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National report Kola project
Catchment study 1994

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REPORT

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Summary:

During the period 1994-1996, the Geological Survey og Norway (NGU) and Finland (GTK) and the Central Kola Expedition (CKE) are carrying out a joint project on eco-geochemical mapping and monitoring within an area extending from longitudes 24° to 35°30' and southwards to the Arctic Circle in Finland and to the boundary between the Murmansk and Karelia regions in Russia.

As a part of this project, a detailed study of eights catchment areas (three in Finland, one in Norway and four in Russia) was carried out during 1994. The following sample media were taken for this catchment study: snowpack, rainwater, stream water, groundwater, organic stream sediment, moss, topsoil, podzol profiles, Quaternary deposits, and bedrocks

This report presents description of the Norwegian catchment (No 5 - Skjellbekken) and summarizes all analytical results obtained

Keywords:	Geochemistry	Podzol
Snow	Moss	Streamwater
Topsoil	Groundwater	Catchment study

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Introduction

The Geological Surveys of Finland (GTK) and Norway (NGU) and the Central Kola Expedition (CKE) are collaborating on a major regional geochemical mapping project in a 188,000 km2 area north of the Arctic Circle. The aims are:

1. To characterise qualitatively and quantitatively the regional patterns of distribution in terrestrial environments of about 30 elements, including the top-priority pollutants (Al, As, Cd, Cr, Cu, F, Hg, Ni, Pb, Sb and Zn) as defined by environmental authorities in Norway, and a radionuclide (Cs-137):
   a) in media reflecting mostly atmospheric deposition (moss, humus, topsoil), and
   b) in media reflecting mostly natural background (B- and C-horizons in soils).

2. To present easy-to-read maps illustrating these regional patterns.

3. To interpret these maps, giving special attention to:
   a) estimating the degree of anthropogenic pollution versus natural background by comparing patterns of distribution in different media (e.g., moss vs. C-horizon, etc.), and
   b) assessing the dynamics of toxic elements in the ecosystem (mobility, storage, etc.)

4. To provide a podzol inventory of the area studied, and to establish at the Geological Survey of Norway a podzol sample bank for all horizons from a heavily polluted area in Russia as a basis for further investigations in the future.

5. To study processes of weathering and deteriorating soil quality in selected soil profiles, as a basis for estimating future developments in the region.

6. To analyse the content of various radionuclides at selected hot-spots.

7. To identify areas of potential environmental hazard (high concentrations of heavy metals and increased erodability due to vegetation dieback), on the basis of data obtained in this project in conjunction with satellite imagery.
   a) A time-series of satellite images will be used to assess the development of damaged land around Monchegorsk.
   b) The applicability of satellite imagery as an independent environmental monitoring tool will be tested, based on actual results from the project.

8. To link the data obtained with:
   a) the international programme «*Monitoring of atmospheric heavy metal deposition in Europe using bryophytes and humus samples as indicators*» in order to compare environmental pollution in this region with other, selected regions in Europe, and
   b) existing monitoring programmes in the same area, e.g. as part of the «*Arctic monitoring and assessment programme*» (AMAP).

9. To collect all relevant literature on the area and make it accessible in a literature database containing English abstracts of the articles written in Russian, Finnish and Norwegian.

Before starting the regional sampling and mapping in 1995, a detailed study of eight catchments in the survey area (four in Russia, three in Finland and one in Norway) was carried out in 1994. The objectives of the catchment study were:

1. to decide on the final field methods for the regional mapping in 1995 and train all sampling teams accordingly,

2. to study the local versus the regional variability of all media considered for regional mapping,

3. to study seasonal effects for some media,

4. to identify inter-relationships between the different media, and

5. to find methods of distinguishing better between the geogenic and anthropogenic origins of the element levels measured.

This national report documents and summarizes the analytical results obtained from the Norwegian catchment (No. 5, Skjellbekken). It will be followed by an international report comparing and interpreting the results from all eight catchments.

Description of the catchment

Location, topography, industry, climate

by Jo H.Halleraker

Figure 1 shows the location of the catchment within the survey area.

Topographic location: 29° 27' E, 69° 23' N
Elevation: 80 - 280 m.a.s.l.

Distance and direction to industry in the area:
Distance to Kirkenes (A/S Sydvaranger, iron ore mine and mill): 48 km NNE
Distance to Nikel (nickel smelter): 30 km ENE
Distance to Zapolyarniy (roasting of sulphidic ores): 52 km ENE

Distance to the coast: 65 km N

Main wind direction: dominating S-N at Svanvik (25 km NE)

Climatic conditions:
Annual precipitation: 400 - 500 mm/year
Annual runoff: 400 - 500 mm/year
Annual average temperature: 0 - -2° C

Vegetation zone: northern boreal region (dominated by birch forest and low-productivity pine forest)

Table 1 shows meteorological data from the nearest meteorological station in the area. From October 1993 until September 1994, 426 mm precipitation were recorded at Svanvik. The wind directions varied much more during the summer months of 1994 than in the winter of 1993/94. Wind from south and south west dominated in the winter, as shown in figure 2.

	Svanvik				Pasvik (Noatun)			
	Temperature (°C)			Precipitation	Temperature (°C)			
	Mean	Max.	Min.	mm	Mean	Normal	Max.	Min.
October 1993	-3.2	8.2	-14.2	60.6	-2.3	0.3	10.4	-13.0
November	-5.4	2.3	-14.2	7.8	-4.5	-7.0	3.5	-15.0
December	-11.2	-0.9	-27.1	11.2	-10.2	-12.7	0.0	-30.0
January 1994	-16.8	-3.9	-38.3	36.1	-18.0	-15.4	-3.0	-37.0
February	-10.9	3.1	-29.0	13.7	-11.1	-13.9	4.6	-37.5
March	-6.5	3.3	-24.6	1.0	-5.9	-8.7	4.1	-28.0
April	0.4	11.1	-11.5	40.2	1.7	-2.0	11.6	-11.5
May	2.1	14.1	-6.7	20.6	3.5	4.1	14.5	-5.0
June	7.8	22.8	0.4	89.4	9.4	10.4	23.5	0.1
July	12.8	25.0	0.5	98.6	14.3	13.7	27.0	4.1
August	11.7	26.9	-1.9	27	12.7	11.4	26.6	-1.4
September	6.1	17.9	-2.0	19.8	6.0	6.4	17.0	-3.0

Table 1. Temperature and precipitation from Svanvik and temperature from Pasvik (Noatun) from October 1993 to March 1994 (Hagen et al. 1995a, Hagen et al. 1995b).

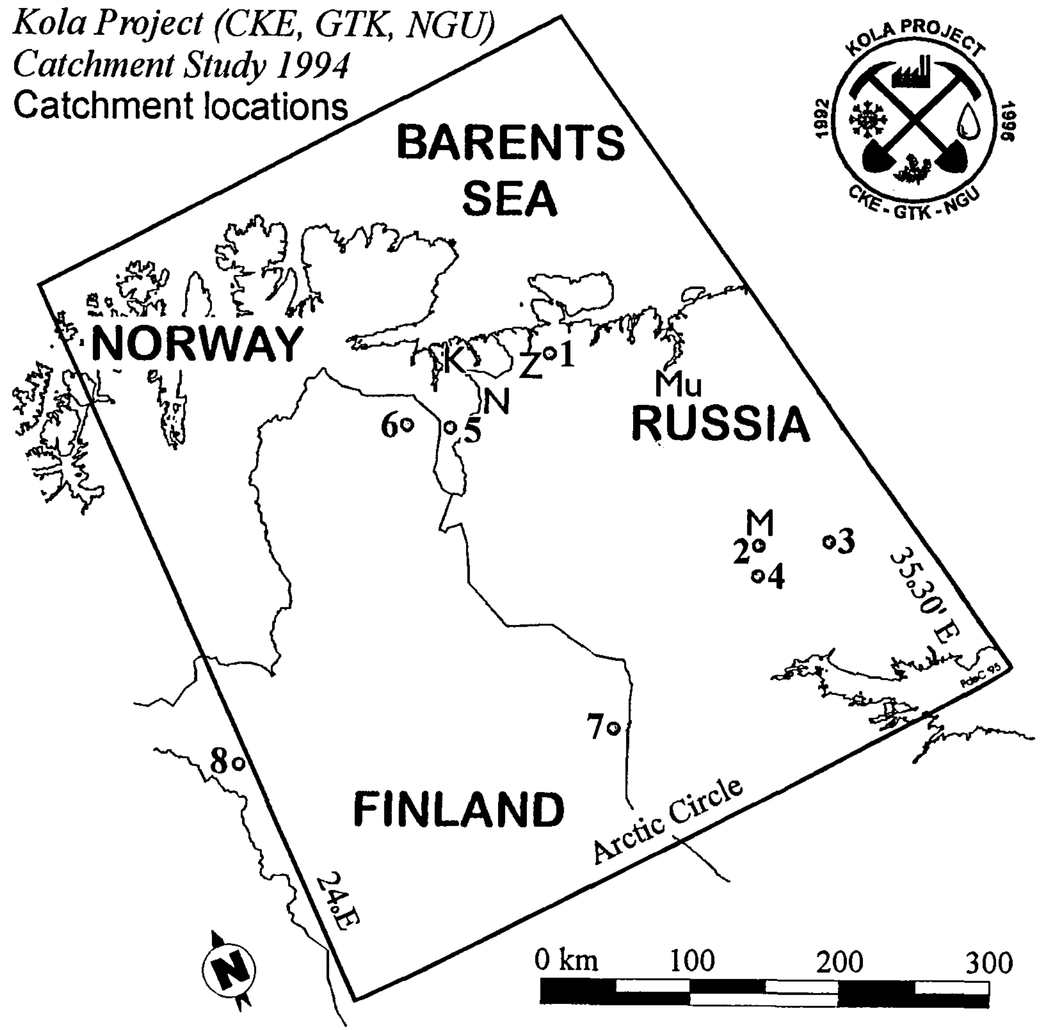


Fig. 1-Location map of study area for geochemical mapping (frame) and for the catchment study discussed here (1: Zapoljarniy, 2: Monchegorsk, 3: Kirovsk, 4: Kurka, 5: Skjellbekken, 6: Kirakka, 7: Naruska, 8: Pallas). K: Kirkenes, N: Nikel, Z: Zapoljarniy, Mu: Murmansk, M: Monchegorsk.

