54.2	9.47	110900	0.006
RV110	YES	DEEP	<0.01	<0.002	4.7	<0.002	3996	0.004	52.2	<0.002	14820	<0.1	1.68	48010	0.003
RV111	YES	DEEP	<0.01	0.003	3.2	<0.002	3654	0.100	21.6	<0.002	20430	267	2.37	53700	0.010
RV112	YES	DEEP	<0.01	0.003	0.4	<0.002	6110	0.081	5.3	<0.002	8540	13.5	0.33	12200	0.011
RV113	YES	DEEP	<0.01	<0.002	17.1	<0.002	10810	0.016	2.6	<0.002	15770	1530	5.28	31200	0.006
RV114	YES	SHALL	0.800	0.003	1.6	<0.002	1787	0.470	0.3	<0.002	9140	6.1	1.09	11250	0.013
RV115	YES	DEEP	0.074	<0.002	82.2	<0.002	1368	0.002	0.5	<0.002	23740	245	8.43	87200	0.004
RV116	YES	DEEP	<0.01	<0.002	27.2	0.002	1288	0.022	0.5	<0.002	25740	200	1.24	29280	0.008
RV117	YES	DEEP	<0.01	0.002	4.5	<0.002	1722	0.045	1.4	<0.002	24160	1.7	1.87	29800	0.014
RV118	YES	DEEP	<0.01	0.018	29.1	<0.002	24020	0.550	34.9	0.003	24920	49.6	13.5	386300	0.34
RV119	YES	DEEP	<0.01	0.041	15.4	0.011	2817	1.400	21.6	0.011	62000	247	0.81	123000	0.087
RV120	YES	DEEP	<0.01	<0.002	11.0	<0.002	11650	0.020	7.5	<0.002	36250	0.1	0.52	119600	0.004
RV121	YES	DEEP	<0.01	0.069	1.2	0.004	4594	2.330	4.1	0.026	16270	148	3.79	93400	0.17
RV122	YES	DEEP	<0.01	0.002	8.7	<0.002	4940	0.061	9.9	<0.002	17050	9.8	1.76	42680	0.013
RV123	YES	spring	0.015	0.005	3.3	<0.002	6850	0.110	1.3	0.002	7410	10.5	0.61	14000	0.009

*ID	*DW	*TYPE	Hg_M	Ho_M	I_M	In_M	K_E	La_M	Li_M	Lu_M	Mg_E	Mn_M	Mo_M	Na_E	Nb_M
RV124	YES	hspring	0.017	<0.002	51.4	<0.002	37840	0.035	40.5	<0.002	46120	12.9	34.6	595000	0.012
RV125	YES	DEEP	<0.01	0.003	21.5	<0.002	6790	0.096	6.2	<0.002	23290	12.1	6.41	82700	0.023
RV126	YES	SHALL	0.038	<0.002	47.9	<0.002	14410	0.017	46.2	<0.002	19140	10.0	39.3	286600	0.006
RV127	YES	SHALL	0.062	<0.002	15.5	<0.002	849	0.010	3.4	<0.002	50800	14.8	12.0	103300	0.008
RV128	YES	SHALL	0.033	0.002	38.5	<0.002	3020	0.039	10.3	<0.002	45450	13.0	11.5	385000	0.007
RV129	YES	SHALL	0.021	<0.002	5.9	<0.002	3726	0.012	1.9	<0.002	13590	11.0	4.50	20780	0.003
RV130	YES	DEEP	0.086	<0.002	26.5	<0.002	1704	0.016	5.2	<0.002	43240	29.3	0.99	40560	0.002
RV131	YES	DEEP	0.093	0.002	9.0	<0.002	1854	0.022	3.8	<0.002	72700	12.5	0.64	54400	0.002
RV132	YES	SHALL	0.081	0.002	9.5	<0.002	1769	0.023	15.3	<0.002	43640	16.4	1.02	74300	0.004
RV133	YES	SHALL	0.020	0.003	7.5	<0.002	1140	0.037	13.7	<0.002	39700	11.5	0.72	72800	0.004
RV134	YES	SHALL	0.099	0.002	27.0	<0.002	9490	0.031	55.5	<0.002	64100	48.3	17.8	137500	0.012
RV135	YES	Infi	0.029	0.002	3.5	<0.002	1722	0.058	1.1	<0.002	26430	11.1	1.57	83500	0.007
RV136	YES	SHALL	<0.01	0.005	4.9	<0.002	3270	0.140	5.4	0.002	50500	78.1	2.16	90400	0.022
RV137	YES	SHALL	0.099	<0.002	18.3	<0.002	1052	0.015	1.2	<0.002	116100	9.0	0.72	110500	0.004
RV138	YES	DEEP	0.022	<0.002	7.4	<0.002	1204	0.007	4.4	<0.002	40690	8.1	1.11	34030	0.002
RV139	YES	DEEP	0.016	0.002	9.1	<0.002	7990	0.017	3.6	<0.002	13450	8.0	2.39	52300	0.026
RV140	YES	SHALL	0.077	0.003	4.4	<0.002	1233	0.100	0.3	0.002	29310	0.3	0.22	30350	0.002
RV141	YES	DEEP	0.067	0.003	12.3	<0.002	7370	0.077	5.7	0.002	14170	1.3	1.28	109300	0.023
RV142	YES	DEEP	0.043	0.024	11.4	0.002	10820	0.720	17.7	0.007	20840	17.1	2.91	62300	0.053
RV143	YES	DEEP	0.094	0.002	30.2	<0.002	28590	0.027	38.7	<0.002	1568	0.2	71.7	546000	0.011
RV144	YES	SHALL	<0.01	<0.002	28.1	<0.002	16400	0.028	33.1	<0.002	6150	0.3	11.1	108400	0.007
RV145	YES	DEEP	0.035	0.003	10.3	<0.002	14110	0.110	29.1	0.002	6090	14.0	4.97	68800	0.033
RV146	YES	DEEP	0.027	<0.002	6.9	<0.002	12800	0.023	23.6	<0.002	8560	0.5	2.92	53800	0.004
RV147	YES	DEEP	0.021	0.005	10.3	0.002	13050	0.170	50.6	0.003	9720	52.0	6.37	139200	0.052
RV148	YES	DEEP	<0.01	0.043	2.5	0.006	2925	0.790	32.0	0.022	240	24.1	1.85	84200	2.26

*ID	*DW	*TYPE	Nd_M	Ni_M	NO2_I	NO3_I	Pb _M	Pr_M	Rb_M	Sb_M	Se_M	Si_E	Sm_M	Sn_M	SO4_I	Sr_M
RV001	YES	DEEP	0.055	2.68	<5	30500	0.42	0.013	22.3	0.094	1.32	35742	0.016	<0.002	36400	611
RV002	NO	river	71.5	48.4	≤5	4630	15.6	19.0	53.9	0.041	0.73	69872	14.5	0.056	10800	269
RV003	YES	DEEP	0.068	4.19	<5	13700	0.17	0.019	24.9	0.062	2.93	36794	0.011	0.023	156000	987
RV004	YES	DEEP	0.011	0.31	<5	40400	0.42	0.003	24.3	0.023	0.88	42155	<0.002	0.021	18300	131
RV005	YES	hspring	0.032	0.27	<5	1450	0.04	0.006	68.2	0.043	1.02	53209	0.004	<0.002	107000	203
RV006	YES	DEEP	0.031	0.40	<5	<50	0.05	0.007	21.6	0.030	0.31	45679	0.004	<0.002	52700	303
RV007	YES	DEEP	0.010	0.53	<5	10500	1.17	0.003	20.2	0.012	0.63	43445	<0.002	<0.002	11900	256
RV008	YES	DEEP	0.23	0.64	<5	<50	0.22	0.060	10.6	0.029	0.34	42963	0.048	0.17	6730	173
RV009	YES	DEEP	0.013	0.82	<5	8010	1.18	0.003	18.5	0.27	1.46	39304	0.002	0.064	12600	397
RV010	YES	spring	0.028	1.44	<5	2520	0.65	0.007	8.10	0.020	0.28	21828	0.006	0.003	1280	135
RV011	YES	DEEP	0.009	0.65	<5	3300	1.80	0.003	16.8	0.009	0.39	39449	0.003	0.002	5170	285
RV012	NO	river	0.25	1.36	≤5	2910	0.09	0.065	2.84	0.039	0.19	12353	0.051	0.033	2170	69
RV013	YES	DEEP	0.012	0.72	<5	3480	4.14	0.004	21.1	0.027	0.58	46301	0.004	0.014	4250	177
RV014	YES	DEEP	0.003	0.18	19	13500	0.32	<0.002	15.2	0.034	0.80	41402	<0.002	0.018	7920	86
RV015	YES	spring	0.65	1.27	<5	6940	0.34	0.16	10.1	0.017	0.12	20430	0.15	0.035	2310	69
RV016	YES	DEEP	0.010	0.31	24	1530	0.26	0.003	20.6	0.042	0.35	45062	0.003	0.062	16200	166
RV017	YES	DEEP	0.003	0.81	32	3680	0.34	<0.002	17.1	0.009	0.37	41739	<0.002	0.005	4310	219
RV018	NO	lake	2.17	3.82	≤5	2100	1.00	0.56	49.7	0.21	1.88	49741	0.49	0.52	494000	60
RV019	YES	SHALL	0.13	3.03	<5	22600	0.38	0.030	9.88	0.066	1.66	35242	0.028	0.14	156000	733
RV020	YES	DEEP	0.015	0.17	<5	3610	2.85	0.006	33.9	0.095	1.70	39308	0.005	0.028	67900	47
RV021	YES	DEEP	0.014	0.09	<5	2820	0.75	0.004	45.1	0.050	1.17	32554	0.006	0.004	83800	103
RV022	YES	SHALL	0.039	0.22	<5	690	0.09	0.010	6.71	0.062	0.85	33438	0.006	0.021	1910	43
RV023	YES	SHALL	0.61	0.51	<5	880	0.19	0.15	17.1	0.070	0.27	38603	0.12	0.022	2320	21
RV024	NO	lake	6.99	6.49	≤5	5840	2.68	1.96	17.8	0.092	0.26	25137	1.36	0.39	6250	178
RV025	YES	SHALL	0.043	1.11	<5	<50	0.20	0.010	13.7	0.079	0.41	39593	0.012	0.046	180	532
RV026	YES	SHALL	0.039	0.45	<5	1350	0.60	0.010	22.3	0.34	1.54	42991	0.005	0.049	49700	226
RV027	YES	DEEP	0.010	0.10	<5	<50	0.09	<0.002	6.07	0.12	0.20	31372	0.002	0.012	4460	55
RV028	YES	DEEP	0.011	0.26	41	250	0.50	0.004	16.2	0.17	0.37	42272	<0.002	0.070	2040	48
RV029	YES	DEEP	0.008	0.77	<5	400	2.89	0.003	15.4	0.062	0.26	45576	<0.002	0.077	8960	130
RV030	YES	DEEP	0.013	0.21	12	1650	2.23	0.005	40.8	0.063	0.46	53658	0.003	0.003	21900	56
RV031	YES	DEEP	0.019	0.74	<5	4200	0.36	0.005	14.6	0.041	0.26	41809	0.004	0.018	25600	394
RV032	YES	DEEP	0.028	1.11	<5	9100	1.55	0.009	23.8	0.049	2.12	52297	0.005	0.074	49500	597
RV033	YES	DEEP	0.15	4.68	59	149000	2.20	0.037	5.89	0.028	0.73	32994	0.034	0.066	21800	1480
RV034	YES	DEEP	0.007	0.33	<5	35400	0.15	<0.002	20.6	0.11	1.41	47268	<0.002	0.006	158000	238
RV035	YES	hspring	0.019	0.12	<5	3510	0.21	0.004	11.9	0.016	1.81	30517	0.003	0.003	105000	70
RV036	YES	SHALL	0.039	0.24	28	3940	0.15	0.010	21.7	0.032	0.88	39729	0.006	0.017	60400	141
RV037	YES	SHALL	0.006	0.29	47	12800	0.04	<0.002	3.08	0.051	0.97	36107	<0.002	0.006	165000	264
RV038	YES	DEEP	0.002	0.49	7	3400	3.66	<0.002	24.2	0.028	0.75	45375	<0.002	<0.002	22200	430
RV039	YES	SHALL	0.020	0.93	<5	9250	0.13	0.005	7.35	0.035	1.58	32760	0.003	0.011	15600	327
RV040	YES	DEEP	0.009	0.17	<5	70	0.97	<0.002	9.11	0.11	0.61	38776	<0.002	0.012	3020	48
RV041	YES	SHALL	0.011	0.52	<5	910	1.43	<0.002	6.41	0.20	0.48	41477	<0.002	0.002	4550	224
RV042	YES	DEEP	0.015	0.34	23	1530	0.60	0.003	10.7	0.063	0.54	48596	<0.002	0.008	2480	90
RV043	NO	lake	15.6	13.4	≤5	1050	4.31	4.44	33.3	0.13	1.90	61014	3.07	0.39	16300	57
RV044	NO	lake	0.94	1.73	≤5		0.1	0.19	99.9	0.96	7.91	59832	0.23	0.26	260000	57
RV045	NO	lake	4.35	2.17	≤5	1400	0.1	0.80	136	0.39	8.78	50559	1.25	<0.002	133000	61
RV046	YES	DEEP	0.086	0.3	21	350	0.22	0.015	3.78	0.031	0.36	37892	0.021	<0.002	790	52
RV047	YES	DEEP	0.046	0.44	118	12000	1.75	0.010	22.1	0.037	0.81	54849	0.009	1.96	20400	82
RV048	YES	DEEP	0.017	0.44	16	2540	0.89	<0.002	15.6	0.066	0.48	48988	0.003	0.052	6210	139
RV049	YES	DEEP	0.020	0.37	13	6860	0.63	0.004	13.8	0.11	0.81	55747	<0.002	0.041	7290	46
RV050	YES	river	0.71	0.49	7	1140	0.40	0.19	8.85	0.017	0.09	40664	0.14	0.038	830	45
RV051	YES	hspring	0.067	0.20	8	20	0.15	0.017	61.2	0.016	0.54	67881	0.012	0.016	170	99
RV052	NO	lake	0.89	0.69	≤5	1700	0.83	0.22	46.8	0.052	0.98	32587	0.19	0.049	380	98
RV053	YES	hspring	0.01	0.15	<5	80	0.05	<0.002	82.2	1.78	0.60	53793	0.002	<0.002	45600	187
RV054	YES	DEEP	0.015	0.34	<5	<50	8.90	<0.002	9.11	0.036	0.86	49582	0.002	<0.002	700	111
RV055	YES	hspring	0.076	0.22	11	1410	0.15	0.022	21.2	0.020	0.17	49470	0.017	0.023	4860	47
RV056	YES	river	5.27	1.82	17	6190	1.46	1.38	3.76	0.012	0.16	15303	1.10	0.017	970	46
RV057	YES	DEEP	0.082	1.00	<5	1790	0.72	0.019	9.61	0.063	1.10	35401	0.015	0.027	72700	44
RV058	YES	DEEP	0.003	0.20	34	<50	0.21	<0.002	14.1	0.046	0.24	49591	<0.002	<0.002	90	90
RV059	YES	DEEP	0.21	2.05	<5	<50	0.13	0.054	14.3	0.015	0.05	39542	0.042	0.017	300	88
RV060	YES	DEEP	0.023	0.22	27	3780	0.53	0.005	13.1	0.024	0.13	36158	0.005	0.003	2320	141