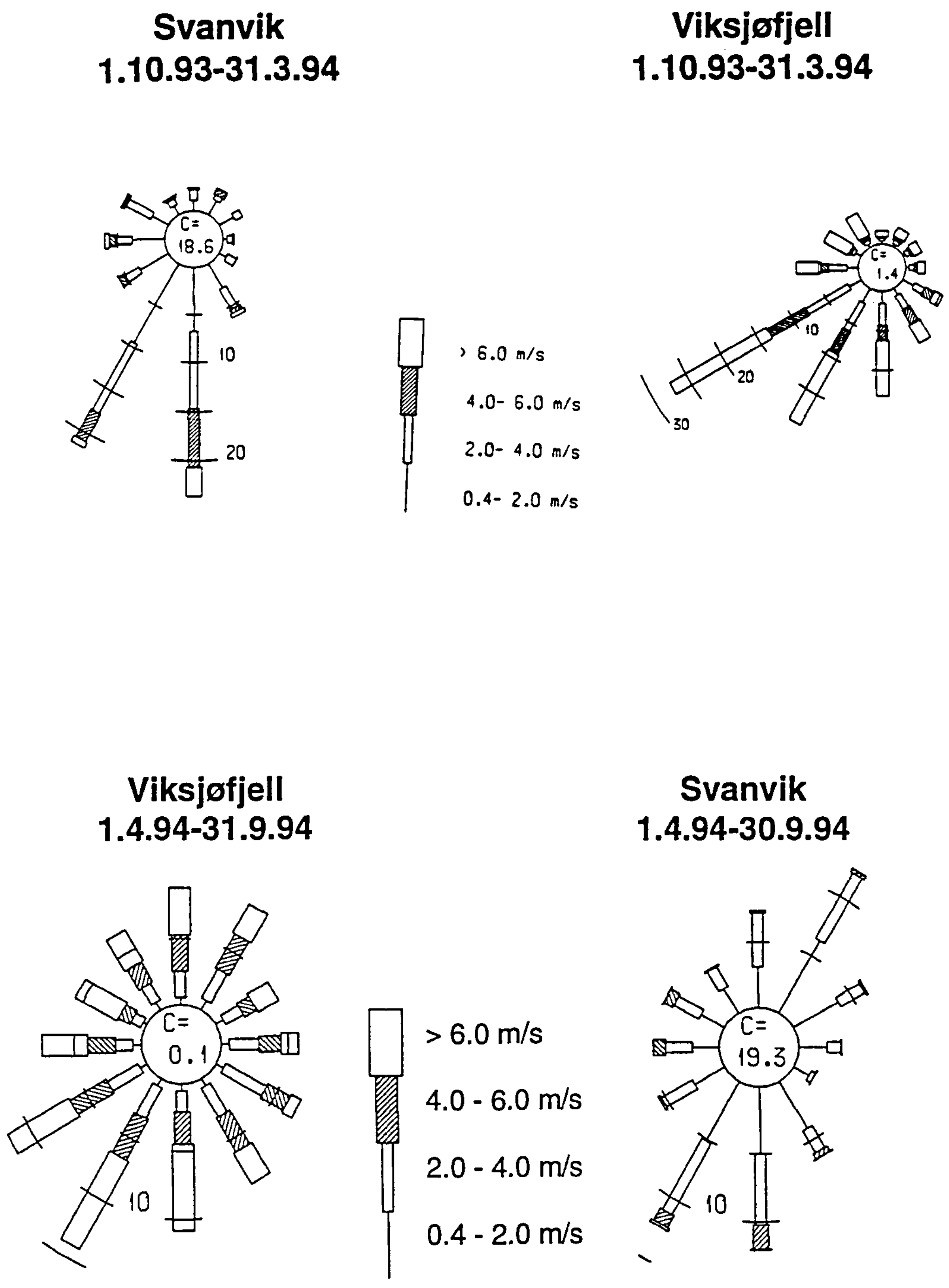


Fig. 2: Main wind directions at Svanvik and Visjøfjell during this catchment study. From Hagen et al. (1995a) and Hagen et al. (1995b).

The main bedrock lithologies of the Skjellbekken test area

by Victor A.Melezhik

A number of different lithologies are present in the Skjellbekken catchment. The percentages of different rock types, based on both drill-core material and exposed areas are as follows:

- (1) andesites, andesitic volcanoclastic schists 40%
- (2) tholeiitic basalts, tuffs 30%
- (3) 'black shales' 20%
- (4) intermediate and basic alkaline volcanic rocks 5%
- (5) ultramafic and mafic intrusions 5%
- (6) carbonate rocks, quartzites, cherts, quartz veins <1%

The andesites and andesitic volcanoclastic schists occupylthe middle and southern parts of the area. The rocks contain SiO_2, Al_2O_3, Na_2O andCaO as the main components. No unusual trace element contents for this rock rype were detected.

The tholeiitic basalts and tuffs occupy the northern part of the area. SiO_2, Al_2O_3, FeO, Na_2O and CaO are main components. In places, tholeiitic basalts and tuffs are slightly enriched in S (up to 0.5%).

The 'black shales' occur in the northern part of the test area as a relatively thick (up to 800 m) continuous formation sandwiched between tholeiitic basalts, and also in the middle part of the area where they develop a number of discontinuous layers within andesites and andesitic volcanoclastic schists. In both areas the rocks are very much enriched in S and organic matter.

The intermediate and basic alkaline volcanic rocks are only locally present in the extreme norhern part of the area. The main components of these rocks are SiO_2, Al_2O_3, Fe_2O_3, Na_2O, K_2O and CaO. Some lithologies may be enriched in P_2O_5.

The ultramafic and mafic intrusions mainly occur in association with the northern development of 'black shales'. These rocks belong to so-called 'ferro-type' therefore relatively enriched in FeO. Apart from this, they are regular mafic-mafic rocks primarily containing MgO, CaO, SiO_2 and Al_2O_3 as the main components. Cr and Ni are very typical trace elements

The carbonate rocks are associated with quartzites and both occur sporadically in the extreme northern part of the area. The carbonate rocks are both dolostones and limestones. The latter may by slightly enriched in MnO.

The cherts and quartz veins are frequent in the middle and southern part of the Skjellbekken area. Quartz veins are normally barren, but are sometimes highly enriched in As, S and Au. The main geochemical feature of the cherts are high SiO_2 and an enrichment in S and organic matter

Figure 3 shows the generalized geology of the catchment.

Catchment 5 BEDROCK

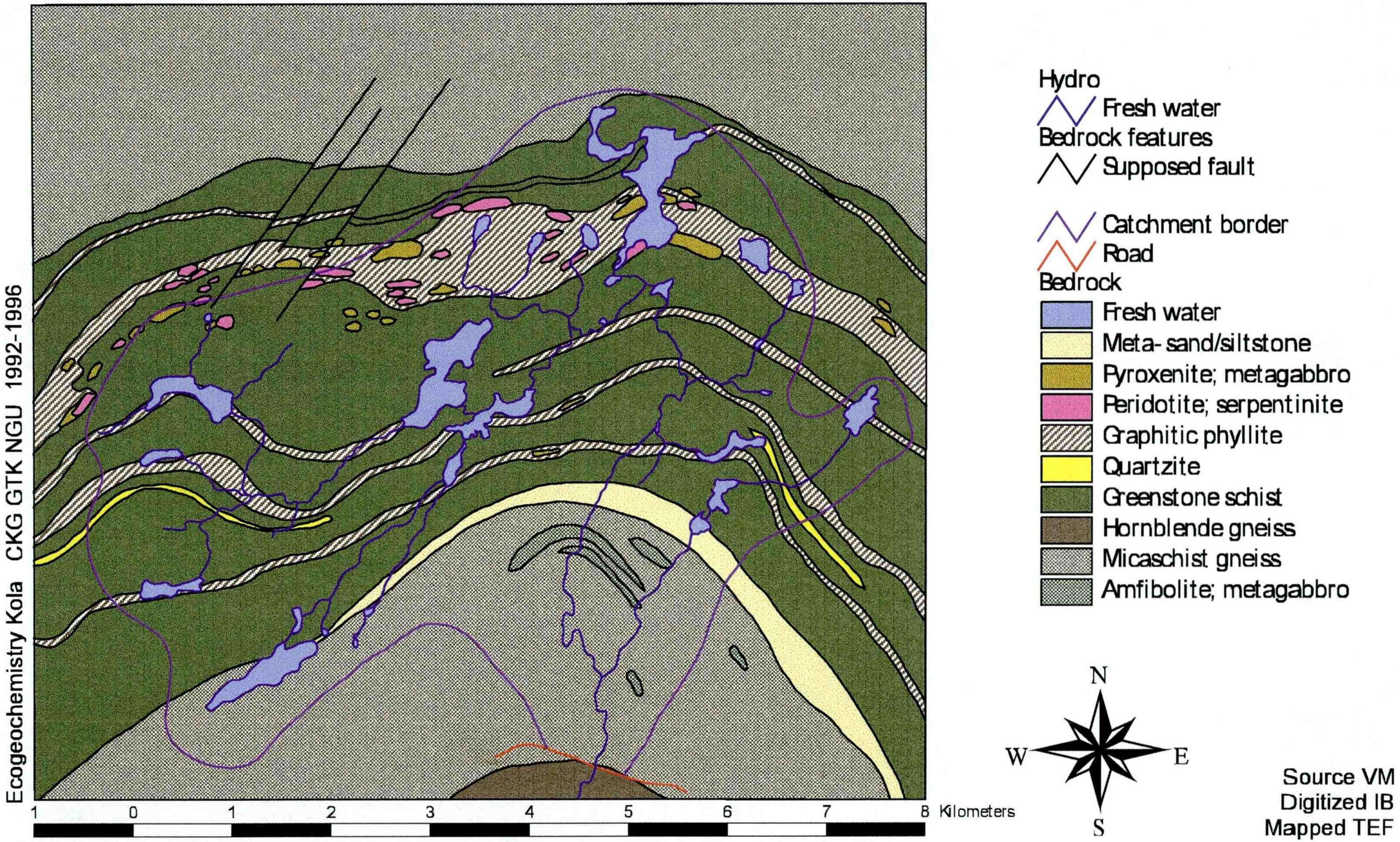


Figure 3: Generalized geology of the Skjellbekken catchment

Quaternary Geology

by Lars Olsen

The main surficial deposits in the Skjellbekken Catchment are tills and glaciofluvial material. Glaciolacustrine silt and fine sand occur as the topmost unit in some small areas within the areas of hummocky moraine, which characterize a significant part of the catchment. They also occur as scattered small sediment bodies in the area of the complex glaciofluvial esker system, a major SW - NE trending feature which dominates the Quaternary surficial deposits in this catchment.

Narrow, elongated bodies of fluvial gravel and sand occur locally along stream channels. In areas below the late glacial or postglacial marine limit, c.100 m a.s.l., marine clayey silt and clay occasionally occur below fluvial sand.

The tills occur in areas characterized by hummocky moraine and in other moraine covered areas,such as those with a smoother surface or a surface characterized by elongated, drumlin like forms. The tills date from three stadials which encompass the two youngest of seven glaciations recorded on Finnmarksvidda, some 150 - 200 km farther west.However, older units may also occur at Skellbekken since several of our test excavations reaching 3 - 4 m below the ground surface did not reach the underlying bedrock. This means that the data we can provide for the chemical composition of the Quaternary deposits in this area are *not likely to give a full natural background mineralogical/chemical source representation* for the material eroded, transported and deposited by Skjellbekken. It is thought most likely that the dominant part of the sources have been reached in our shallow test pits.

Analyses using XRF, XRD and ICP, and analyses of TC and TOC, have been carried out on till and sediment samples, and a correlation diagram based on XRF data indicates that:

1 The marine clays correlate best with the youngest till and stepwise less well with older units, and the correlation with weathered bedrock is weak.

2 The intermediate and youngest tills show the strongest and weakest correlation with weathered bedrock, respectively, and:

3 The two oldest tills correlate better with each other than with any other unit, but not better than 0.61, which is a correlation of medium to relatively low strength.

From our data it may be concluded that *the best correspondence between material in transport in Skjellbekken and the local bedrock* is expected to be found in a position downstream of fluvial erosion in any of the older till units, or even better, directly in the bedrock. Rocks of local origin are expected to be much less represented in Skjellbekken downstream of fluvial erosion in marine clays or in the youngest till.

Fig. 4 shows a map of the Quaternary geology in the Skjellbekken catchment.

Catchment 5 QUATERNARY DEPOSITS

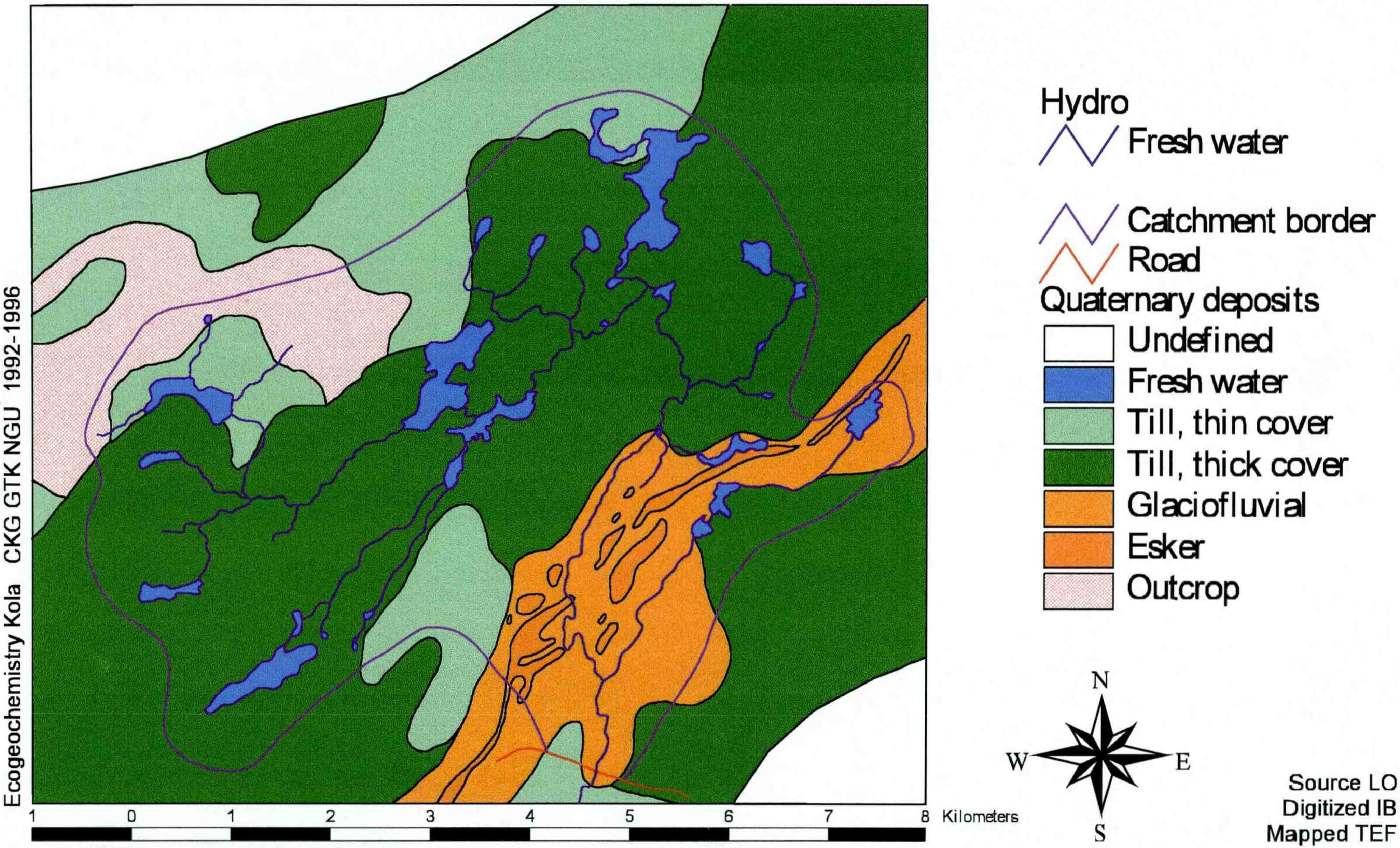


Figure 4 Quaternary geology of the Skjellbekken catchment.

Previous investigations

by Jo H.Halleraker

Tables 2 and 3 present an overview of previous investigations of terrestrial and aquatic media from the municipality of Sør-Varanger. The monitoring programmes of the Norwegian Institute for Water Research (NIVA) monitoring the water chemistry of Dalelv, and the. Norwegian Institute for Air Research (NILU) monitoring air and precipitation at several locations along the border to Russia are still continuing. NIVA's and NILU's results are reported annualy. Radioactivity is monitored continously at Svanhovd environmental centre. The Norwegian Institute for Forest Research (NISK) is doing forest ecology studies in several plots including one in the Skjellbekken catchment. These investigations have not yet been reported, but NISK scientists are sampling rainwater, including "throughfall precipitation", vegetation and soil water for heavy metal analysis (D. Aamlid, pers. comm.).

Most of the studies carried out so far focus on very few elements (the known main contaminants)(Tab. 2 and 3).

Table 2. Chemical composition in aquatic media from parts of Sør-Varanger municipal, Finnmark - Norway.

Sampled media	No of metals analysed	No of localities Finnmark (N)	No of samples	Period (year)	Chemical analyses Extraction	Instrument(s)	Main Institusion	Reference
Stream water	32	S-V: 15	45	1992		ICP - AES, IC	NGU	Chekushin et al. 1993
Water	14	S-V: 58	99	1990 - 1993		AAS	NINA	Langeland (ed.) 1993
Water	6	x		1989 - 1990			NIVA	Traaen et al. 1991
Water	5	S-V: 20	20	1993			NIVA	Traaen et al. 1994
River sediment	6	PR:2	10	1989			NIVA	Rognerud 1990
Lake sediment	7	S-V: 34	50	1990	HNO3	AAS	NIVA	Rognerud et al. 1993
Lake sediment	4	S-V: 2	2	1993		AAS	NIVA	Traaen et al. 1994
Lake sediment	15	S-V: 2	2	1990	HNO3	AAS	NIVA	Norton et al. 1992
Sediments	2	S-V: 12	46	1991	HNO3	AAS	FM-Fi	Traaen et al. 1991
Stream sediments	9	1/30 km2		1980 - 1983		ICP, XRF	NGU	Bølviken et al. 1986
Overbank sediments	30	S-V: 15	45	1992	Several	ICP - AES	NGU	Chekushin et al. 1993
Stream sediments	23	S-V: 15	45	1992	Several	AAS, ICP - AE	NGU	Chekushin et al. 1993
Stream organic material	25	1/30 km2		1980 - 1983		XRF	NGU	Bølviken et al. 1986
Aquatic mosses	9	S-V: 24	31	1991	HNO3	AAS	NINA	Langeland (ed.) 1993
Stream moss	14	1/30 km2		1980 - 1983		NAA	NGU	Bølviken et al. 1986
Fish	3	S-V: 7	15	1990 - 1992	HNO3	AAS	NINA	Langeland (ed.) 1993
Fish	1	x		1988			NIVA	Rognerud & Fjeld 19
Fish, water, sediments	1	PR					FM-Fi	Norheim et al. 1985
Fish tissues	7	PR			HNO3	AAS	UT - TM	Amundsen et al. 1993
Areacodes:	x : Samples from all over Finnmark, PR: Pasvik riversystem, JF: Jarfjord, S-V: Sør-Varanger commune							
Instrument codes:	AAS: Atomic Absorption Spectrophotometer, NAA : Neutron activation analysis, XRF : X - ray fluorescense							
	ICP : Inductively coupled argon plasma spectrometery							

Tabel 3. Chemical composition in terrestrial media from Sør-Varanger

Sampled media	Phase/species	No. of elements	No of localities Finnmark (N)	Distri-bution	Chemical analyses Extraction	Instrument(s)	Sampling period (year)	Reference
Air/Moss	Terr. moss	34	x. app. 45	R	HNO3	ICP-MS	1989, 1990	Berg 1993
Air/precipitation	Dry/wet dep.	16	Jergul, S-V: 2	MP		ICP-MS	1987/90 -	SFT 1993
Air/precipitation	Dry/wet dep.	7	S-V: 7	MP		ICP-MS	1990 -	Hagen et al. 1990, Sivertsen & Hagen 1992
Air/precipitation	Dry/wet dep.	9	S-V:2	MP		AAS	1991	Junto 1992, Hongisto 1992
Precipitation	Snow	3	S-V / VP	R			1990/91	Hagen et al. 1992
Precipitation	Snow	14	S-V: 25	R		Atomic emission, JCP sp	1991 - 1993	Makarova et al. 1994
Precipitation	Snow	7	S-V:15	R		AAS	1992	Chekushin et al. 1993
Preciptation		14	S-V: 7	MP				Hagen et al. 1994
Preciptation	Snow	18	x: 38	R			1994	Hagen et al. 1995
Peat bogs	Ombrotrofic	31	S-V:2	T	HNO3	ICP-MS	1992	Traaen et al. 1994
Humus	Ao horizon	1	S-V: 43	R	NH4NO3	ICP	1989	Aamlid & Venn 1993
Humus	Ao horizon		x: 1/30 km2	R	HNO3	OES, NAA, XRF	1980 - 85	Finne in prep.
Soil	Cultivated soil	6	S-V		HNO3	AAS	1993	Almås 1994
Soil horizons	Ao - C horizon	35	S-V:15	R		ICP- AES, ICP- MS	1992	Chekushin et al. 1993
Soil horizons	Ao - C horizon	29	x: 38	R	HNO3	ICP-ES	1977, 1985	Njåstad et al. 1994
Till	C -horizon	24	1/30 km2	R		OES, NAA, XRF	1980-83	Bølviken et al. 1986
Vegetation	*Empetrum h., Vaccinium*	14	S-V	R			1991	Uhlig 1992
Vegetation	Cloudberry, bilberry	11	S-V: 18	R		ICP-MS	1992	Aamlid, D. & Skogheim, I. 1993
Vegetation	Birch/pine/Betula spp.	2	S-V: 76	R		ICP	1988-1992	Aamlid 1992, Aamlid & Venn 1993
Vegetation	Cladina stelleris	5	S-V: 76	R		ICP-AES		Aamlid 1992
Vegetation	Lichens	31	x	R			1991	Meland 1992
Vegetation	Terr. mosses	8	1,6/1000km2	R		ICP/ AAS/ NAA	1989 - 1992 (1990)	Ruhling et al. 1992, Ruhling (ed.) 1994
Vegetation	Terr. mosses	44	x: 45	R	HNO3	AAS, NAA, ICP-MS	1977, 1985, 1990	Steinnes et. al. 1993.
Vegetation	Terr. mosses, lichens	8	S-V:26	R	HNO3	AAS, NAA	1977/1981	Scjoldager et al. 1981
Vegetation	*Betula, Salix etc.*	2	S-V: 76	R		ICP-AES		Aamlid 1992, Aarstad & Aamlid in prep.
Animals	Woodland birds/ hare	10	S-V: 138, W-Fi: 2	R	HNO3	AAS	Autum 1991, 92	Kålås et al. 1993
Mammals	Kidney/liver	9	S-V: 124 W-Fi: 89	R	HNO3	AAS	1990	Sivertsen et al. 1991
Areacodes:	x : Samples from all over Finnmark, PR: Pasvik riversystem, JF: Jarfjord, S-V: Sør-Varanger commune							
Distribution codes:	T: Transect(s), R: Regional distribution/mapping, M: Monitoring point							
Instrument codes:	AAS: Atomic Absorption Spectrophotometer, NAA : Neutron activation analysis, XRF : X - ray fluorescense, ICP : Inductively coupled argon plasma spectrometery							
	Col: Colorimetric method, OES: Optical emission spectrometry,							

Table 2 and 3: Previous studies on the chemical compositon of aquatic (Tab.2) and terrestrial media (Tab.3) in Sør Varanger.