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RV061	YES	DEEP	0.003	0.44	12	3110	0.14	<0.002	9.91	0.006	0.30	40313	0.002	<0.002	1940	130
RV062	YES	SHALL	0.006	0.44	8	50	0.12	<0.002	18.9	0.015	0.15	43038	0.002	<0.002	980	192
RV063	YES	DEEP	0.022	0.42	12	770	1.00	0.005	16.1	0.052	0.37	46885	0.007	0.22	1830	131
RV064	YES	DEEP	0.089	0.35	18	530	3.44	0.023	24.6	0.042	0.12	46086	0.020	0.006	1280	79
RV065	YES	DEEP	0.78	1.16	16	13100	1.00	0.20	27.8	0.028	0.49	41103	0.15	0.084	2880	314
RV066	YES	DEEP	0.041	0.31	<5	360	0.30	0.011	19.4	0.053	0.20	42136	0.009	0.017	1640	94
RV067	YES	hspring	0.099	0.13	28	1360	0.023	0.023	33.5	0.084	0.78	53690	0.02	<0.002	22400	48
RV068	YES	spring	0.31	0.19	97	3120	0.13	0.084	20.0	0.046	0.34	54784	0.068	0.050	420	32
RV069	YES	spring	18.2	2.16	40	45300	2.03	4.97	26.3	0.004	0.29	28002	3.47	0.047	3190	42
RV070	NO	lake	34.1	11.0	<5	2050	6.39	9.23	30.8	0.12	0.94	56644	6.65	0.18	16600	138
RV071	YES	DEEP	0.027	1.06	55	27800	0.07	0.007	0.94	0.005	0.62	25011	0.003	<0.002	12000	816
RV072	YES	DEEP	0.054	0.20	122	1320	0.26	0.015	31.7	0.012	0.13	46259	0.012	0.009	380	36
RV073	YES	DEEP	0.046	0.30	27	9200	0.94	0.010	29.0	0.016	0.48	51255	0.010	0.007	320	89
RV074	YES	DEEP	0.22	0.25	33	14500	1.67	0.045	8.28	0.012	0.60	44398	0.066	0.004	2040	10
RV075	YES	SHALL	4.02	4.58	<5	710	1.75	1.04	17.8	0.065	0.67	40954	0.83	0.14	7310	129
RV076	YES	river	11.6	2.67	8	6570	2.90	3.02	7.06	0.013	0.32	16387	2.20	0.029	1230	30
RV077	YES	SHALL	0.11	0.95	<5	<50	4.22	0.029	6.04	0.005	0.80	29437	0.02	0.049	<50	152
RV078	YES	DEEP	0.019	0.38	<5	1480	0.21	0.005	1.73	0.004	0.21	22262	0.003	<0.002	330	198
RV079	YES	DEEP	0.004	0.38	<5	13100	0.43	<0.002	4.94	<0.002	1.78	17439	0.002	<0.002	350	322
RV080	YES	DEEP	0.011	1.08	<5	<50	0.74	0.003	5.16	0.006	0.20	31741	0.003	0.003	11100	409
RV081	YES	SHALL	0.032	0.40	<5	510	0.61	0.008	4.35	0.003	0.56	22739	0.006	0.006	7340	196
RV082	YES	DEEP	4.57	3.82	<5	<50	20.4	1.16	5.46	0.038	0.41	31559	0.85	0.16	2090	435
RV083	YES	DEEP	0.01	0.25	<5	<50	1.28	0.003	4.68	0.005	0.23	32045	0.003	0.008	350	94
RV084	YES	DEEP	0.008	0.35	<5	4130	0.14	<0.002	1.44	0.003	0.27	23066	<0.002	<0.002	140	163
RV085	YES	DEEP	0.009	1.47	<5	51700	0.12	<0.002	3.36	0.007	2.61	27684	<0.002	0.007	100000	479
RV086	YES	DEEP	1.20	3.61	<5	5240	1.86	0.33	8.88	0.024	1.07	30554	0.24	0.023	73000	390
RV087	YES	DEEP	0.059	1.55	5	40100	1.78	0.016	1.77	0.01	1.74	30577	0.015	0.14	11400	684
RV088	YES	DEEP	0.41	1.01	<5	1740	2.19	0.10	1.59	0.017	0.33	32998	0.089	0.050	930	243
RV089	YES	SHALL	0.028	1.48	<5	36300	1.64	0.008	3.47	0.012	1.03	39477	0.002	0.009	700	967
RV090	YES	DEEP	0.018	5.44	<5	5790	1.12	0.004	0.49	0.022	2.09	19687	0.004	0.055	29700	658
RV091	YES	SHALL	1.37	6.39	<5	27100	0.56	0.32	1.50	0.024	3.25	24496	0.27	0.031	48600	782
RV092	YES	DEEP	0.16	8.75	<5	5330	2.76	0.037	2.58	0.034	7.58	25768	0.035	0.25	304000	276
RV093	YES	DEEP	0.19	0.79	16	16100	0.44	0.050	8.50	0.032	0.56	30231	0.034	0.021	10100	355
RV094	YES	spring	0.29	0.58	<5	2710	0.43	0.074	1.04	0.013	0.21	15331	0.056	0.025	420	59
RV095	NO	lake	3.66	8.00	<5	5290	0.67	0.95	7.38	0.13	1.80	16434	0.76	0.088	7420	122
RV096	YES	spring	0.026	0.95	389	3980	0.08	0.006	4.66	0.057	0.40	17780	0.006	0.11	1150	204
RV097	YES	DEEP	0.008	0.63	8	6810	0.44	<0.002	5.71	0.020	0.59	46936	0.003	<0.002	8900	398
RV098	YES	DEEP	0.058	0.90	<5	6690	1.02	0.017	2.89	0.064	2.18	25361	0.018	0.038	94400	528
RV099	YES	DEEP	0.068	0.61	<5	120	0.13	0.017	2.32	0.019	5.35	26665	0.010	0.026	253000	520
RV100	YES	DEEP	0.009	0.33	<5	60	0.13	<0.002	2.05	0.07	3.71	27787	0.002	0.014	143000	330
RV101	YES	SHALL	0.51	1.89	5	15900	0.50	0.13	1.40	0.085	0.53	24478	0.1	0.009	16500	331
RV102	YES	DEEP	0.004	0.13	<5	13300	0.22	<0.002	4.04	0.026	2.77	21486	0.002	0.002	131000	78
RV103	YES	SHALL	0.86	4.60	<5	40	0.18	0.22	3.71	0.022	0.29	30545	0.18	0.20	143000	2120
RV104	YES	DEEP	0.015	0.98	<5	3400	3.13	0.003	9.54	0.007	4.91	32783	0.002	<0.002	112000	722
RV105	YES	DEEP	0.004	1.61	1120	14200	0.47	<0.002	0.60	0.008	0.78	20229	<0.002	<0.002	25400	1230
RV106	YES	DEEP	0.029	0.33	19	68900	1.33	0.008	1.92	0.013	4.16	30002	0.007	0.006	112000	545
RV107	YES	SHALL	0.004	0.23	<5	630	1.42	<0.002	0.77	0.015	3.28	7427	<0.002	0.026	140000	63
RV108	YES	SHALL	0.002	0.56	<5	1750	3.95	<0.002	2.38	0.031	0.44	29138	<0.002	<0.002	26100	305
RV109	YES	SHALL	0.019	0.98	593	6030	8.62	0.004	4.18	0.15	0.87	46132	0.005	0.066	67500	255
RV110	YES	DEEP	0.007	0.79	15	4170	0.78	<0.002	4.02	0.016	1.03	32293	<0.002	<0.002	38600	377
RV111	YES	DEEP	0.13	0.91	<5	<50	0.11	0.028	7.00	0.004	0.49	30016	0.023	0.020	16500	345
RV112	YES	DEEP	0.088	1.54	<5	25100	0.20	0.021	8.01	0.014	2.16	44735	0.018	0.050	15100	225
RV113	YES	DEEP	0.016	2.37	<5	3140	0.41	0.005	2.86	0.042	1.86	35373	0.003	0.021	12900	364
RV114	YES	SHALL	0.091	3.46	<5	12500	3.21	0.021	2.23	0.029	0.29	26142	0.016	0.031	7350	178
RV115	YES	DEEP	0.003	0.74	<5	<50	0.10	<0.002	0.81	0.01	0.36	18542	0.002	0.004	54000	605
RV116	YES	DEEP	0.026	1.62	<5	4080	0.22	0.006	0.64	0.028	0.22	27011	0.011	0.042	5090	288
RV117	YES	DEEP	0.049	1.08	<5	7200	1.87	0.013	1.10	0.16	0.38	17995	0.008	5.18	32500	337
RV118	YES	DEEP	0.81	11.2	<5	4100	1.48	0.18	74.9	0.024	1.32	29843	0.17	7.48	460000	1430
RV119	YES	DEEP	1.80	9.88	<5	3720	46.4	0.43	2.48	0.060	0.37	26899	0.38	0.18	205000	819
RV120	YES	DEEP	0.016	2.30	<5	55400	14.2	0.004	6.06	0.013	4.50	37696	0.003	0.12	130000	1480
RV121	YES	DEEP	2.46	5.12	895	7970	0.69	0.62	4.89	0.015	0.60	33639	0.51	0.029	91200	447
RV122	YES	DEEP	0.057	1.29	<5	1050	0.43	0.016	4.56	0.018	0.69	34223	0.025	0.024	9470	247
RV123	YES	spring	0.14	0.83	4	22400	0.03	0.030	5.85	0.018	0.91	26226	0.032	0.007	12400	213