Sample Media, field procedures, sample preparation and analytical techniques

The following sample media were collected for the catchment study :

- SNOWPACK
- RAINWATER
- STREAMWATER
- GROUNDWATER (some catchments)
- ORGANIC STREAM SEDIMENT
- TERRESTRIAL MOSS
- TOPSOIL 0-5 cm
- OVERBANK SEDIMENTS (where available)
- complete PODZOL PROFILES
- QUATERNARY DEPOSITS
- BEDROCK

Field methods are detailed in Äyräs and Reimann (1995). Laboratory methods (sample preparation and analytical techniques) are described in the following two chapters as well as in Nikavaara (1995).

Sample preparation and analytical methods, GTK,

by Heikki Niskavaara

Podzol profiles; mineral soils

Samples were dried in the original paper bags at 40°C and hammered to break the agglomerates formed during drying. From selected samples, a subsample of 100-200 g was split and used for grain size determinations. The whole sample was sieved to the <2 mm fraction. This fraction was split into four equal parts using a riffle splitter.

One portion was sent to NGU for XRF, LOI and TOC- analysis and for water extractions for the determination of pH, conductivity and F.

The second was used for ammonium acetate extraction.

A 6 g subsample was extracted in a horizontal shaker for two hours with 30 ml of 1.0 M ammonium acetate solution buffered with acetic acid to pH 4.5. After filtration through a 0.45 µm membrane filter, solutions were analysed with ICP-AES for 26 elements (GTK method 201P). In addition, As and Cd were determined with a graphite furnace -AAS (method 201U).

A third portion was ground to <0.15 mm in a swing mill using an agate mortar. This subsample was used for heavy metal analysis and CHN determinations.

A 2 g subsample was digested for 2 hours at 90°C with 12 ml of aqua regia (1:3 HCl and HNO_3) (modified ISO standard draft 11466; GTK method 512). After digestion, samples were diluted with water to 60 ml, mixed and centrifuged. The clear solution was analysed with ICP-AES for 31 elements (GTK method 512P; Niskavaara,1995). In addition, Ag, As, Cd and Pb were determined with a graphite furnace -AAS (method 512U), Hg with cold vapor -AAS (512H) and Bi, Sb,Se and Te with a graphite furnace -AAS after preconcentration with reductive co-precipitation (512U; Niskavaara and Kontas,1990). Carbon, hydrogen and nitrogen were analysed with a CHN analyser (method 820L).

The fourth portion was sieved to the <0.5mm fraction. Selected samples (29) from this set were used to study the effect of different grain size. These samples were again split and one set was ground in an agate mortar. The same analyses as with the <2mm fraction were carried out on these samples.

Podzol samples; humus

Field samples were dried at < 40°C. Big roots, needles etc. were removed during visual inspection. The samples were homogenized by milling with a domestic blender with blades made of uncontaminating material and subsequently sieved to < 2 mm.

0,500 g of the sample was digested with 10 ml of concentrated nitric acid in a microwave oven and diluted to 50 ml with water (US EPA standard 3051; GTK method 503). The clear solution was analysed with ICP-AES for 30 elements (GTK method 503P; Niskavaara,1995) and with an inductively coupled plasma mass spectrometer (ICP-MS)(GTK method 503M). In addition Hg was determined with cold vapour -AAS (503H). A 3 g subsample was extracted in a horizontal shaker for two hours with 30 ml of 1.0 M ammonium acetate solution buffered to pH 4.5. After filtration through a 0,45 µm membrane filter, the solutions were analysed with ICP-AES for 26 elements (GTK method 201P). In addition, As and Cd were determined with a graphite furnace -AAS (method 201U).Carbon, hydrogen and nitrogen were analysed with a CHN analyser (method 820L).

Organic stream sediment, moss, lichen and empetrum nigris

Field samples were dried in opened original bags at < 40°C and homogenized by milling with a domestic blender with blades made of uncontaminating material.

0,500 g of the sample was digested with 10 ml of concentrated nitric acid in a microwave oven and diluted to 50 ml with water (US EPA standard 3051, GTK method 503). The clear solution was analysed with ICP-AES for 30 elements (GTK method 503P; Niskavaara,1995) and with ICP-MS (GTK method 503M). In addition, Hg was determined with cold vapour - AAS (503H)

Snow

After sampling the plastic bags of snow were stored in a freezing room. Each day five samples were allowed to melt in the bags and were filtered "in situ" at room temperature. The bags were hung in the fume hood and a hole was made in the bottom end of the bags. Meltwater was drained from them directly to the Nalgene filtering system through a replaceable cellulose acetate membrane filter (0.45μm)(see Fig. 5). Soot and particulate material concentrates in the lower part of the snow during melting and only a small portion adheres to the bag (compare Fig. 6). At the end of the melting process the rest of snow containing this material was taken out of the bag and placed into the filter. After all the snow melted the filter was taken out and placed in an ampule for analysis (Fig. 5 and 6).

Fig. 5: Overview of the system used for on-line melting and filtering of snow.

Fig. 6: Concentration of soot and particulates at the bottom of the PE-bag during the melting process.

The volume of meltwater was recorded. pH and conductivity (GTK method 143R) were measured.

The filtrate was divided into two subsamples. One was used for potentiometric determination of F (GTK method 143I) and ionchromatographic determination of Br, Cl, NO3 and SO4 (GTK method 143R). The other was acidified with suprapure nitric acid (0.5 ml/100ml of sample) and used for analysis with ICP-MS (GTK method 140M) and ICP-AES (GTK method 140P).

The filter paper was digested with 10 ml of concentrated nitric acid in a microwave oven, diluted to 50 ml with water and analysed with ICP-AES (GTK method 503P). The results were calculated back to the original sample volume.

Surface water, groundwater and rainwater

Conductivity, pH, F, Br, Cl, NO3 and SO4 (GTK methods 143R and 143I) were measured from the unacidified samples.

The acidified samples were analysed with ICP-AES (GTK method 140P) and ICP-MS (GTK method 140M).

Topsoil

The effect of different drying techniques on topsoil samples was tested. From the first set of samples (winter), a subsample was freeze-dried and selected samples were air-dried at room temperature. Independently of the results, freezedrying was found to be too time consuming. In addition only a relatively small subsample could be used. This created problems with sample representativity. Subsequently the second (spring), third (summer) and fourth (autumn) sets were air-dried after subsampling. The dried subsample was homogenized by milling with a domestic blender with blades made of uncontaminating material and sieved to pass through a < 2mm sieve.

0,500 g of the sample was digested with 10 ml of concentrated nitric acid in a microwave oven and diluted to 50 ml with water (US EPA standard 3051; GTK method 503). The clear solution was analysed with ICP-AES for 30 elements (GTK method 503P; Niskavaara,1995) and with an inductively coupled plasma mass spectrometer (ICP-MS)(GTK method 503M). In addition, Hg was determined with cold vapour -AAS (503H). A 3 g subsample was extracted for two hours with 30 ml of 1.0 M ammonium acetate solution buffered to pH 4.5 in a horizontal shaker. After filtration through 0.45 μm membrane filter solutions were analysed with ICP-AES for 26 elements (GTK method 201P). In addition As and Cd were determined with a graphite furnace -AAS (method 201U).

Carbon, hydrogen and nitrogen were analysed with a CHN analyser (method 820L).

Winter samples from Russian catchments were analysed with a graphite furnace -AAS for Au,Pd,Rh and Pt after ashing at 450°C, digestion of the ash with aqua regia and separation with reductive co-precipitation.

Overbank sediment

These samples were prepared by NGU.

A 2 g subsample was digested for 2 hours at 90°C with 12 ml of aqua regia (1:3 HCl and HNO_3) (modified ISO standard draft 11466; GTK method 512). After digestion, samples were diluted with water to 60 ml, mixed and centrifuged. The clear solution was analysed with ICP-AES for 31 elements (GTK method 512P; Niskavaara,1995). In addition Ag, As, Cd and Pb were determined with a graphite furnace -AAS (method 512U), Hg with cold vapour -AAS (512H) and Bi, Sb, Se and Te with a graphite furnace -AAS after preconcentration with reductive co-precipitation (512U; Niskavaara and Kontas,1990).

Bedrock samples

All samples were prepared by NGU.

A 2 g subsample was digested for 2 hours at 90°C with 12 ml of aqua regia (1:3 HCl and HNO_3) (modified ISO standard draft 11466; GTK method 512). After digestion, samples were diluted with water to 60 ml, mixed and centrifuged. The clear solution was analysed with ICP-AES for 31 elements (GTK method 512P; Niskavaara,1995). In addition Ag, As, Cd and Pb were determined with a graphite furnace -AAS (method 512U), Hg with cold vapor -AAS (512H) and Bi, Sb, Se and Te with a graphite furnace -AAS after preconcentration with reductive co-precipitation (512U; Niskavaara and Kontas,1990).

Quaternary deposit samples

Samples were dried at 40°C (GTK method 11), split and one subsample was sieved to the <0.064mm fraction (GTK method 22). The other was stored for future use.

A 0.3 g subsample was digested for 2 hours at 90°C with 3 ml of aqua regia (1:3 HCl and HNO_3) (GTK method 511). After digestion samples were diluted with water to 15 ml, mixed and centrifuged. The clear solution was analysed with ICP-AES for 31 elements (GTK method 511P; Niskavaara,1995).

Quality assurance/control

The chemical laboratory of the Geological Survey of Finland is accredited to meet the requirements of the EN 45001 standard and the ISO Guide 25. The QA/QC- procedures used in ICP-AES analysis are described by Niskavaara (1995).

In every batch of samples 8-10% of the samples are randomly selected for duplicate analysis to assess reproducibility. In addition, 1-3 reference samples and a reagent blank are included in every batch. NIST 1572 (Citrus Leaves), NIST 1573 (Tomato Leaves) and NIST 1575 (Pine Needles) are used as reference samples for methods 503P/M and BCR 277 (Estuarine Sediment), BCR 320 (River Sediment) and USGS GXR 2 (Soil) are used as reference samples for methods 512P/U. QC-charts are generated after each batch of samples.

Sample Preparation and analytical methods, NGU

by Andreas Grimstvedt

XRFanalysis of major elements

Samples are diluted (1:7) with Lithium tetraborate ($Li_2B_4O_7$) and fused to glass disks which are analysed on a Philips PW 1480 sequential X-ray spectrometer containing an X-ray tube with a Sc/W anode.

ICP-AES analysis (water analysis)

Water samples are analysed with a Thermo Jarell Ash ICP 61 after filtration through a 0.45μm filter and acidification with HNO_3 ($pH < 2$).

ICP-AES analysis (geological materials)

Solid samples are analysed with a Thermo Jarell Ash ICP 61 after partial extraction with 7 N HNO_3 according to NS 4770.

IC analysis

IC-analysis is performed on a Dionex 2120i ion chromatograph using a conductivity detector and a Dionex IonPac AS4A-SC separation column.

Determination of pH

pH is determined according to NS 4720 using a glass electrode (GK2701) from Radiometer connected to a pH-meter (PHM84 research pH-meter) from Radiometer.

Determination of conductivity

Conductivity is determined according to NS 4721 using a conductivity meter (CDM83) from Radiometer.

Alkalinity, Potentiometric titration

Alkalinity is determined by potentiometric titration according to NS 4754 using a burette (Schott Geräte) and a glass electrode (GK2701) from Radiometer connected to a pH-meter (PHM84 research pH-meter) from Radiometer.

Determination of colour number, spectrophotometric method

Colour is determined spectrophotometrically according to NS 4787 using a Shimadzu UV - 1201 spectrophotometer.

Determination of turbidity

Turbidity is determined nephelometrically according to NS 4723 using a Hach 2100A turbidimeter.

Determination of total carbon (TC)

Total carbon is determined with a Leco furnace, type SC-444 (combustion of carbon in an oxygen environment, followed by detection of CO_2 in an IR cell).

Determination of total organic carbon (TOC)

Samples are heated to 50°C and HCl is added to remove CO_2 bound as carbonate. The residue is checked for remaining CO_2 and then washed with distilled water. Total carbon in the residue is then determined with a Leco furnace, type SC-444 (combustion of carbon in an oxygen environment, followed by detection of CO_2 in an IR cell).

Determination of total sulphur (TS)

Total sulphur is determined with a Leco furnace, type SC-444 (combustion of sulphur in oxygen environment, followed by detection of SO_2 in an IR cell).

RESULTS

The analytical results for all the media collected in catchment 5 are presented in the following chapters. A short discussion of these results in combination with a table giving summary statistics is followed by a printout of the data file in the appendix. In some cases, a number of graphicsare also presented. In Norway, only one catchment was selected for this project. Consequently there is no comparison with another Norwegian catchment. Comparisons with the other 7 catchments will be carried out in the joint project report following the series of national reports.

Figures 7 show the location of the sampling sites within catchment 5 for the different media. All location numbers for all media discussed as well as the location numbers used in the appendix refer to the location numbers used in Figure 7.

Catchment 5
Sampling sites

Source ØJ
Digitized IB
Mapped TEF

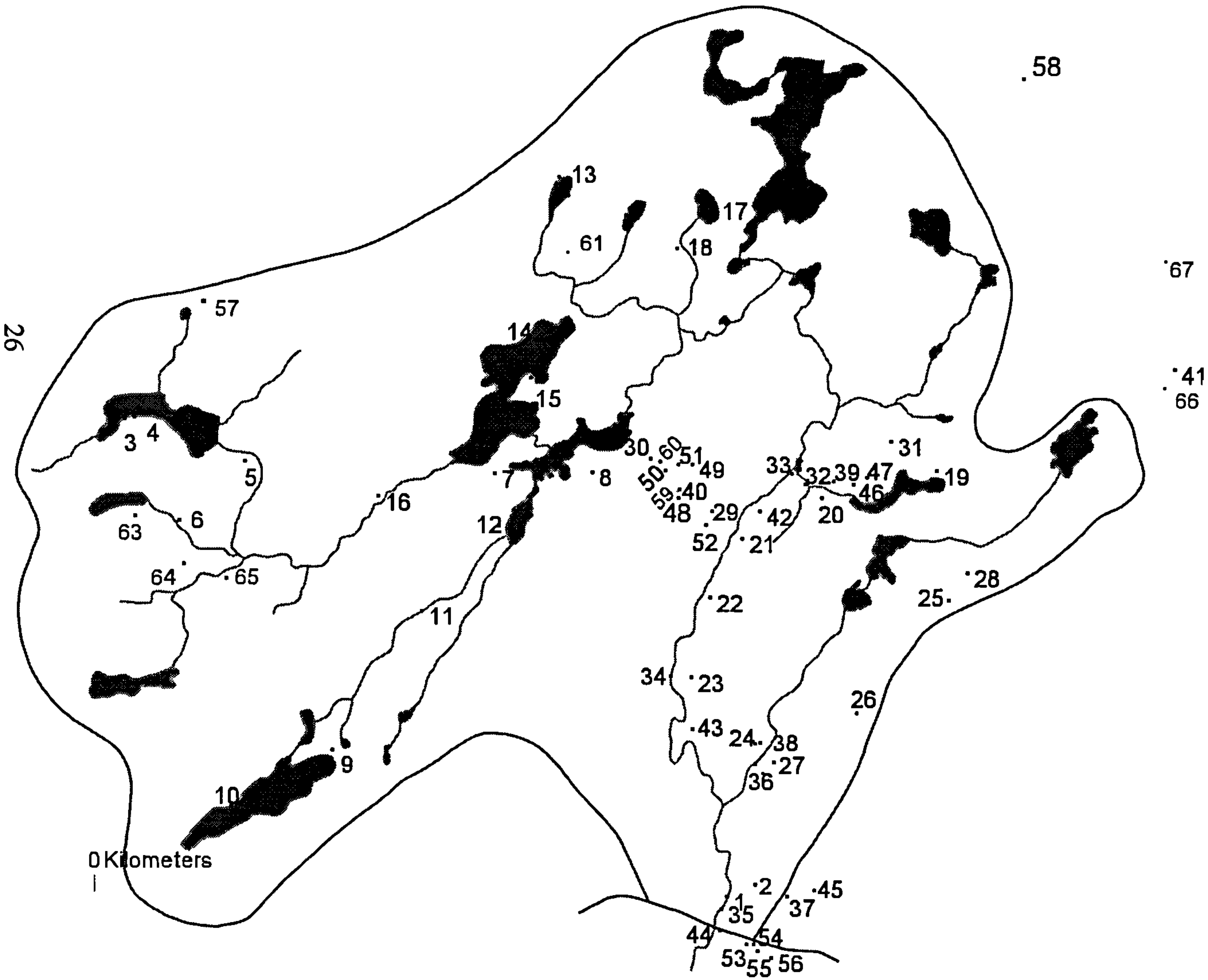


Fig 7: Sample locations in catchment 5 and location numbers.

S_ID	ALTITU	OSS	SS	SW	GW	OB	POD	QDEP	BEDR	RW	SNOW	MOS	TOP	FT	Alt. ID
1	85		1												
2	80										1	2	3	1	
3	189										1		1	1	
4	187										1		1	1	
5	185											2	3	1	
6	190										1		1	1	
7	130										1		1	1	
8	131												2	1	
9	180										1		3	1	
10	176												1	1	
11	155										1		3	1	
12	130											1	2	1	
13	153										1		3	1	
14	130												3	1	
15	130										1		1	1	
16	140												3	1	
17	136										1	2	1	1	
18	130												3	1	
19	115										1		1	1	
20	105												2	1	
21	95												1	1	
22	100											2	3	1	
23	90												1	1	
24	90										1		2	1	
25	120											2	3	1	
26	105												1	1	
27	88									1			2		
28	120									1			2		
29	100									1			2		
30	135											2			
31	120											2			
32	100	1											2		
33	90	1											2		
34	75	1				1							2		
35	75	1											2		
36	80	1											2		
37	95						1								
38	85						1								
39	115						1								
40	125						1								
41	120						1								
42	95				1										
43	90				1										
44	70				1										
45	98							1							1
46	120							1							2
47	123							1							3
48	125							1							4
49	136							1							5
50	135							1							6
51	135							1							7
52	100							1							9
53	76							1							10
54	80							1							11
55	78							1							12
56	81							1							13
57									1						91-98
58									1						91-8,10,15,20,30
59									1						91-33
60									1						91-38,40
61									1						91-135
62									1						92-4,5
63									1						92-15
64									1						92-16
65									1						92-18
66									1						93-2
67									1						93-5

OSS	Organic Stream Sediments	BEDR	BEDRock	Figures indicate
SS	Stream Sediments	RW	RainWater	number of times
SW	Stream Water	SNOW	SNOW pack	site has been
GW	Ground Water	MOS	terrestrial MOSs	visited for
OB	OverBank sediments	TOP	TOPsoil 0-3cm	sampling
POD	PODzol profiles	FT	Frozen Topsoil	
QDEP	Quaternary DEPosits	Alt. ID	Alternative IDentity	

Snow

by Clemens Reimann

12 snow samples of about 3 kg each were taken in catchment 5 in March/April 1994. Details on sampling are given in Äyräs and Reimann (1995) and details on sample preparation and analysis were summarised above.

Analytical results for meltwater, filtered and analysed by ICP-MS and for the filter residues (>0.45 µ) analysed by ICP-AES, are summarised in Table 4, all analytical results are given in Appendix.

Values for meltwater are generally very low, an excemption being the sea spray elements Mg, Na and Cl, which show rather high values. Surprisingly, S does not follow this trend, the S-content in snow samples from catchment 5 being rather low. Of the "contamination elements", only As, Co, Cu and Ni may be very slightly above background.

Values for the filter residues are again very low and none of the elements show enrichments or unusual behaviour in these samples.

The concentrations can be recalculated to deposition data ($\mu g/m^2$) for the winter half of the year. Data are presented in Reimann et al.(1995) and compared with the deposition data for the following summer. Again catchment 5 can be taken as a typical background catchment for the area with very, very slight, almost undetectable, additional atmospheric input of As, Co, Cu and Ni in the range of less than 1 $\mu g/m^2$ (compared to >500 and up to >9000 $\mu g/m^2$ in Russia).

Table 4: Analytical results of snow samples. _mw:= meltwater; _fr:= filter residue.