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RV124	YES	hspring	0.033	3.32	<5	6710	0.23	0.007	73.7	0.098	2.15	39014	0.005	0.18	164000	2890
RV125	YES	DEEP	0.11	0.57	23	21900	0.68	0.026	5.35	0.035	1.54	27736	0.021	0.027	27700	211
RV126	YES	SHALL	0.016	0.69	<5	11900	0.06	0.003	27.5	0.029	4.99	49287	0.007	0.018	264000	582
RV127	YES	SHALL	0.012	2.66	<5	9090	0.04	<0.002	0.62	0.005	0.38	14854	0.002	0.011	692000	9850
RV128	YES	SHALL	0.038	1.24	<5	56800	0.15	0.010	1.99	0.018	6.87	19355	0.012	0.015	617000	1270
RV129	YES	SHALL	0.017	1.37	<5	12900	0.07	0.003	0.84	0.012	0.54	9128	0.005	0.008	222000	1220
RV130	YES	DEEP	0.018	2.01	<5	18900	0.10	0.005	0.86	0.007	0.81	18135	0.004	0.015	66300	934
RV131	YES	DEEP	0.026	2.68	<5	27800	0.08	0.004	1.13	0.006	6.10	13012	0.008	0.006	316000	1360
RV132	YES	SHALL	0.028	2.14	<5	100000	0.29	0.006	0.58	0.014	1.70	19649	0.009	0.055	70900	641
RV133	YES	SHALL	0.036	2.08	<5	97200	0.15	0.008	0.38	0.010	2.09	17280	0.010	0.018	67900	537
RV134	YES	SHALL	0.030	1.90	<5	90200	0.13	0.007	1.91	0.011	2.85	17112	0.009	0.008	57700	1150
RV135	YES	Infi	0.067	1.65	<5	7230	0.43	0.014	0.66	0.041	1.06	24730	0.013	0.029	169000	666
RV136	YES	SHALL	0.18	1.72	<5	3140	0.12	0.040	1.38	0.020	1.37	16551	0.044	0.014	273000	1370
RV137	YES	SHALL	0.012	2.29	<5	71200	0.27	0.004	0.59	0.006	1.12	26020	0.004	0.003	358000	297
RV138	YES	DEEP	0.009	1.46	<5	22900	0.62	<0.002	0.54	0.014	1.92	17981	0.004	0.096	56500	685
RV139	YES	DEEP	0.023	0.56	20	14300	0.17	0.004	19.1	0.028	0.26	39028	0.005	0.003	6920	315
RV140	YES	SHALL	0.070	1.87	22	43700	0.95	0.019	0.75	0.014	1.49	25076	0.014	0.007	18700	580
RV141	YES	DEEP	0.080	4.04	5	2440	2.28	0.019	21.0	0.044	0.30	40379	0.013	0.021	15500	505
RV142	YES	DEEP	0.84	1.81	<5	3120	0.57	0.21	19.6	0.017	1.04	34433	0.17	0.032	29700	567
RV143	YES	DEEP	0.029	0.37	<5	5870	4.68	0.007	59.0	0.13	1.23	44123	0.008	0.080	110000	78
RV144	YES	SHALL	0.031	0.50	63	12700	0.25	0.008	24.5	0.031	0.85	49974	0.008	0.008	12100	133
RV145	YES	DEEP	0.10	0.62	9	6150	0.46	0.026	25.7	0.045	0.02	43828	0.016	0.016	6440	142
RV146	YES	DEEP	0.022	0.62	16	1090	0.50	0.007	18.8	0.013	0.20	45081	0.006	0.090	3790	152
RV147	YES	DEEP	0.18	0.68	<5	880	8.27	0.044	11.5	0.092	0.32	41472	0.033	0.094	6830	177
RV148	YES	DEEP	0.78	0.18	<5	1600	1.66	0.20	5.55	0.55	0.27	36644	0.18	0.082	3690	9

*ID	*DW	*TYPE	Ta_M	Tb_M	Te_M	Th_M	Ti_M	Tl_M	Tm_M	U_M	V_M	W_M	Y_M	Yb_M	Zn_M	Zr_M
RV001	YES	DEEP	0.005	0.003	<0.005	0.17	2.1	0.084	0.007	18.6	16.1	0.25	0.49	0.049	49.9	0.34
RV002	NO	river	0.13	2.14	0.011	3.94	180	0.24	1.00	3.30	59.9	0.073	64.8	6.30	99.8	7.66
RV003	YES	DEEP	0.004	0.004	<0.005	0.035	5.8	0.046	0.004	19.9	11.6	0.051	0.34	0.032	70.0	0.73
RV004	YES	DEEP	0.003	<0.002	<0.005	0.010	2.7	<0.002	<0.002	1.92	8.87	0.027	0.021	<0.002	32.0	0.062
RV005	YES	hspring	0.008	0.002	<0.005	0.011	3.9	0.042	0.004	3.40	17.3	0.40	0.19	0.015	15.6	1.46
RV006	YES	DEEP	0.003	<0.002	<0.005	0.008	2.2	<0.002	0.002	1.24	5.23	0.74	0.10	0.007	2.5	0.11
RV007	YES	DEEP	<0.002	<0.002	<0.005	0.003	<5	<0.002	<0.002	3.97	30.3	0.010	0.013	<0.002	319	0.045
RV008	YES	DEEP	0.002	0.006	<0.005	0.030	9.6	<0.002	0.004	6.77	8.68	0.006	0.20	0.017	6.0	1.00
RV009	YES	DEEP	<0.002	<0.002	0.010	0.002	3.6	<0.002	<0.002	7.25	20.5	0.004	0.05	0.003	107	0.071
RV010	YES	spring	<0.002	<0.002	<0.005	0.002	2.4	<0.002	<0.002	0.76	18.7	0.006	0.038	0.003	124	0.069
RV011	YES	DEEP	<0.002	<0.002	<0.005	<0.002	2.8	<0.002	<0.002	3.46	23.7	0.003	0.062	0.005	718	0.034
RV012	NO	river	0.004	0.008	0.018	0.017	5.0	0.007	0.004	0.33	12.3	0.030	0.24	0.021	7.9	1.32
RV013	YES	DEEP	0.002	<0.002	<0.005	0.003	3.8	<0.002	<0.002	4.19	24.0	0.006	0.047	0.003	1950	0.072
RV014	YES	DEEP	0.003	<0.002	<0.005	0.002	3.6	<0.002	<0.002	3.91	33.7	0.24	0.008	<0.002	10.8	0.040
RV015	YES	spring	0.026	0.026	<0.005	0.12	40	0.008	0.015	0.12	6.72	0.015	1.02	0.095	24.0	3.04
RV016	YES	DEEP	0.002	<0.002	<0.005	0.007	4.1	<0.002	<0.002	3.02	64.2	0.066	0.073	0.006	13.1	0.11
RV017	YES	DEEP	<0.002	<0.002	0.015	<0.002	3.1	<0.002	<0.002	1.33	4.85	0.004	0.017	<0.002	9.0	0.044
RV018	NO	lake	0.21	0.089	0.028	0.38	65.2	0.014	0.056	22.6	108	22.7	3.66	0.32	39.5	7.52
RV019	YES	SHALL	0.012	0.005	0.002	0.023	9.5	0.011	0.004	32.2	75.9	2.22	0.25	0.027	31.6	0.78
RV020	YES	DEEP	0.014	<0.002	0.008	0.008	5.8	0.009	<0.002	4.09	70.7	1.73	0.032	0.003	55.5	0.13
RV021	YES	DEEP	0.008	0.002	0.013	0.003	4.2	0.007	0.002	7.48	44.8	1.71	0.14	0.012	28.9	0.30
RV022	YES	SHALL	0.002	0.002	0.006	0.008	5.4	<0.002	<0.002	1.14	9.03	0.028	0.059	0.003	422	0.24
RV023	YES	SHALL	0.007	0.020	<0.005	0.060	15.3	0.012	0.009	2.40	10.8	0.044	0.63	0.057	5.0	3.28
RV024	NO	lake	0.018	0.21	<0.005	0.76	282	0.043	0.11	1.82	17.4	0.027	6.77	0.72	28.0	23.9
RV025	YES	SHALL	0.003	0.002	<0.005	0.007	3.8	0.021	0.002	4.38	3.65	0.040	0.091	0.009	38.3	0.30
RV026	YES	SHALL	0.028	0.002	<0.005	0.011	10.3	0.022	<0.002	42.5	61.8	0.23	0.070	0.008	89.7	0.40
RV027	YES	DEEP	0.003	<0.002	<0.005	0.002	3.7	0.007	<0.002	3.97	235	0.35	0.035	0.005	3.53	0.06
RV028	YES	DEEP	0.010	0.003	<0.005	0.003	6.8	0.006	0.006	5.22	2.75	0.79	0.33	0.033	37.3	0.15
RV029	YES	DEEP	<0.002	<0.002	<0.005	<0.002	<5	<0.002	<0.002	4.25	16.0	0.021	0.026	0.004	313	0.045
RV030	YES	DEEP	0.002	<0.002	<0.005	0.003	<5	0.003	<0.002	1.77	20.5	0.75	0.026	<0.002	61.1	0.14
RV031	YES	DEEP	<0.002	<0.002	<0.005	0.002	1.9	<0.002	<0.002	1.86	26.6	0.016	0.024	0.002	36.1	0.073
RV032	YES	DEEP	<0.002	<0.002	<0.005	<0.002	2.4	0.006	0.002	3.71	25.6	0.012	0.11	0.008	159	0.085
RV033	YES	DEEP	<0.002	0.005	<0.005	0.010	5.4	0.024	0.002	1.54	11.2	<0.002	0.14	0.011	1920	0.099
RV034	YES	DEEP	0.002	<0.002	<0.005	0.023	3.3	0.004	<0.002	4.32	64.1	0.54	0.024	0.002	11.8	0.025
RV035	YES	hspring	0.003	<0.002	<0.005	0.010	3.7	0.003	<0.002	2.20	68.6	1.02	0.048	0.003	7.5	0.079
RV036	YES	SHALL	0.005	<0.002	<0.005	0.016	5.3	<0.002	<0.002	5.23	60.6	0.82	0.065	0.005	7.2	0.50
RV037	YES	SHALL	0.005	<0.002	0.015	0.006	4.3	0.004	<0.002	8.50	55.6	0.98	0.037	0.004	2.7	0.058
RV038	YES	DEEP		<0.002	<0.005	<0.002	1.5	<0.002	<0.002	3.08	20.2	0.008	0.022	<0.002	272	0.025
RV039	YES	SHALL	0.002	<0.002	<0.005	0.005	3.2	0.002	<0.002	9.22	2.42	0.022	0.068	0.011	5.2	0.12
RV040	YES	DEEP	0.013	<0.002	<0.005	0.007	4.9	<0.002	0.002	1.25	3.88	3.81	0.11	0.013	119	0.097
RV041	YES	SHALL	0.003	<0.002	<0.005	<0.002	3.3	0.007	<0.002	3.24	13.8	0.038	0.083	0.008	287	0.036
RV042	YES	DEEP	0.002	<0.002	0.006	0.002	5.3	0.002	<0.002	4.07	39.6	0.34	0.015	<0.002	67.3	0.064
RV043	NO	lake	0.093	0.50	0.021	3.93	567	0.071	0.31	2.15	20.2	1.33	17.1	2.10	49.7	179
RV044	NO	lake	0.74	0.057	0.075	0.77	8.4	0.003	0.097	43.2	16.3	290	4.03	0.62	1.5	6.10
RV045	NO	lake	0.20	0.33	0.32	0.86	0.8	0.004	0.34	31.2	28.1	304	22.9	2.04	1.9	39.1
RV046	YES	DEEP	0.003	0.007	0.012	0.036	4.7	0.003	0.006	1.58	14.9	0.018	0.59	0.035	102	0.11
RV047	YES	DEEP	0.004	0.002	0.008	0.018	5.0	0.005	0.003	8.69	21.2	0.075	0.21	0.01	153	0.20
RV048	YES	DEEP	0.003	<0.002	<0.005	0.008	4.7	0.003	<0.002	6.06	72.5	0.036	0.085	0.005	189	0.057
RV049	YES	DEEP	0.005	<0.002	0.011	0.009	4.1	0.004	<0.002	4.42	69.1	0.25	0.071	0.007	305	0.13
RV050	YES	river	0.004	0.022	0.015	0.077	14.3	0.007	0.010	0.12	2.91	0.005	0.76	0.070	17.2	3.65
RV051	YES	hspring	0.003	0.003	0.012	0.10	2.1	0.030	0.002	0.005	0.09	0.029	0.068	0.003	2.1	0.20
RV052	NO	lake	0.059	0.031	0.013	0.13	33.5	0.007	0.016	0.23	1.96	3.91	1.24	0.11	5.9	6.42
RV053	YES	hspring	0.014	<0.002	0.011	0.013	3.6	0.15	<0.002	1.65	3.93	3.29	0.011	<0.002	12.9	0.085
RV054	YES	DEEP	0.002	<0.002	0.008	0.003	1.8	0.007	<0.002	0.81	5.00	0.025	0.028	0.002	3980	0.025
RV055	YES	hspring	0.002	0.002	0.002	0.011	4.3	0.004	<0.002	0.30	1.40	0.037	0.063	0.007	18.7	0.49
RV056	YES	river	0.003	0.15	0.008	0.12	85.1	0.032	0.065	0.22	4.42	0.008	4.38	0.41	18.8	2.26
RV057	YES	DEEP	0.003	0.003	0.008	0.019	3.8	0.010	<0.002	5.19	27.0	0.11	0.095	0.007	207	0.55
RV058	YES	DEEP	0.003	<0.002	0.007	0.003	1.7	0.004	<0.002	2.12	2.62	0.12	0.041	0.005	17.0	0.029
RV059	YES	DEEP	<0.002	0.005	0.017	0.023	5.6	0.015	0.003	0.20	0.26	<0.002	0.18	0.017	91.9	0.71
RV060	YES	DEEP	<0.002	<0.002	<0.005	0.003	0.7	0.002	<0.002	2.27	16.9	0.011	0.054	0.004	294	0.12

*ID	*DW	*TYPE	Ta_M	Tb_M	Te_M	Th_M	Ti_M	Tl_M	Tm_M	U_M	V_M	W_M	Y_M	Yb_M	Zn_M	Zr_M
RV061	YES	DEEP	<0.002	<0.002	0.011	<0.002	0.7	<0.002	<0.002	1.37	6.60	<0.002	0.023	0.002	33.0	0.037
RV062	YES	SHALL	0.002	<0.002	0.004	0.002	<5	0.008	<0.002	2.60	9.32	0.003	0.031	0.003	23.2	0.050
RV063	YES	DEEP	<0.002	<0.002	0.006	0.005	2.3	0.002	<0.002	4.31	14.5	0.031	0.053	0.005	12.3	0.13
RV064	YES	DEEP	<0.002	0.003	<0.005	0.005	0.7	0.006	<0.002	1.50	5.42	0.020	0.088	0.008	958	0.37
RV065	YES	DEEP	0.003	0.021	0.009	0.12	21.0	0.004	0.010	5.45	10.9	0.003	0.64	0.068	55.9	5.14
RV066	YES	DEEP	0.002	<0.002	0.012	0.009	2.1	0.006	<0.002	1.34	14.6	0.006	0.058	0.004	86.4	0.39
RV067	YES	hspring	0.035	0.007	0.016	0.062	7.2	0.007	0.006	6.44	7.35	2.45	0.57	0.043	1.1	0.41
RV068	YES	spring	0.011	0.018	0.005	0.23	11.2	0.009	0.014	1.47	1.32	0.078	0.94	0.083	6.7	12.3
RV069	YES	spring	0.018	0.41	0.008	1.59	123	0.021	0.13	0.62	<5	0.013	10.3	0.77	17.4	2.56
RV070	NO	lake	0.077	0.98	0.022	6.00	681	0.11	0.48	6.43	36.6	0.099	28.6	3.15	55.0	103
RV071	YES	DEEP	<0.002	<0.002	0.009	0.009	2.4	0.004	<0.002	1.62	13.1	0.006	0.069	0.005	41.5	0.27
RV072	YES	DEEP	<0.002	0.002	0.009	0.011	2.4	0.003	0.002	0.34	0.36	<0.002	0.16	0.017	693	0.57
RV073	YES	DEEP	<0.002	0.004	0.011	0.006	0.4	0.014	0.003	0.41	1.26	<0.002	0.32	0.017	22.7	0.28
RV074	YES	DEEP	<0.002	0.025	<0.005	0.013	1.2	0.005	0.020	0.28	0.23	<0.002	1.50	0.15	26.8	0.16
RV075	YES	SHALL	0.017	0.12	<0.005	0.30	53.3	0.015	0.056	0.54	1.67	1.65	3.77	0.36	111	25.0
RV076	YES	river	0.003	0.29	<0.005	0.24	106	0.045	0.12	0.44	6.48	0.006	8.21	0.72	18.8	1.84
RV077	YES	SHALL	<0.002	0.004	0.005	0.024	6.7	0.003	<0.002	0.006	0.41	<0.002	0.11	0.010	4370	0.21
RV078	YES	DEEP	<0.002	<0.002	<0.005	0.002	1.3	0.002	<0.002	0.025	7.24	<0.002	0.025	0.002	26.8	0.040
RV079	YES	DEEP	<0.002	<0.002	<0.005	<0.002	2.9	0.012	<0.002	0.17	7.46	<0.002	0.004	<0.002	85.6	0.028
RV080	YES	DEEP	<0.002	<0.002	0.007	0.004	4.3	<0.002	<0.002	0.041	0.11	<0.002	0.026	<0.002	510	0.095
RV081	YES	SHALL	<0.002	<0.002	<0.005	0.002	3.4	0.002	<0.002	0.069	1.57	<0.002	0.035	0.004	80.6	0.14
RV082	YES	DEEP	0.004	0.11	<0.005	0.64	42.5	0.029	0.039	2.24	9.23	0.002	2.94	0.23	476	0.91
RV083	YES	DEEP	0.007	<0.002	<0.005	0.038	2.1	0.010	<0.002	0.051	0.23	0.055	0.033	0.002	19.8	0.047
RV084	YES	DEEP	<0.002	<0.002	<0.005	0.004	2.1	0.006	<0.002	0.015	2.48	0.003	0.007	<0.002	86.6	0.009
RV085	YES	DEEP	0.002	<0.002	<0.005	0.010	5.6	0.008	<0.002	3.26	2.93	0.005	0.018	<0.002	39.8	0.023
RV086	YES	DEEP	0.005	0.033	0.012	0.20	40.2	0.009	0.012	2.55	34.8	0.007	0.87	0.080	1020	1.60
RV087	YES	DEEP	0.003	0.003	0.009	0.015	0.3	0.004	0.002	4.15	7.32	0.043	0.17	0.016	46.1	1.37
RV088	YES	DEEP	<0.002	0.012	<0.005	0.014	10.5	0.004	0.006	0.062	14.5	0.002	0.35	0.028	1510	0.46
RV089	YES	SHALL	<0.002	<0.002	<0.005	0.006	2.2	0.003	<0.002	1.08	8.66	<0.002	0.030	<0.002	328	0.13
RV090	YES	DEEP	<0.002	<0.002	<0.005	0.005	<5	0.013	<0.002	4.41	11.0	0.029	0.026	<0.002	486	0.047
RV091	YES	SHALL	0.002	0.032	0.006	0.053	36.6	0.019	0.013	3.10	7.01	0.011	1.13	0.089	44.0	0.12
RV092	YES	DEEP	<0.002	0.005	<0.005	0.017	13.5	0.018	0.004	0.52	7.74	<0.002	0.31	0.018	169	0.25
RV093	YES	DEEP	<0.002	0.005	<0.005	0.012	6.6	0.004	0.003	2.17	2.15	<0.002	0.20	0.018	22.7	0.30
RV094	YES	spring	0.006	0.012	<0.005	0.047	12.1	0.003	0.006	0.026	2.92	<0.002	0.38	0.039	61.4	0.88
RV095	NO	lake	0.017	0.10	<0.005	0.31	147	0.011	0.042	2.80	29.9	0.12	2.93	0.25	13.1	16.0
RV096	YES	spring	<0.002	<0.002	<0.005	0.002	2.11	<0.002	<0.002	0.43	9.23	0.009	0.029	0.003	5.2	0.041
RV097	YES	DEEP	0.002	<0.002	<0.005	0.002	1.6	0.002	<0.002	1.52	27.7	0.009	0.058	0.005	13.2	0.025
RV098	YES	DEEP	<0.002	0.002	<0.005	0.007	8.8	0.006	<0.002	0.86	43.7	0.012	0.076	0.005	270	0.24
RV099	YES	DEEP	<0.002	0.002	0.006	0.006	12.0	0.014	<0.002	0.26	17.7	0.52	0.055	0.005	12.6	0.076
RV100	YES	DEEP	0.002	<0.002	<0.005	0.002	5.7	0.011	<0.002	1.18	70.0	0.65	0.013	<0.002	23.9	0.053
RV101	YES	SHALL	0.004	0.016	<0.005	0.094	24.5	0.006	0.006	0.26	33.0	0.032	0.42	0.042	37.8	1.31
RV102	YES	DEEP	0.005	<0.002	<0.005	0.019	5.3	0.003	<0.002	2.90	68.5	0.31	0.005	<0.002	12.0	0.048
RV103	YES	SHALL	<0.002	0.026	<0.005	0.088	48.9	0.007	0.011	0.23	8.12	0.022	0.80	0.071	4.6	2.07
RV104	YES	DEEP	<0.002	<0.002	<0.005	0.004	5.4	0.027	<0.002	2.92	20.5	0.003	0.039	0.002	611	0.040
RV105	YES	DEEP	<0.002	<0.002	<0.005	0.002	3.1	0.003	<0.002	0.36	4.53	<0.002	0.023	0.002	222	0.013
RV106	YES	DEEP	<0.002	<0.002	<0.005	0.006	5.3	0.003	<0.002	2.88	113	0.005	0.040	0.005	183	0.081
RV107	YES	SHALL	0.002	<0.002	<0.005	0.004	6.6	0.002	<0.002	0.011	1.07	0.094	0.003	<0.002	122	0.038
RV108	YES	SHALL	<0.002	<0.002	<0.005	<0.002	3.2	0.004	<0.002	0.94	50.6	0.016	0.011	<0.002	238	0.020
RV109	YES	SHALL	<0.002	<0.002	<0.005	0.002	2.3	0.013	<0.002	0.90	97.8	0.21	0.022	0.002	80.7	0.038
RV110	YES	DEEP	0.002	<0.002	<0.005	<0.002	4.8	0.002	<0.002	0.55	27.4	0.003	0.039	0.005	75.9	0.032
RV111	YES	DEEP	<0.002	0.003	<0.005	0.014	8.1	0.013	<0.002	0.008	0.43	0.011	0.11	0.005	40.2	0.29
RV112	YES	DEEP	<0.002	0.002	0.012	0.013	5.0	0.005	0.002	0.22	3.50	0.003	0.085	0.008	23.8	0.11
RV113	YES	DEEP	<0.002	<0.002	0.019	0.002	2.8	0.025	<0.002	3.34	23.3	0.002	0.031	0.004	71.6	0.050
RV114	YES	SHALL	<0.002	0.003	0.011	0.002	6.0	0.006	<0.002	0.18	17.0	0.009	0.12	0.008	16.8	0.064
RV115	YES	DEEP	<0.002	<0.002	0.004	<0.002	4.3	0.002	<0.002	1.93	23.3	0.003	0.011	0.002	27.5	0.016
RV116	YES	DEEP	0.002	<0.002	<0.005	0.036	2.4	0.012	<0.002	2.36	76.9	0.016	0.081	0.008	12.9	0.042
RV117	YES	DEEP	0.003	<0.002	<0.005	0.012	5.9	0.008	<0.002	0.57	34.0	0.012	0.056	0.003	214	0.11
RV118	YES	DEEP	0.006	0.022	<0.005	0.055	264	0.008	0.005	0.08	29.5	0.042	0.41	0.022	293	2.49
RV119	YES	DEEP	0.004	0.049	<0.005	0.17	110	0.024	0.013	1.46	28.8	0.011	1.11	0.085	5140	1.55
RV120	YES	DEEP	0.003	<0.002	0.006	0.005	7.1	0.005	<0.002	4.18	13.6	0.003	0.038	0.003	1570	0.066
RV121	YES	DEEP	0.006	0.066	<0.005	0.37	91.1	0.025	0.025	1.26	60.4	0.011	1.81	0.16	96.1	2.25
RV122	YES	DEEP	0.002	<0.002	<0.005	0.007	6.5	0.005	<0.002	2.93	11.9	0.002	0.078	0.007	15.9	0.20
RV123	YES	spring	<0.002	0.004	<0.005	<0.002	2.0	0.008	0.002	0.14	2.92	<0.002	0.15	0.014	1.69	0.076