Element	Unit	Method	Min	25th %ile	Med	Mean	1 S.D.	75th %ile	Max
Ag_mw	µg/l	140M	0,005	0,005	0,005	0,005	0,0000	0,005	0,005
Al_mw	µg/l	140M	1,62	2,31	2,88	3,54	2,0995	3,67	8,36
Al_fr	µg/l	503P	3,0	4,8	5,5	6,7	3,7497	7,0	17,0
As_mw	µg/l	140M	0,05	0,05	0,13	0,11	0,0454	0,14	0,16
As_fr	µg/l	503P	0,15	0,15	0,15	0,15	0,0000	0,15	0,15
B_mw	µg/l	140M	0,25	0,25	0,25	1,62	3,6291	0,25	12,50
B_fr	µg/l	503P	0,15	0,15	0,15	0,15	0,0000	0,15	0,15
Ba_mw	µg/l	140M	0,05	0,11	0,15	0,17	0,1027	0,19	0,38
Ba_fr	µg/l	503P	0,005	0,005	0,020	0,023	0,0224	0,033	0,080
Be_mw	µg/l	140M	0,15	0,15	0,15	0,15	0,0000	0,15	0,15
Bi_mw	µg/l	140M	0,01	0,01	0,01	0,01	0,0000	0,01	0,01
Ca_mw	mg/l	140P	0,06	0,09	0,10	0,18	0,1814	0,14	0,61
Ca_fr	mg/l	503P	0,005	0,005	0,005	0,005	0,0014	0,005	0,010
Cd_mw	µg/l	140M	0,015	0,015	0,015	0,015	0,0000	0,015	0,015
Cd_fr	µg/l	503P	0,025	0,025	0,025	0,025	0,0000	0,025	0,025
Co_mw	µg/l	140M	0,015	0,026	0,045	0,040	0,0170	0,050	0,060
Co_fr	µg/l	503P	0,025	0,060	0,095	0,084	0,0290	0,103	0,120
Cr_mw	µg/l	140M	0,10	0,10	0,10	0,12	0,0491	0,10	0,24
Cr_fr	µg/l	503P	0,025	0,044	0,075	0,139	0,1438	0,190	0,450
Cu_mw	µg/l	140M	0,77	0,87	0,96	1,04	0,2827	1,10	1,75
Cu_fr	µg/l	503P	0,58	0,89	1,06	1,13	0,5078	1,26	2,53
Fe_mw	mg/l	140M	0,007	0,007	0,007	0,007	0,0000	0,007	0,007
Fe_fr	mg/l	503P	0,01	0,02	0,02	0,02	0,0079	0,03	0,03
K_mw	mg/l	140M	0,04	0,05	0,06	0,06	0,0135	0,07	0,08
K_fr	mg/l	503P	0,005	0,005	0,005	0,016	0,0211	0,013	0,060
La_fr	µg/l	503P	0,035	0,035	0,035	0,035	0,0000	0,035	0,035
Li_mw	µg/l	140M	0,05	0,05	0,14	0,11	0,0567	0,15	0,19
Li_fr	µg/l	503P	0,035	0,035	0,035	0,035	0,0000	0,035	0,035
Mg_mw	mg/l	140P	0,06	0,09	0,10	0,11	0,0346	0,14	0,16
Mg_fr	mg/l	503P	0,005	0,005	0,005	0,005	0,0000	0,005	0,005
Mn_mw	µg/l	140M	0,34	0,65	0,79	0,87	0,3825	1,02	1,79
Mn_fr	µg/l	503P	0,06	0,09	0,13	0,13	0,0456	0,16	0,21
Mo_mw	µg/l	140M	0,025	0,025	0,025	0,025	0,0000	0,025	0,025
Mo_fr	µg/l	503P	0,035	0,035	0,035	0,035	0,0000	0,035	0,035
Na_mw	mg/l	140P	0,60	0,70	0,75	0,94	0,3528	1,18	1,60
Na_fr	mg/l	503P	0,005	0,005	0,005	0,005	0,0014	0,005	0,010
Ni_mw	µg/l	140M	0,42	0,63	0,76	0,76	0,2087	0,87	1,19
Ni_fr	µg/l	503P	1,10	1,65	2,30	2,18	0,6672	2,73	3,00
P_mw	mg/l	140P	0,001	0,001	0,007	0,012	0,0150	0,018	0,051
P_fr	mg/l	503P	0,00025	0,00058	0,00090	0,00119	0,00126	0,00123	0,00500
Pb_mw	µg/l	140M	0,23	0,27	0,33	0,34	0,0899	0,36	0,56
Pb_fr	µg/l	503P	0,15	0,15	0,15	0,15	0,0000	0,15	0,15
Rb_mw	µg/l	140M	0,025	0,025	0,060	0,084	0,0821	0,085	0,260
S_mw	mg/l	140P	0,15	0,17	0,21	0,23	0,0912	0,23	0,47
S_fr	mg/l	503P	0,0025	0,0025	0,0025	0,0037	0,0042	0,0025	0,017
Sb_mw	µg/l	140M	0,015	0,015	0,015	0,017	0,0072	0,015	0,040
Sb_fr	µg/l	503P	0,25	0,25	0,25	0,25	0,0000	0,25	0,25
Sc_fr	µg/l	503P	0,005	0,005	0,005	0,005	0,0000	0,005	0,005
Se_mw	µg/l	140M	0,25	0,25	0,25	0,25	0,0000	0,25	0,25

Element	Unit	Method	Min	25th %ile	Med	Mean	1 S.D.	75th %ile	Max
Si_mw	mg/l	140P	0,05	0,05	0,05	0,05	0,0000	0,05	0,05
Si_fr	mg/l	503P	0,005	0,005	0,005	0,005	0,0000	0,005	0,005
Sr_mw	µg/l	140M	0,51	0,57	0,63	0,90	0,5338	1,08	2,37
Sr_fr	µg/l	503P	0,02	0,02	0,02	0,04	0,0381	0,0325	0,13
Th_mw	µg/l	140M	0,005	0,005	0,005	0,005	0,0000	0,005	0,005
Th_fr	µg/l	503P	0,25	0,25	0,25	0,25	0,0000	0,25	0,25
Ti_fr	µg/l	503P	0,31	0,49	0,66	0,71	0,3392	0,77	1,57
Tl_mw	µg/l	140M	0,005	0,005	0,005	0,005	0,0000	0,005	0,005
U_mw	µg/l	140M	0,005	0,005	0,005	0,005	0,0000	0,005	0,005
V_mw	µg/l	140M	0,15	0,18	0,19	0,20	0,0334	0,22	0,25
V_fr	µg/l	503P	0,025	0,025	0,025	0,038	0,0163	0,053	0,060
Y_fr	µg/l	503P	0,005	0,005	0,005	0,005	0,0014	0,005	0,010
Zn_mw	µg/l	140M	1,13	2,22	2,71	3,27	1,8419	3,46	7,32
Zn_fr	µg/l	503P	0,01	0,13	0,36	0,41	0,3494	0,53	1,13
EC	µS/cm	143I	12,50	13,85	14,80	16,16	3,1324	17,95	22,90
pH	-	143I	4,60	4,72	4,74	4,75	0,0789	4,82	4,89
Br	mg/l	143R	0,1	0,1	0,1	0,1	0,0000	0,1	0,1
Cl	mg/l	143R	1,00	1,20	1,25	1,58	0,5643	2,00	2,70
F	mg/l	143R	0,025	0,025	0,025	0,025	0,0000	0,025	0,025

Rainwater

by Patrice de Caritat

Rainwater collectors were installed at Points 27, 28 and 29 (see map, Fig. 7) in clusters of five individual collectors, in accordance with the specifications given in the field manual (Äyräs & Reimann, 1995), Sampling occurred 5 times during June to September 1994, hence 15 rainwater analyses are available for catchment 5.

Sampling methods are detailed in Äyräs & Reimann (1995) and analytical methods are given in this report and/or Niskavaara (1995). A summary of the analytical results for rainwater is presented in Table 5. Detailed results are given in Appendix.

Deposition rates were calculated from the rain chemical and volumetric data, and are illustrated in Figure 8. In the calculation, elements with detection limit problems, which were numerous in this 'quasi-background' catchment, were ignored. Deposition, normalised to a period of 30 days, ranges widely from element to element, over some five orders of magnitude. The highest deposition rates were calculated for SO_4, S, Cl and NO_3 (median values in the range 100,000 to 10,000 $\mu g/m^{-2}/30d^{-1}$). Lower rates were obtained for Na, K and Ca (10,000 to 1000 $\mu g/m^{-2}/30d^{-1}$), for H, Al and Zn (1000 to 100 $\mu g/m^{-2}/30d^{-1}$), for Pb, Cu, Ni, Mn, Ba, Sr and As (100 to 10 $\mu g/m^{-2}/30d^{-1}$), and, finally for V and Rb (<10 $\mu g/m^{-2}/30d^{-1}$).

Total summer deposition was also computed for comparison with existing data. Table 6 shows that the comparison of the Skjellbekken deposition data for summer 1994 is in reasonable agreement with the deposition data available from Svanvik and Karpdalen for the same year and for previous summers (Hagen et al., 1995). The discrepancies can be explained by the different location of the three stations compared. Deposition of Na at Skjellbekken is clearly less than at the other two stations,because Skjellbekken is located further inland. Ni and Cu deposition is also much lower, due to the greater distance to the Nikel smelters and the main wind directions. Pb and Zn deposition, however, is comparatively high at Skjellbekken.

Comparison of snow (winter) and rain (summer) deposition (Reimann et al., 1995) shows that some elements (Al, Ca, Cu, Ni, Sr, V and H) are deposited at comparable rates in summer and winter in 'background' catchments (Catchments 5 to 8), whilst others are dominantly deposited in summer (As, Ba, K, Mn, Pb, Rb, S and Zn) or winter (Cl and Na). The 'summer' elements are presumably emitted to higher altitudes within the troposphere in winter due to the cold air temperatures. They are thus transported further away and deposited over a larger area in winter (leading to lower winter deposition rates close to the source) than in summer. (This interpretation ignores any seasonal variation in emission rates from the smelters.) 'Winter' elements are sea salts originating from strong winter storms blowing marine aerosol far onto the land, at a higher frequency than in summer.

Compared with remote (background) precipitation data from northern Sweden (Ross, 1990), rainwater at Skjellbekken (median values) is depleted in Cd, enriched in Ni (by a factor of 10!), Pb, and about equal (within a factor of 2) in V and Zn.