*ID	*DW	*TYPE	Ta_M	Tb_M	Te_M	Th_M	Ti_M	Tl_M	Tm_M	U_M	V_M	W_M	Y_M	Yb_M	Zn_M	Zr_M
RV124	YES	hspring	0.008	<0.002	<0.005	0.007	5.6	0.038	<0.002	0.66	191	3.66	0.048	0.003	7.8	0.14
RV125	YES	DEEP	0.002	0.003	<0.005	0.009	4.3	0.006	<0.002	1.41	96.3	0.10	0.081	0.007	76.4	0.21
RV126	YES	SHALL	0.003	<0.002	<0.005	0.004	10.4	0.050	<0.002	0.40	29.5	0.70	0.026	0.003	8.1	0.054
RV127	YES	SHALL	<0.002	<0.002	<0.005	0.004	19.7	0.002	<0.002	1.25	20.0	0.007	0.058	<0.002	20.7	0.039
RV128	YES	SHALL	0.002	<0.002	<0.005	0.009	15.8	0.006	<0.002	0.93	39.3	0.003	0.037	0.004	150	0.11
RV129	YES	SHALL	<0.002	<0.002	<0.005	<0.002	8.3	0.003	<0.002	0.45	11.3	<0.002	0.012	<0.002	5.7	0.018
RV130	YES	DEEP	<0.002	<0.002	<0.005	0.004	4.9	0.004	<0.002	2.64	3.68	0.003	0.025	<0.002	41.8	0.052
RV131	YES	DEEP	<0.002	<0.002	<0.005	0.002	10.4	0.029	<0.002	1.82	1.90	0.002	0.081	0.006	43.6	0.027
RV132	YES	SHALL	0.002	<0.002	<0.005	0.037	5.2	0.014	<0.002	7.11	3.21	0.003	0.052	0.002	36.9	0.050
RV133	YES	SHALL	0.002	<0.002	<0.005	0.012	5.6	0.003	<0.002	43.3	3.53	0.005	0.093	0.006	14.6	0.045
RV134	YES	SHALL	0.003	<0.002	<0.005	0.007	4.0	0.004	<0.002	47.7	5.50	0.003	0.040	0.004	253	0.090
RV135	YES	Infi	<0.002	0.002	<0.005	0.007	7.5	0.003	<0.002	0.58	29.7	<0.002	0.061	0.006	27.4	0.087
RV136	YES	SHALL	0.002	0.005	<0.005	0.012	16.1	0.004	0.002	1.55	5.47	<0.002	0.16	0.014	8.7	0.21
RV137	YES	SHALL	<0.002	<0.002	<0.005	0.003	10.5	0.003	<0.002	3.08	36.8	<0.002	0.014	0.002	130	0.015
RV138	YES	DEEP	<0.002	<0.002	<0.005	<0.002	3.9	0.007	<0.002	2.16	2.90	<0.002	0.018	<0.002	40.4	0.023
RV139	YES	DEEP	<0.002	<0.002	<0.005	0.002	2.8	0.003	<0.002	2.33	15.4	0.009	0.076	0.006	12.5	0.061
RV140	YES	SHALL	<0.002	<0.002	<0.005	0.022	3.9	<0.002	0.002	1.22	17.1	0.002	0.14	0.010	19.2	0.046
RV141	YES	DEEP	<0.002	0.003	<0.005	0.007	5.4	0.004	<0.002	2.86	10.6	0.003	0.10	0.013	594	0.085
RV142	YES	DEEP	0.004	0.023	<0.005	0.055	23.6	0.011	0.008	3.42	4.31	0.004	0.67	0.049	72.1	0.84
RV143	YES	DEEP	0.022	<0.002	<0.005	0.009	6.8	0.012	<0.002	8.40	55.5	2.51	0.030	0.006	84.3	0.10
RV144	YES	SHALL	<0.002	<0.002	<0.005	0.003	4.7	0.003	<0.002	10.5	25.5	0.032	0.045	0.005	7.5	0.074
RV145	YES	DEEP	0.002	0.003	<0.005	0.022	7.0	0.005	0.002	4.28	18.9	0.028	0.084	0.009	24.9	0.75
RV146	YES	DEEP	0.002	<0.002	<0.005	0.002	4.1	0.002	<0.002	4.69	13.6	0.005	0.044	0.005	90.7	0.061
RV147	YES	DEEP	0.003	0.005	<0.005	0.026	10.7	0.017	0.003	3.32	33.8	0.072	0.17	0.015	274	0.58
RV148	YES	DEEP	0.054	0.032	<0.005	0.55	44.4	0.005	0.021	1.10	4.15	0.041	0.91	0.13	189	13.0

*ID	*DW	*TYPE	T(oC)	pH_F	EC_L	Alk_L	ToHa	CaHa	Solids	IBD_%	DEPTH	XCOO	YCOO	UTM	*TYPE2
RV001	YES	DEEP	24.6	6.94	1079	565	17.2	25.9	927	2.3		525979	933359	37	driwel
RV002	NO	river	28.3	8.14	415	202	5.5	9.3	333	0.2		518865	936592	37	river
RV003	YES	DEEP	25.4	7.14	2330	633	19	29	1408	2		529066	927651	37	driwel
RV004	YES	DEEP	29.8	7.31	798	413	5.8	19	694	2.4		536579	929650	37	driwel
RV005	YES	hspring	43.7	7.19	2350	1070	5.5	49.1	1841	0.5		543761	928019	37	hotspring
RV006	YES	DEEP	34.7	7.51	1057	533	6.3	24.5	883	2.3		546409	932991	37	driwel
RV007	YES	DEEP	38.4	7.29	593	340	8.1	15.6	501	2.3		547666	987096	37	driwel
RV008	YES	DEEP	26.8	7.14	574	328	6.3	15.1	461	1.6		510194	948427	37	driwel
RV009	YES	DEEP	24.5	7.33	789	480	14.3	22	695	2.4		539073	897657	37	driwel
RV010	YES	spring	21.2	6.77	210	131	5	6	181	0.1		512028	948427	37	spring
RV011	YES	DEEP	28.5	6.61	528	328	10.2	15.1	454	2.3	196	548353	914029	37	driwel
RV012	NO	river		6.33	161	78.1	2.7	3.6	116	0.01		543824	915013	37	river
RV013	YES	DEEP	29	7.43	445	266	7.9	12.2	375	2.1	252	524748	948858	37	driwel
RV014	YES	DEEP	35	8.03	715	414	<5	19	616	0.8	150	545493	952770	37	driwel
RV015	YES	spring	15.6	6.34	130	49.8	2.1	2.3	82	1		521668	887457	37	spring
RV016	YES	DEEP	33.2	7.66	623	358	4.3	16.4	539	1.2	180	547000	957785	37	driwel
RV017	YES	DEEP	30.8	7.13	423	254	7.8	11.7	361	2.1	230	591710	938842	37	driwel
RV018	NO	lake		9.71	6890	1820	0.6	83.5	5360	0.9		599361	984170	37	lake
RV019	YES	SHALL	25.6	6.94	2160	570	24.1	26.2	1472	2.3	48	601289	978055	37	driwel
RV020	YES	DEEP	39.1	8.29	1344	570	1.1	26.2	1061	2.3		590567	970901	37	driwel
RV021	YES	DEEP	38.8	8.55	1776	740	0.9	34	1436	0.8	60	591946	994228	37	driwel
RV022	YES	SHALL	24.6	6.68	238	167	3.8	7.7	235	0.1	42	501361	889716	37	driwel
RV023	YES	SHALL	24.5	6.88	401	256	3	11.7	364	1.8	24	497330	894604	37	dugwell
RV024	NO	lake	21.3	7.37	445	242	4.3	11.1	372	0.4		470191	875886	37	lake
RV025	YES	SHALL	23.9	7.17	887	550	14.3	25.2	773	<5	52	468940	876758	37	driwel
RV026	YES	SHALL	23.4	8.01	1966	938	2.6	43	1693	0.7	40	465898	875449	37	driwel
RV027	YES	DEEP	27	7.99	855	542	1.4	24.9	770	1.6	75	467625	868283	37	driwel
RV028	YES	DEEP	28.3	7.44	982	548	3.4	25.1	842	1.3	66	467625	868283	37	driwel
RV029	YES	DEEP	28.1	7.18	590	360	7.4	16.5	520	0.01	120	508139	943197	37	driwel
RV030	YES	DEEP	42.3	7.54	785	430	1.7	19.7	667	1.8	170	537666	948332	37	driwel
RV031	YES	DEEP	32.7	7.05	649	234	7.6	10.7	408	0.2	85	628749	1009023	37	driwel
RV032	YES	DEEP	35.5	6.73	900	264	8	12.1	535	1	120	652661	996277	37	driwel
RV033	YES	DEEP	31	6.56	1240	420	30.1	19.3	1017	0.3	155	684364	1012017	37	driwel
RV034	YES	DEEP	37.9	7.65	2020	460	4.9	21.1	1377	2.4	75	681507	1126315	37	driwel
RV035	YES	hspring	41.6	7.73	1245	402	1.2	18.4	914	1.5		668802	1102681	37	hotspring
RV036	YES	SHALL	32.2	7.75	1184	496	3.4	22.8	940	0.7		625914	1021282	37	driwel
RV037	YES	SHALL	28.3	7.36	2200	830	6.2	38.1	1770	2.3	50	629562	1031743	37	driwel
RV038	YES	DEEP	30	6.65	656	348	8.7	16	561	0.6		632129	999535	37	driwel
RV039	YES	SHALL	22.4	7.21	810	406	9	18.6	623	2	54	480506	900695	37	driwel
RV040	YES	DEEP	21.5	7.83	1031	562	2.1	25.8	896	0.01	120	487677	910094	37	driwel
RV041	YES	SHALL	22.5	7.41	739	352	6.6	16.2	526	0.9	25	461691	853141	37	dugwell
RV042	YES	DEEP	34.4	7.53	555	334	3	15.3	484	1.5	156	429235	839493	37	driwel
RV043	NO	lake	22.3	9.09	1616	624	1.6	28.6	1322	1.5		465158	834405	37	lake
RV044	NO	lake	25.4	10.21	23300	3710	0.3	170	18668	0.5		459018	832361	37	lake
RV045	NO	lake	27.1	10.01	23300	3820	0.7	175	19137	0.7		458996	827870	37	lake
RV046	YES	DEEP	21.7	7.28	243	137	3.5	6.3	227	1.7	160	462932	812596	37	driwel
RV047	YES	DEEP	38.5	7.30	801	442	5	20.3	692	0.3	330	415332	805058	37	driwel
RV048	YES	DEEP	33	7.26	689	394	4.2	18.1	568	0.5	222	402131	789356	37	driwel
RV049	YES	DEEP	29.4	7.82	700	418	2.1	19.2	621	0.5	330	412570	797389	37	driwel
RV050	YES	river	20.8	7.49	189	97.2	2.1	4.5	139	0.01		459039	783801	37	river
RV051	YES	hspring	67.3	7.09	976	562	2.6	25.8	830	0.2		460039	782480	37	hotspring
RV052	NO	lake	23.9	8.79	798	468	2.9	21.5	715	0.01		441176	779766	37	lake
RV053	YES	hspring	58.4	6.07	1002	511	3.2	23.4	826	1.5		447194	772959	37	hotspring
RV054	YES	DEEP	22.5	6.74	344	219	5.5	10	300	0.1	120	418060	739548	37	driwel
RV055	YES	hspring	37.6	6.60	354	208	2	9.5	304	1.1		431073	744534	37	hotspring
RV056	YES	river	16.9	6.21	64	18	0.8	0.8	37	1.2		440489	745477	37	river
RV057	YES	DEEP	20.3	6.11	216	135	2.6	6.2	185	2	152	434790	729451	37	driwel
RV058	YES	DEEP	35	7.19	755	412	2.4	18.9	589	0.5	270	448486	885025	37	driwel
RV059	YES	DEEP	40	7.43	1017	341	1.6	15.6	761	0.5	327	442067	875204	37	driwel
RV060	YES	DEEP	26	7.07	416	262	6.7	12	364	0.4	60	428525	849156	37	driwel

*ID	*DW	*TYPE	T(oC)	pH_F	EC_L	Alk_L	ToHa	CaHa	Solids	IBD_%	DEPTH	XCOO	YCOO	UTM	*TYPE2
RV061	YES	DEEP	22.2	6.33	377	242	8.6	11.1	337	1.5	154	432753	897355	37	driwel
RV062	YES	SHALL	25.00	6.47	509	323	6.4	14.8	453	0.2	27	397074	839483	37	driwel
RV063	YES	DEEP	31.3	6.9	543	339	6.2	15.6	474	0.3	144	399219	807770	37	driwel
RV064	YES	DEEP	37.4	6.33	224	188	4.4	8.6	260	0.6	240	377943	796749	37	driwel
RV065	YES	DEEP	24.1	6.66	626	377	12.5	17.3	560	1.5	204	383913	788645	37	driwel
RV066	YES	DEEP	28.3	6.44	407	257	4.5	11.8	360	0.9	178	391032	784778	37	driwel
RV067	YES	hspring	36.7	6.97	968	547	2.7	25.1	840	0.8		403839	766554	37	hotspring
RV068	YES	spring	32	6.21	203	117	1.4	5.4	174	1.6		380833	763716	37	spring
RV069	YES	spring	24.4	5.22	199	32	0.9	1.5	139	2.3		365010	738917	37	spring
RV070	NO	lake	25.6	8.66	982	362	2	16.6	734	0.6		364088	712164	37	lake
RV071	YES	DEEP	25.4	7.06	805	473	19.2	21.7	674	0.4		361334	714065	37	driwel
RV072	YES	DEEP	21.8	5.90	156	74.4	1.4	3.4	108	0.01		360301	758660	37	driwel
RV073	YES	DEEP	29.5	5.95	237	128	3.2	5.9	195	0.8	90	373646	769684	37	driwel
RV074	YES	DEEP	20.8	5.88	194	79	1.6	3.6	145	0.6	80	438212	759485	37	driwel
RV075	YES	SHALL	29.1	7.41	945	574	7	26.3	834	1	23	443248	779966	37	dugwell
RV076	YES	river	18.6	6.16	52	14.5	0.6	0.7	34	0.7		425150	709515	37	river
RV077	YES	SHALL	23.9	6.19	277	135	4.7	6.2	180	2.6	50	405883	663266	37	driwel
RV078	YES	DEEP	20.2	6.72	229	165	7.1	7.6	218	0.5	160	411256	671922	37	driwel
RV079	YES	DEEP	26.8	7.53	357	250	9.8	11.5	342	0.3	80	418213	697952	37	driwel
RV080	YES	DEEP	25.9	7.7	369	245	3.1	11.2	342	0.9	60	432754	718053	37	driwel
RV081	YES	SHALL	23.2	6.70	268	162	5.9	7.4	228	0.1	50	414858	622461	37	driwel
RV082	YES	DEEP	22.2	6.69	688	420	14.5	19.3	596	1.3	37	375052	603358	37	driwel
RV083	YES	DEEP	23.7	6.88	782	484	18.5	22.2	639	0.9	30	371434	600319	37	driwel
RV084	YES	DEEP	21.1	6.57	218	137	5.7	6.3	188	0.4	82	419015	638447	37	driwel
RV085	YES	DEEP	25.3	6.53	832	192	18.4	8.8	636	0.2	74	404233	539745	37	driwel
RV086	YES	DEEP	29.2	7.75	720	292	10.4	13.4	570	1.6	160	377150	532245	37	driwel
RV087	YES	DEEP	21.6	7.41	984	432	19.7	19.8	687	0.1		327087	591206	37	driwel
RV088	YES	DEEP			390	213	8.6	9.8	287	0.2	60	301674	605325	37	driwel
RV089	YES	SHALL	27.6	6.57	893	536	22.4	24.6	803	0.4	47	321787	559652	37	driwel
RV090	YES	DEEP	22.4	6.99	678	303	16.3	13.9	523	0.5	62	424185	448901	37	driwel
RV091	YES	SHALL	21.9	6.56	1358	309	23.4	14.2	921	0.7	10	453381	411949	37	dugwell
RV092	YES	DEEP	24.7	6.80	1037	268	28.3	12.3	854	1.2	110	453381	411947	37	driwel
RV093	YES	DEEP	45.2	6.35	235	180	8.4	8.3	312	0.9	75	419149	596775	37	driwel
RV094	YES	spring	17.2	6.89	103	50.6	1.8	2.3	72	2.2		339748	693926	37	spring
RV095	NO	lake	31.8	8.94	1520	730	3.8	33.5	1333	1.8		337731	655908	37	lake
RV096	YES	spring	25.5	6.76	287	197	7.7	9	268	0.8		340158	664524	37	spring
RV097	YES	DEEP	31.3	7.10	594	368	10	16.9	530	0.4	70	363284	695757	37	driwel
RV098	YES	DEEP	32.5	7.74	899	373	13.1	17.1	727	1.5	75	692085	1261992	37	driwel
RV099	YES	DEEP	45.6	7.6	1713	189	7.9	8.7	1121	1.8	74	716151	1297035	37	driwel
RV100	YES	DEEP	26.6	7.83	1500	369	4	16.9	1128	1.4	60	725914	1298306	37	driwel
RV101	YES	SHALL	29.3	7.33	243	96	4.6	4.4	188	0.1	10	818622	1333826	37	driwel
RV102	YES	DEEP	32	8.04	1492	482	1.4	22.1	1166	1.1	80	765605	1280163	37	driwel
RV103	YES	SHALL	30	7.17	3300	652	36.8	29.9	2008	0.5	10	785012	1272759	37	driwel
RV104	YES	DEEP	35.2	6.85	967	410	18	18.8	789	2.4	220	611389	1283603	37	driwel
RV105	YES	DEEP	26.2	6.99	729	418	16.4	19.2	638	1.7		609255	1237172	37	driwel
RV106	YES	DEEP	31.9	7.3	1122	440	7.3	20.2	937	2.3	110	652761	1242484	37	driwel
RV107	YES	SHALL	32.4	7.98	936	56.6	1.8	2.6	583	2.1	15	631749	1207481	37	driwel
RV108	YES	SHALL	32.7	7.58	536	301	10.9	13.8	459	0.6	40	644133	1174993	37	driwel
RV109	YES	SHALL	38.2	7.57	635	260	3.9	11.9	509	1.8		640090	1100524	37	driwel
RV110	YES	DEEP	25.7	6.96	564	297	11	13.6	481	1.6	70	598907	1105171	37	driwel
RV111	YES	DEEP	31	6.95	567	345	11.5	15.8	514	0.6	88	608285	1139312	37	driwel
RV112	YES	DEEP	24.6	6.17	379	177	9.2	8.1	309	0.2	64	602233	1166780	37	driwel
RV113	YES	DEEP	24.9	6.95	593	371	14.6	17	538	1.1	75	594264	1185237	37	driwel
RV114	YES	SHALL	20.6	6.9	373	195	9.4	8.9	299	0.8	12	602317	1188399	37	dugwell
RV115	YES	DEEP	26.3	7.38	739	405	12.5	18.6	648	1	78	585336	1206710	37	driwel
RV116	YES	DEEP	22.3	7.26	676	458	18.2	21	621	0.3	60	579349	1228209	37	driwel
RV117	YES	DEEP	25.2	7.25	468	247	11.5	11.3	407	0.2	117	606061	1342479	37	driwel
RV118	YES	DEEP	35.2	7.54	2020	350	9.7	16.1	1431	2	135	596269	1366506	37	driwel
RV119	YES	DEEP	30.5	7.41	1210	396	25.2	18.2	992	0.8	120	607550	1319081	37	driwel
RV120	YES	DEEP	29.0	6.72	1615	412	32.3	18.9	1195	1.5	88	604051	1108163	37	driwel
RV121	YES	DEEP	37.4	6.91	718	341	12.7	15.6	660	0.5	70	606064	1119941	37	driwel
RV122	YES	DEEP	24.2	6.91	587	375	13.2	17.2	530	0.3	62	605401	1142685	37	driwel
RV123	YES	spring	20.8	5.99	333	146	7.6	6.7	270	0.2		607967	1158790	37	spring

*ID	*DW	*TYPE	T(oC)	pH_F	EC_L	Alk_L	ToHa	CaHa	Solids	IBD_%	DEPTH	XCOO	YCOO	UTM	*TYPE2
RV124	YES	hspring	43.8	7.08	3850	99.4	38.1	4.6	2401	0.1		703029	1461394	37	hotspring
RV125	YES	DEEP	31.2	7.48	642	318	9.2	14.6	540	0.3	66	641149	1068652	37	driwel
RV126	YES	SHALL	35.6	7.63	1725	212	11.1	9.7	1145	1.4	9	789766	1095786	37	dugwell
RV127	YES	SHALL	29.2	7.38	1415	128	37.5	5.9	1230	0.2	12	760021	1090277	37	dugwell
RV128	YES	SHALL	34	7.82	2280	241	23.3	11.1	1710	0.1	28	835583	1112875	37	driwel
RV129	YES	SHALL	31.6	8.29	640	88.5	16.2	4.1	467	1.8	10	826142	1097993	37	dugwell
RV130	YES	DEEP	29.2	6.73	980	401	23	18.4	737	0.1	47	805910	1063919	37	driwel
RV131	YES	DEEP	28.5	6.78	1467	370	39.2	17	1113	1.2	72	802245	1056649	37	driwel
RV132	YES	SHALL	25.9	6.84	1279	345	26.7	15.8	907	0.5	34	819069	1056173	37	driwel
RV133	YES	SHALL	24	7.00	1236	324	24.1	14.9	833	0.6	42	833575	1058993	37	driwel
RV134	YES	SHALL	26.3	7.08	1327	495	28.9	22.7	1124	0.9	16	825126	1062047	37	driwel
RV135	YES	Infi	27.5	7.32	920	298	18.5	13.7	742	0.5	7	742517	1055178	37	Infi
RV136	YES	SHALL	25.5	7.76	1041	266	22.2	12.2	814	1.8	5	763135	1057161	37	dugwell
RV137	YES	SHALL	30.8	6.94	1969	460	51.6	21.1	1521	1.8	42	789694	1062821	37	driwel
RV138	YES	DEEP	29.3	6.93	856	389	21.5	17.8	683	0.8	95	805134	1063193	37	driwel
RV139	YES	DEEP	28.9	7.34	471	319	10	14.6	478	0.3	95	693054	1021155	37	driwel
RV140	YES	SHALL	22.3	6.99	803	436	22.1	20	702	0.8	15	705009	1003596	37	driwel
RV141	YES	DEEP	20	7.35	765	466	10.8	21.4	695	0.3	108	701702	1027594	37	driwel
RV142	YES	DEEP	30	6.71	789	400	16.3	18.4	660	1	96	718843	1046507	37	driwel
RV143	YES	DEEP	28.7	8.33	2220	920	0.7	42.2	1821	2.3	180	584985	981981	37	driwel
RV144	YES	SHALL	35.5	7.47	668	400	6	18.4	600	0.6	47	527960	942063	37	driwel
RV145	YES	DEEP	36.9	7.31	469	318	5.9	14.6	459	2	240	531170	949131	37	driwel
RV146	YES	DEEP	31.4	7.13	438	293	6.9	13.4	415	0.4	180	523615	944408	37	driwel
RV147	YES	DEEP	32.6	7.80	725	433	4.9	19.9	643	1.7	130	506550	937279	37	driwel
RV148	YES	DEEP	26.6	7.27	353	204	0.4	9.4	309	0.4	150	493998	906885	37	driwel

Table 14: Correlation coefficients calculated for deep and shallow (SHAL) wells.
The data were ln-transformed (exc. pH) prior to calculation.
Elements with >10% of results <DL not included.