Kola - 94 National Report Fig. Z PdC

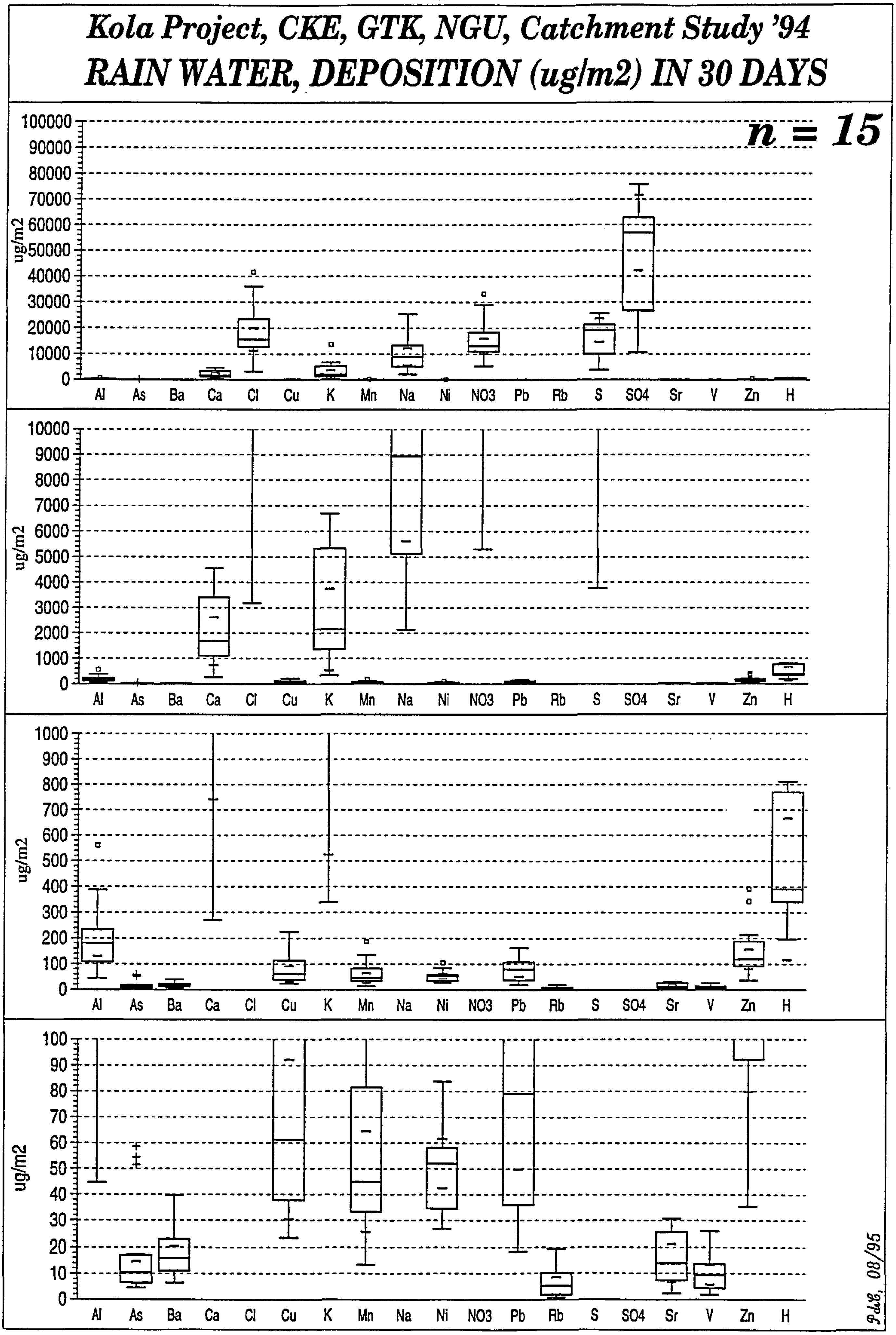


Fig. 8: Rainwater deposition data in catchment 5 compared for selected elements

	Min	25th %ile	**Med**	Mean	*1 S.D.*	75th %ile	Max
Ag	0,005	0,005	**0,005**	0,005	*0,000*	0,005	0,005
Al	2,79	4,07	**5,18**	5,85	*2,69*	7,34	11,10
As	0,15	0,24	**0,26**	0,74	*0,92*	0,58	2,60
B	0,25	0,25	**0,25**	0,32	*0,15*	0,25	0,75
Ba	0,29	0,48	**0,58**	0,55	*0,13*	0,63	0,71
Be	0,15	0,15	**0,15**	0,15	*0,00*	0,15	0,15
Bi	0,01	0,01	**0,01**	0,01	*0,00*	0,01	0,01
Br	100	100	**100**	100,00	*0,00*	100	100
Ca	25	25	**100**	78,00	*47,43*	105	160
Cd	0,015	0,015	**0,015**	0,049	*0,057*	0,040	0,160
Cl	300	300	**400**	626,67	*545,72*	500	1800
Co	0,015	0,040	**0,040**	0,064	*0,054*	0,070	0,190
Cr	0,10	0,10	**0,10**	0,10	*0,00*	0,10	0,10
Cu	0,76	0,94	**1,80**	3,31	*2,88*	5,28	9,00
F	25	25	**25**	25,00	*0,00*	25	25
Fe	5	5	**5**	5,00	*0,00*	5	5
K	30	50	**80**	106,00	*86,50*	130	330
Li	0,05	0,05	**0,05**	0,05	*0,00*	0,05	0,05
Mg	25	25	**25**	49,67	*48,86*	40	200
Mn	0,69	1,27	**1,43**	2,03	*1,14*	2,91	4,50
Mo	0,025	0,025	**0,025**	0,027	*0,006*	0,025	0,050
Na	100	200	**200**	360,00	*335,52*	250	1100
Ni	0,80	0,98	**1,31**	1,97	*1,29*	2,86	4,58
NO3	200	350	**500**	513,33	*229,49*	750	800
P	50	50	**50**	67,78	*53,33*	50	210
Pb	0,53	1,24	**2,42**	2,79	*1,86*	4,04	6,78
PO4	10	10	**10**	60,00	*161,20*	10	630
Rb	0,025	0,075	**0,090**	0,190	*0,152*	0,280	0,470
S	270	320	**350**	500,00	*267,26*	545	1110
Sb	0,015	0,015	**0,015**	0,025	*0,015*	0,035	0,050
Se	0,025	0,025	**0,025**	0,025	*0,000*	0,025	0,025
Si	50	50	**50**	50,00	*0,00*	50	50
SO4	800	950	**1000**	1466,67	*803,27*	1700	3200
Sr	0,21	0,31	**0,35**	0,51	*0,36*	0,50	1,33
Th	0,005	0,005	**0,005**	0,005	*0,000*	0,005	0,005
Tl	0,005	0,005	**0,005**	0,007	*0,004*	0,005	0,020
U	0,005	0,005	**0,005**	0,005	*0,000*	0,005	0,005
V	0,14	0,18	**0,20**	0,37	*0,37*	0,24	1,12
Zn	1,82	3,22	**3,52**	4,50	*2,18*	5,59	9,48
pH	4,40	4,50	**4,55**	4,63	*0,29*	4,60	5,20
EC	0,80	0,85	**1,10**	1,34	*0,64*	1,60	2,80

Table 5. Summary of rainwater data (in μ/l, except pH in pH units, and EC in mS/m). Values below the detection limit are given as half the detection limit.

	Karpdalen				Svanvik						Skjellbekken
	1991	1992	1993	1994	1989	1990	1991	1992	1993	1994	1994
SO4	1090	1230	999	654	944	435	480	630	593	639	273
NO3	160	270	214	288	212	172	95	160	147	217	94
As	0,13	0,24	0,13	0,27	0,62	0,47	0,27	0,40	0,32	0,47	0,11
Cu	1,60	1,50	1,01	2,46	6,43	3,68	2,40	4,20	3,70	4,14	0,48
K	38	83	58	25	22	25	<25	<34	22	42	23
Na	440	440	759	247	261	212	76	110	173	107	59
Ni	1,60	1,30	0,92	2,99	6,82	3,24	2,80	2,90	3,10	4,63	0,30
Pb	0,31	0,54	0,29	0,36	0,64	0,43	0,29	0,35	0,27	0,46	0,43
Zn	1,30	1,50	0,91	1,37	1,86	1,67	0,87	0,97	0,60	1,66	0,90

Tabell 6. Summer deposition at Karpdalen (1991-1993), Svanvik (1989-1993) (Hagen et al., 1994) and Skjellbekken (1994), in mg/m^2

Stream water

by Patrice de Caritat

Skjellbekken is one of three catchments selected for a more detailed monitoring of its runoff chemistry. Accordingly, stream water was collected from Skjellbekken near the outlet of the catchment (point 1 on Fig. 7) on 34 occasions between March and November 1994. The sampling frequency was approximately one sample per week. The period of higher flow (thaw) extended from 15 April to 18 May 1994, with a peak on 4-11 May 1994. As the stream was not gauged, it is not possible to calculate the flux of elements out of the catchment.

Sampling methods are detailed in Äyräs & Reimann (1995), and analytical methods are given in Niskavaara (1995). Table 7 summarizes the analytical results for stream water. Detailed results are given in Appendix. The time-dependent variation in chemical composition is shown as time-series in Fig. 9.

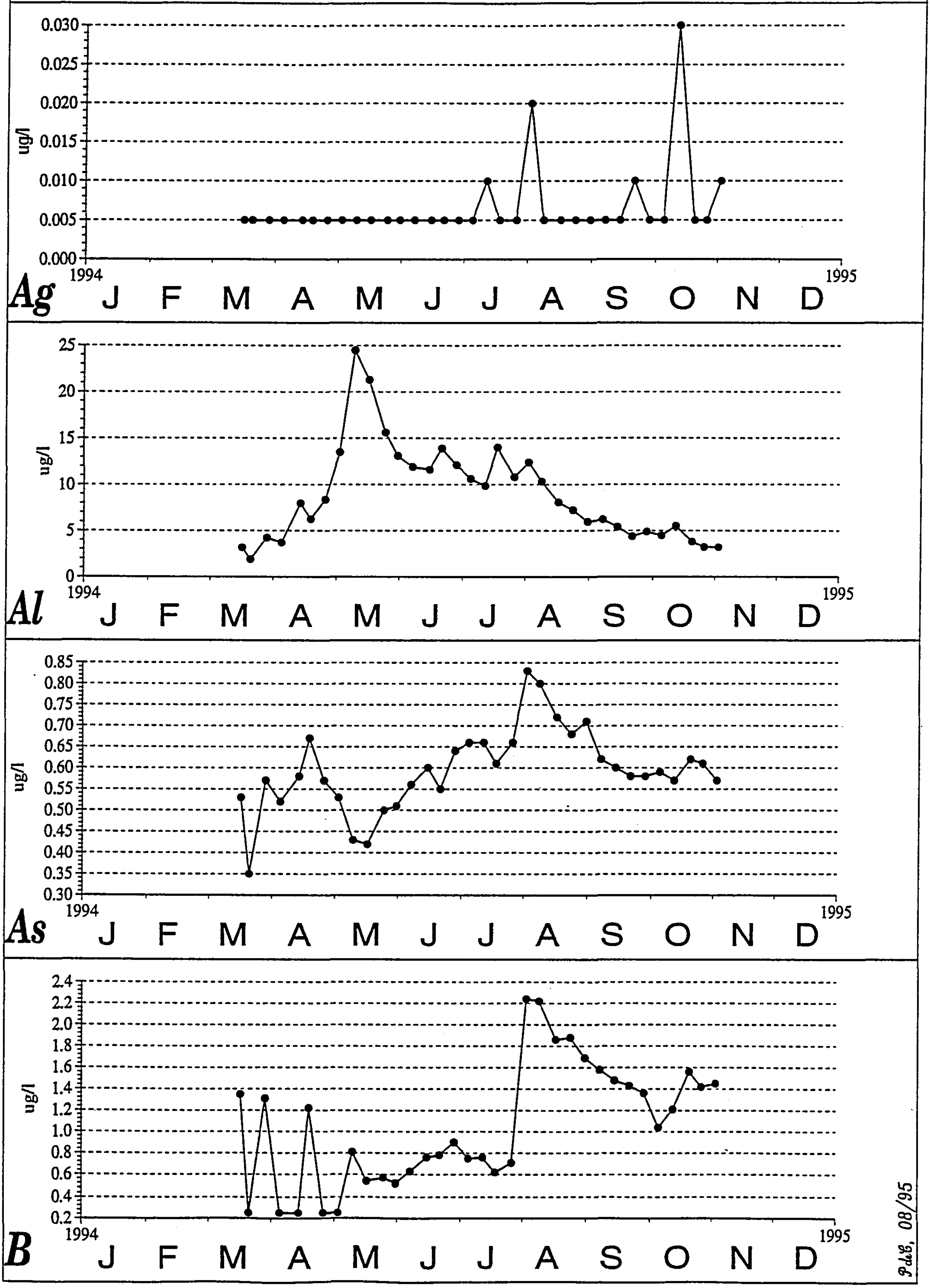
Compared to the table published by Hart & Hines (1995), Skjellbekken stream water is comparable (within a factor of 2) to world-wide background stream water in terms of (median) Cu, Zn and probably also Cd content, lower than background in terms of Pb, and above background in terms of Ni.

The time-series diagrams (Fig. 9) show that when the snow thawed (May 1994) few elements showed a peak (Al, Ni), many showed a depression (As, Ba, Ca, K, Mg, Mn, Mo, Na, S, Sr, U, Cl, SO_4), and others showed no clear change in trend (B, Cu, Fe, Li, Pb, Rb, Si, V, Zn); EC decreased and pH increased. The spring thaw consequently does not lead to an «acid surge» to the stream at Skjellbekken. This is because this catchment receives relatively little acid deposition, despite its proximity to the Nikel smelters. It is known from snow analysis at Skjellbekken that the snowpack there is relatively pristine, though quite loaded in sea salts and mildly enriched in Cu and Ni (Äyräs et al., 1995). When the thaw takes place, the material transferred to the streams is thus dominated by a dilution process.

Table 7 Summary of stream water data (in µg/l except pH units, and EC in mS/m). Values below the detection limit are given as half the detection limit.