	Al	As	B	Ba	Br	Ca	Cd	Ce	Cl	Co	Cr	Cu	F	Fe	Ga	Ge	I	K	La	Li	Mg
As	-0.11	DEEP																			
As	0.03	SHAL																			
B	-0.03	0.72	DEEP																		
B	0.09	0.67	SHAL																		
Ba	0.19	-0.25	-0.04	DEEP																	
Ba	0.38	-0.27	-0.11	SHAL																	
Br	0.12	0.35	0.72	0.32	DEEP																
Br	0.03	0.39	0.77	0.16	SHAL																
Ca	0.1	-0.45	-0.14	0.69	0.25	DEEP															
Ca	0.06	-0.42	0.02	0.48	0.43	SHAL															
Cd	0.14	0.18	0.18	-0.11	0.08	-0.12	DEEP														
Cd	0.15	0.4	0.21	-0.17	0.07	-0.41	SHAL														
Ce	0.83	-0.11	-0.12	0.13	0.03	0.06	0.19	DEEP													
Ce	0.9	-0.04	-0.07	0.32	-0.06	0.09	0.04	SHAL													
Cl	0.15	0.36	0.71	0.3	0.97	0.22	0.08	0.06	DEEP												
Cl	0.09	0.38	0.77	0.17	0.98	0.42	0.07	0.02	SHAL												
Co	0.6	-0.22	-0.01	0.5	0.3	0.53	0.19	0.58	0.26	DEEP											
Co	0.67	0.03	0.09	0.51	0.35	0.37	0.2	0.67	0.36	SHAL											
Cr	0.47	0.19	0.26	-0.1	0.16	-0.09	0.09	0.38	0.2	0.1	DEEP										
Cr	0.45	0.07	0.19	0.18	0.19	0.13	-0.08	0.5	0.25	0.18	SHAL										
Cu	0.35	-0.03	-0.06	0.05	0.1	0.11	0.1	0.26	0.12	0.22	0.46	DEEP									
Cu	0.24	0.12	0.14	0.37	0.13	0.14	0.08	0.35	0.2	0.32	-0.01	SHAL									
F	-0.05	0.77	0.53	-0.35	0.11	-0.56	0.14	-0.09	0.11	-0.34	0.12	-0.05	DEEP								
F	0	0.79	0.52	-0.36	0.15	-0.5	0.32	-0.07	0.14	-0.23	0.16	-0.07	SHAL								
Fe	0.64	-0.25	-0.12	0.41	0.17	0.3	0.06	0.69	0.18	0.68	0.21	0.2	-0.28	DEEP							
Fe	0.67	-0.04	-0.09	0.51	0.08	0.01	0.13	0.63	0.09	0.67	0.34	0.15	-0.21	SHAL							
Ga	0.85	0.03	0.01	0.15	0.13	-0.08	0.17	0.78	0.15	0.58	0.28	0.17	0.04	0.66	DEEP						
Ga	0.8	0.19	0.15	0.31	0.07	-0.18	0.29	0.74	0.12	0.56	0.39	0.24	0.13	0.72	SHAL						
Ge	0.04	0.68	0.49	-0.3	0.05	-0.48	0.09	-0.03	0.07	-0.3	0.27	-0.02	0.78	-0.23	0.09	DEEP					
Ge	-0.01	0.59	0.4	-0.52	0.01	-0.62	0.39	-0.08	0	-0.34	0.11	-0.05	0.75	-0.16	0.16	SHAL					
I	-0.09	0.61	0.65	0.1	0.63	0.04	0.19	-0.12	0.6	0.18	0.05	-0.02	0.35	-0.09	0.05	0.21	DEEP				
I	0.26	0.68	0.66	0.1	0.68	0.02	0.41	0.13	0.63	0.49	0.08	0.19	0.37	0.18	0.25	0.27	SHAL				
K	-0.01	0.57	0.38	-0.27	0.06	-0.35	0.07	-0.02	0.06	-0.29	0.22	0.08	0.64	-0.31	0.01	0.72	0.26	DEEP			
K	0.12	0.56	0.24	-0.13	-0.07	-0.45	0.24	0.09	-0.1	-0.09	0.1	-0.01	0.78	-0.15	0.12	0.67	0.33	SHAL			
La	0.87	-0.13	-0.13	0.17	0.05	0.09	0.21	0.97	0.07	0.58	0.4	0.31	-0.09	0.68	0.78	-0.03	-0.15	-0.02	DEEP		
La	0.85	-0.09	-0.17	0.37	-0.12	0.1	-0.02	0.96	-0.04	0.61	0.54	0.33	-0.1	0.6	0.69	-0.12	0.02	0.08	SHAL		
Li	0.03	0.65	0.51	-0.19	0.16	-0.31	0.12	0	0.16	-0.26	0.22	0.04	0.79	-0.21	0.02	0.83	0.21	0.69	0.02	DEEP	
Li	0	0.47	0.46	-0.17	0.17	-0.23	0.12	-0.09	0.16	-0.26	0.08	-0.01	0.77	-0.16	0.06	0.69	0.21	0.7	-0.12	SHAL	
Mg	0.14	-0.41	-0.04	0.61	0.35	0.86	-0.06	0.05	0.33	0.5	-0.04	0.12	-0.63	0.32	-0.02	-0.57	0.12	-0.43	0.07	-0.45	DEEP
Mg	0.18	-0.25	0.15	0.35	0.49	0.82	-0.31	0.23	0.49	0.45	0.2	0.03	-0.27	0.04	-0.19	-0.48	0.24	-0.2	0.21	-0.09	SHAL
Mo	-0.11	0.8	0.72	-0.24	0.36	-0.37	0.19	-0.11	0.32	-0.18	0.16	-0.09	0.81	-0.2	0.04	0.65	0.61	0.6	-0.13	0.62	-0.38
Mo	-0.02	0.64	0.7	-0.16	0.32	-0.3	0.35	-0.13	0.32	-0.11	0.09	-0.01	0.7	-0.25	0.06	0.55	0.49	0.61	-0.2	0.61	-0.12

	Al	As	B	Ba	Br	Ca	Cd	Ce	Cl	Co	Cr	Cu	F	Fe	Ga	Ge	I	K	La	Li	Mg
Na	0.08	0.81	0.85	-0.09	0.63	-0.33	0.18	-0.03	0.63	-0.05	0.24	-0.03	0.73	-0.07	0.17	0.64	0.66	0.48	-0.03	0.61	-0.25
Na	0.08	0.68	0.87	-0.08	0.76	-0.01	0.19	-0.03	0.76	0.09	0.2	0.12	0.66	-0.09	0.15	0.51	0.7	0.43	-0.11	0.61	0.2
Nb	0.63	0.23	0.1	-0.05	0.1	-0.2	0.21	0.71	0.14	0.38	0.26	0.17	0.33	0.41	0.71	0.22	0.14	0.24	0.71	0.25	-0.23
Nb	0.78	0.41	0.18	0.05	-0.04	-0.23	0.31	0.76	0	0.52	0.33	0.15	0.45	0.47	0.75	0.33	0.35	0.47	0.72	0.33	-0.02
Nd	0.86	-0.15	-0.14	0.17	0.05	0.11	0.19	0.97	0.07	0.6	0.39	0.32	-0.11	0.69	0.78	-0.05	-0.16	-0.05	0.99	0.01	0.09
Nd	0.92	-0.03	-0.07	0.4	-0.08	0.07	0.05	0.98	0	0.66	0.51	0.37	-0.05	0.66	0.76	-0.08	0.13	0.12	0.97	-0.05	0.19
Ni	0.5	-0.36	-0.04	0.62	0.38	0.77	0.13	0.45	0.35	0.81	0.15	0.31	-0.48	0.62	0.37	-0.36	0.07	-0.28	0.47	-0.27	0.7
Ni	0.53	-0.28	0.01	0.55	0.32	0.75	-0.12	0.58	0.35	0.75	0.32	0.38	-0.43	0.41	0.3	-0.5	0.12	-0.34	0.61	-0.3	0.66
NO3	-0.04	-0.1	0.1	0.05	0.35	0.28	-0.06	-0.01	0.33	0.07	0.26	0.16	-0.25	-0.07	-0.15	-0.19	0.08	-0.01	-0.01	-0.15	0.27
NO3	-0.18	-0.13	0.22	-0.03	0.37	0.46	-0.2	-0.09	0.44	-0.02	0.24	0.11	-0.18	-0.23	-0.32	-0.28	-0.09	-0.4	-0.07	-0.04	0.36
Pb	0.37	0.08	0.09	-0.03	0.03	0	0.5	0.3	0.08	0.14	0.48	0.52	0.09	0.16	0.17	0.21	-0.01	0.13	0.35	0.16	0.01
Pb	0.02	0	-0.36	-0.04	-0.23	-0.23	0.41	0.09	-0.22	0.18	-0.21	0.18	-0.22	0.18	0.08	0.01	-0.07	-0.11	0.18	-0.34	-0.31
Rb	0.1	0.38	0.24	-0.34	-0.09	-0.4	0.12	0.07	-0.09	-0.33	0.24	0.03	0.57	-0.28	0.05	0.7	0.03	0.89	0.09	0.66	-0.46
Rb	0.1	0.45	0.03	-0.27	-0.25	-0.58	0.27	0.13	-0.28	-0.14	0.18	-0.09	0.67	-0.07	0.13	0.72	0.21	0.9	0.15	0.53	-0.33
Sb	0.11	0.69	0.45	-0.2	0.16	-0.38	0.33	0.18	0.19	-0.02	0.29	0.19	0.66	-0.05	0.18	0.48	0.34	0.45	0.19	0.54	-0.43
Sb	0.16	0.78	0.39	-0.27	-0.01	-0.47	0.27	0.12	-0.01	-0.03	0.02	0.22	0.69	-0.08	0.16	0.54	0.35	0.62	0.15	0.45	-0.33
Se	-0.08	0.17	0.44	0.32	0.71	0.25	0.11	-0.11	0.69	0.12	0.11	0.2	-0.04	0.01	-0.11	-0.15	0.4	-0.06	-0.08	-0.01	0.33
Se	-0.09	0.16	0.4	0.04	0.58	0.18	0.13	-0.05	0.62	0.07	0.27	0.25	0.05	0.1	0.02	0.05	0.27	-0.16	-0.11	0.21	0.17
Si	-0.04	0.34	0.08	-0.32	-0.28	-0.33	0.08	0	-0.28	-0.35	0.19	0.05	0.52	-0.31	-0.1	0.65	-0.07	0.75	0.04	0.63	-0.55
Si	0.08	0.39	-0.04	-0.28	-0.16	-0.33	0.12	0.15	-0.18	-0.01	0.08	0.05	0.47	-0.13	-0.11	0.5	0.26	0.67	0.2	0.3	-0.03
SO4	0.15	0.33	0.71	0.31	0.86	0.26	0.15	0.11	0.86	0.31	0.26	0.05	0.11	0.26	0.14	0.09	0.52	0.01	0.09	0.18	0.36
SO4	-0.02	0.17	0.72	0	0.65	0.35	-0.02	-0.13	0.7	0.01	0.11	0.11	0.02	-0.19	-0.08	-0.05	0.27	-0.24	-0.21	0.1	0.3
Sr	0.16	-0.28	0.15	0.71	0.52	0.83	-0.01	0.03	0.49	0.55	-0.03	0	-0.5	0.32	0.02	-0.4	0.25	-0.32	0.05	-0.33	0.9
Sr	0.06	-0.2	0.3	0.48	0.49	0.78	-0.22	-0.02	0.5	0.36	0.19	0.11	-0.32	-0.01	-0.15	-0.45	0.23	-0.31	-0.03	-0.17	0.73
Ti	0.76	0.07	0.28	0.24	0.35	0.08	0.21	0.63	0.36	0.56	0.41	0.2	0.09	0.55	0.67	0.08	0.08	-0.07	0.62	0.13	0.11
Ti	0.84	0.1	0.33	0.24	0.27	0.17	0.14	0.74	0.32	0.59	0.49	0.18	0	0.59	0.71	-0.01	0.32	-0.07	0.65	-0.04	0.27
U	-0.06	0.54	0.47	-0.05	0.33	0.02	0.04	-0.06	0.3	-0.03	0.17	0.14	0.51	-0.23	-0.06	0.37	0.56	0.5	-0.07	0.41	-0.08
U	-0.14	0.36	0.38	0.01	0.31	0.24	-0.3	-0.07	0.32	-0.06	0.08	0.14	0.47	-0.31	-0.29	0.07	0.21	0.35	-0.09	0.54	0.38
V	0.04	0.55	0.59	-0.07	0.34	-0.12	0.09	-0.04	0.34	-0.01	0.38	0.05	0.29	-0.17	0.03	0.24	0.49	0.26	-0.06	0.11	0
V	-0.2	0.48	0.47	-0.28	0.25	-0.04	0.06	-0.18	0.26	-0.16	0.06	0.04	0.31	-0.49	-0.36	0.19	0.28	0.2	-0.18	0.04	0.09
Y	0.7	-0.07	-0.1	0.1	0.02	0.08	0.19	0.81	0.04	0.45	0.32	0.27	0.05	0.48	0.61	0.04	-0.11	0.06	0.85	0.16	-0.02
Y	0.87	0.06	-0.04	0.35	-0.08	0.09	0.04	0.89	-0.01	0.62	0.45	0.34	0.09	0.55	0.62	-0.06	0.19	0.21	0.9	0.04	0.26
Zn	0.3	-0.2	-0.1	0.1	-0.03	0.2	0.52	0.28	-0.02	0.28	0.29	0.25	-0.19	0.21	0.14	-0.07	-0.07	-0.09	0.3	-0.05	0.18
Zn	-0.11	-0.07	-0.37	-0.05	-0.17	-0.12	0.42	-0.05	-0.21	0.06	-0.2	-0.06	-0.13	0.17	-0.04	0	-0.06	-0.16	-0.06	-0.15	-0.08
Zr	0.74	0.04	-0.07	0	0	-0.11	0.18	0.86	0.01	0.42	0.34	0.22	0.18	0.55	0.74	0.15	-0.08	0.18	0.86	0.2	-0.13
Zr	0.79	0.24	0.08	0.14	-0.15	-0.3	0.25	0.8	-0.09	0.4	0.48	0.11	0.36	0.54	0.75	0.32	0.17	0.44	0.78	0.29	-0.05
Alk_L	0.01	0.49	0.61	0.16	0.45	0.04	0.08	-0.14	0.44	0.11	0.03	-0.1	0.44	0	0.08	0.31	0.59	0.23	-0.14	0.24	0.12
Alk_L	0.07	0.39	0.32	-0.01	0.38	0.11	-0.07	0.16	0.37	0.17	0.16	0.14	0.46	-0.15	-0.11	0.17	0.43	0.49	0.17	0.37	0.47
pH_F	0	0.6	0.58	-0.2	0.24	-0.38	0.12	-0.12	0.27	-0.08	0.15	-0.1	0.51	-0.06	0.15	0.38	0.46	0.21	-0.18	0.25	-0.17
pH_F	-0.1	0.38	0.7	-0.28	0.3	-0.21	0.19	-0.25	0.31	-0.21	0.04	-0.07	0.33	-0.22	-0.01	0.35	0.22	0.17	-0.31	0.29	-0.19
EC_L	0.1	0.48	0.72	0.29	0.77	0.12	0.12	-0.04	0.75	0.23	0.09	-0.01	0.3	0.13	0.19	0.22	0.68	0.18	-0.03	0.24	0.24
EC_L	0.05	0.41	0.79	0.13	0.93	0.42	-0.01	0	0.92	0.28	0.28	0.14	0.29	-0.02	0.04	0.08	0.64	0.09	-0.07	0.29	0.57
	Al	As	B	Ba	Br	Ca	Cd	Ce	Cl	Co	Cr	Cu	F	Fe	Ga	Ge	I	K	La	Li	Mg

	Mo	Na	Nb	Nd	Ni	NO3	Pb	Rb	Sb	Se	Si	SO4	Sr	Ti	U	V	Y	Zn	Zr	Alk_L	pH_F	
As																						
As																						
B																						
B																						
Ba																						
Ba																						
Br																						
Br																						
Ca																						
Ca																						
Cd																						
Cd																						
Ce																						
Ce																						
Cl																						
Cl																						
Co																						
Co																						
Cr																						
Cr																						
Cu																						
Cu																						
F																						
F																						
Fe																						
Fe																						
Ga																						
Ga																						
Ge																						
Ge																						
I																						
I																						
K																						
K																						
La																						
La																						
Li																						
Li																						
Mg																						
Mg																						
Mo	DEEP																					
Mo	SHAL																					

	Mo	Na	Nb	Nd	Ni	NO3	Pb	Rb	Sb	Se	Si	SO4	Sr	Ti	U	V	Y	Zn	Zr	Alk_L	pH_F	
Na	0.81	DEEP																				
Na	0.68	SHAL																				
Nb	0.21	0.3	DEEP																			
Nb	0.25	0.25	SHAL																			
Nd	-0.14	-0.04	0.7	DEEP																		
Nd	-0.11	-0.03	0.77	SHAL																		
Ni	-0.27	-0.14	0.17	0.5	DEEP																	
Ni	-0.28	-0.05	0.27	0.58	SHAL																	
NO3	-0.11	-0.06	-0.11	0	0.25	DEEP																
NO3	0	0.09	-0.34	-0.1	0.32	SHAL																
Pb	0.01	0.1	0.19	0.32	0.22	0.1	DEEP															
Pb	-0.43	-0.34	0.06	0.1	0.1	-0.16	SHAL															
Rb	0.43	0.35	0.25	0.05	-0.29	-0.06	0.19	DEEP														
Rb	0.47	0.26	0.46	0.15	-0.41	-0.5	0.01	SHAL														
Sb	0.57	0.55	0.51	0.16	-0.16	-0.09	0.28	0.36	DEEP													
Sb	0.42	0.36	0.52	0.17	-0.2	-0.15	0.17	0.51	SHAL													
Se	0.16	0.33	-0.13	-0.08	0.26	0.42	0.08	-0.23	-0.05	DEEP												
Se	0.11	0.41	-0.19	-0.06	0.06	0.56	-0.11	-0.22	-0.09	SHAL												
Si	0.38	0.2	0.16	0	-0.35	-0.14	0.23	0.79	0.41	-0.32	DEEP											
Si	0.22	0.21	0.34	0.14	-0.18	-0.25	0.15	0.79	0.54	-0.25	SHAL											
SO4	0.4	0.58	0.07	0.1	0.43	0.36	0.07	-0.11	0.16	0.66	-0.29	DEEP										
SO4	0.46	0.52	-0.2	-0.14	0.2	0.58	-0.39	-0.42	-0.08	0.45	-0.42	SHAL										
Sr	-0.24	-0.04	-0.18	0.07	0.72	0.31	0	-0.37	-0.36	0.41	-0.49	0.51	DEEP									
Sr	0.02	0.19	-0.19	-0.02	0.6	0.33	-0.31	-0.45	-0.34	0.18	-0.33	0.47	SHAL									
Ti	0.06	0.32	0.48	0.64	0.48	-0.04	0.24	-0.02	0.19	0.17	-0.21	0.43	0.22	DEEP								
Ti	0.14	0.25	0.61	0.73	0.54	-0.03	-0.18	-0.08	0.04	0.07	-0.17	0.34	0.23	SHAL								
U	0.56	0.48	0.15	-0.09	-0.01	0.27	0.15	0.29	0.53	0.17	0.31	0.31	0.01	-0.03	DEEP							
U	0.36	0.46	0.07	-0.07	0.07	0.44	-0.4	0.12	0.34	0.17	0.28	0.25	0.17	-0.15	SHAL							
V	0.49	0.49	0.08	-0.07	-0.05	0.26	0.14	0.06	0.44	0.25	0.07	0.42	0.11	0.17	0.54	DEEP						
V	0.49	0.37	-0.11	-0.21	-0.09	0.38	-0.11	0.13	0.45	0	0.35	0.47	0.13	-0.04	0.42	SHAL						
Y	-0.02	0.02	0.75	0.86	0.37	-0.03	0.3	0.17	0.26	-0.11	0.17	0.02	-0.05	0.48	0.06	-0.13	DEEP					
Y	-0.03	0.04	0.81	0.93	0.55	-0.14	0.04	0.22	0.28	-0.19	0.31	-0.19	0.01	0.65	0.1	-0.13	SHAL					
Zn	-0.19	-0.13	0.06	0.29	0.37	0.11	0.72	-0.01	0.04	0.05	0.02	0.03	0.17	0.24	-0.04	0.01	0.21	DEEP				
Zn	-0.37	-0.28	-0.07	-0.09	-0.05	-0.18	0.57	-0.06	-0.09	0.13	-0.02	-0.44	-0.15	-0.17	-0.31	-0.28	-0.16	SHAL				
Zr	0.08	0.11	0.84	0.85	0.26	-0.03	0.26	0.27	0.31	-0.17	0.16	0.05	-0.13	0.52	0.06	-0.04	0.79	0.17	DEEP			
Zr	0.19	0.16	0.9	0.81	0.19	-0.35	0.03	0.48	0.36	-0.19	0.33	-0.25	-0.23	0.58	-0.03	-0.16	0.79	-0.06	SHAL			
Alk_L	0.51	0.64	0.14	-0.16	0.07	0	0.08	0.1	0.3	0.19	-0.03	0.39	0.28	0.18	0.47	0.41	-0.1	-0.13	-0.05	DEEP		
Alk_L	0.24	0.55	0.29	0.14	0.14	0.07	-0.08	0.36	0.34	0.02	0.61	-0.01	0.09	-0.07	0.68	0.3	0.3	-0.17	0.25	SHAL		
pH_F	0.56	0.64	0.14	-0.18	-0.24	-0.15	0	0.11	0.37	0.08	-0.04	0.29	-0.08	0.24	0.22	0.49	-0.21	-0.15	-0.02	0.64	DEEP	
pH_F	0.53	0.42	-0.04	-0.23	-0.21	0.14	-0.16	-0.01	0.33	0.23	-0.26	0.6	0.14	0.15	0.06	0.38	-0.3	-0.32	-0.09	-0.11	SHAL	
EC_L	0.51	0.75	0.15	-0.04	0.25	0.12	0.03	0.02	0.24	0.51	-0.17	0.68	0.42	0.35	0.35	0.37	-0.03	-0.09	-0.01	0.8	0.57	DEEP
EC_L	0.43	0.85	0.06	-0.02	0.31	0.31	-0.36	-0.11	0.03	0.46	-0.04	0.65	0.54	0.31	0.45	0.31	0.02	-0.3	-0.03	0.55	0.32	SHAL
	Mo	Na	Nb	Nd	Ni	NO3	Pb	Rb	Sb	Se	Si	SO4	Sr	Ti	U	V	Y	Zn	Zr	Alk_L	pH_F	