	Min	25th %ile	Med	Mean	*1 S.D.*	75th %ile	Max
Ag	0,005	0,005	**0,005**	0,007	*0,005*	0,005	0,030
Al	1,90	4,58	**8,02**	8,92	*5,25*	12,05	24,50
As	0,35	0,55	**0,59**	0,59	*0,10*	0,66	0,83
B	0,25	0,62	**0,97**	1,06	*0,57*	1,45	2,24
Ba	7,41	10,00	**11,20**	11,16	*1,89*	11,80	15,20
Be	0,15	0,15	**0,15**	0,15	*0,00*	0,15	0,15
Bi	0,01	0,01	**0,01**	0,01	*0,00*	0,01	0,01
Br	100	100	**100**	100,00	*0,00*	100	100
Ca	8250	13075	**16150**	15020,59	*2903,40*	17175	19400
Cd	0,015	0,015	**0,015**	0,015	*0,000*	0,015	0,015
Cl	1700	2225	**2600**	2902,94	*2432,29*	2700	16500
Co	0,015	0,015	**0,015**	0,015	*0,003*	0,015	0,030
Cr	0,10	0,10	**0,10**	0,10	*0,02*	0,10	0,21
Cu	0,25	0,76	**0,92**	0,95	*0,36*	1,09	2,24
F	25	25	**25**	25,00	*0,00*	25	25
Fe	10	20	**40**	44,12	*28,08*	50	130
K	530	760	**900**	863,82	*182,49*	970	1180
Li	0,05	0,23	**0,29**	0,29	*0,11*	0,37	0,51
Mg	600	925	**1170**	1097,65	*209,43*	1248	1500
Mn	1,05	1,96	**2,61**	2,85	*1,18*	3,30	5,95
Mo	0,025	0,150	**0,160**	0,160	*0,035*	0,180	0,210
Na	1300	1825	**2100**	2029,41	*341,59*	2200	2900
Ni	0,41	0,80	**0,92**	0,98	*0,26*	1,12	1,59
NO3	100	100	**100**	158,82	*132,84*	100	700
P	50	50	**50**	50,00	*0,00*	50	50
Pb	0,015	0,015	**0,040**	0,047	*0,039*	0,070	0,190
PO4	10	10	**10**	10,00	*0,00*	10	10
Rb	0,45	0,61	**0,66**	0,67	*0,09*	0,72	0,85
S	1450	2040	**2155**	2192,35	*306,95*	2418	2980
Sb	0,015	0,015	**0,015**	0,015	*0,000*	0,015	0,015
Se	0,025	0,025	**0,025**	0,025	*0,000*	0,025	0,025
Si	1170	1520	**1900**	1962,06	*588,23*	2175	3400
SO4	4900	6100	**6550**	6629,41	*935,02*	7275	9100
Sr	14,10	23,53	**31,35**	28,23	*6,25*	32,40	37,40
Th	0,005	0,005	**0,005**	0,005	*0,000*	0,005	0,005
Tl	0,005	0,005	**0,005**	0,005	*0,000*	0,005	0,005
U	0,02	0,04	**0,06**	0,05	*0,01*	0,07	0,07
V	0,11	0,19	**0,21**	0,21	*0,04*	0,24	0,32
Zn	0,42	1,03	**1,43**	2,21	*2,75*	2,01	15,90
pH	6,65	7,00	**7,20**	7,16	*0,24*	7,30	7,60
EC	5,50	8,55	**10,40**	9,81	*1,86*	11,03	13,30

Kola Project, CKE, GTK, NGU, Catchment Study '94
STREAM WATER: Catchment 5



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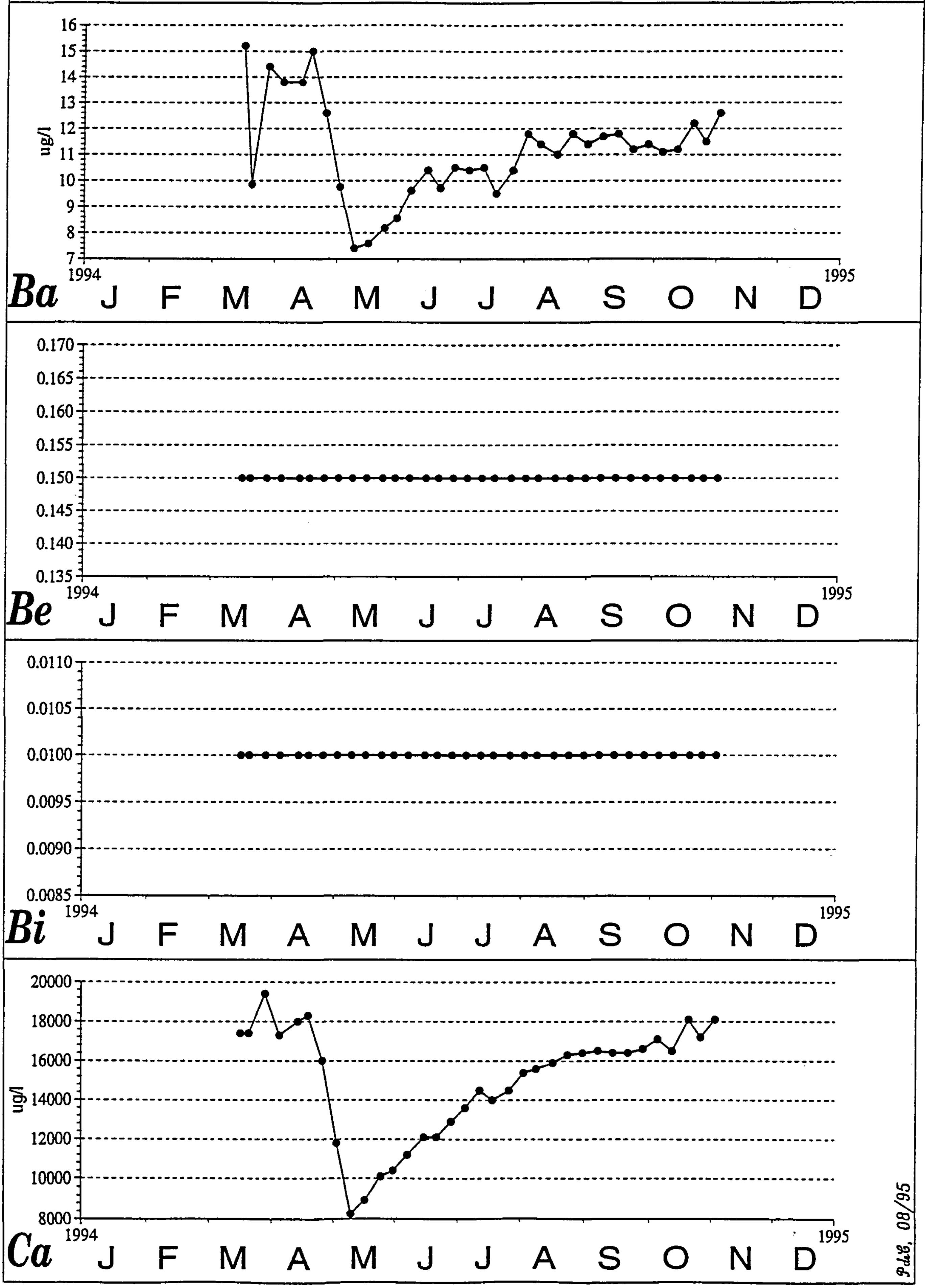

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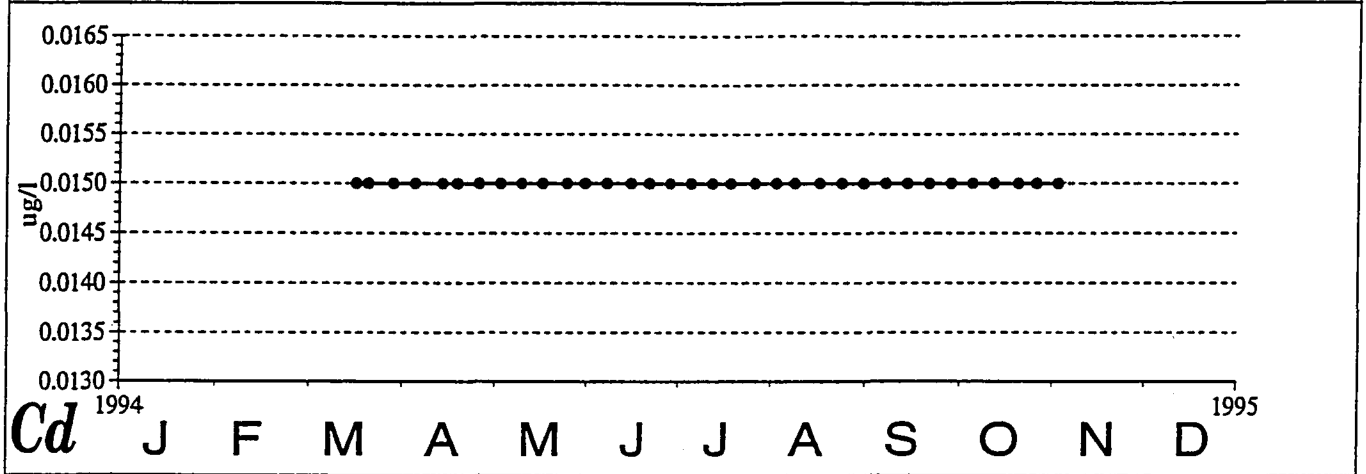

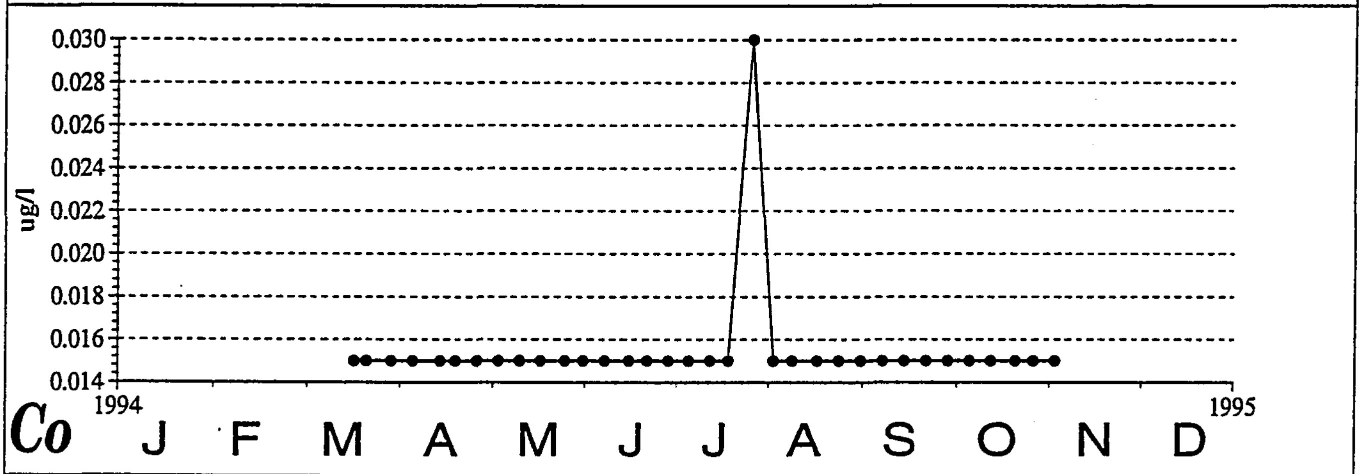

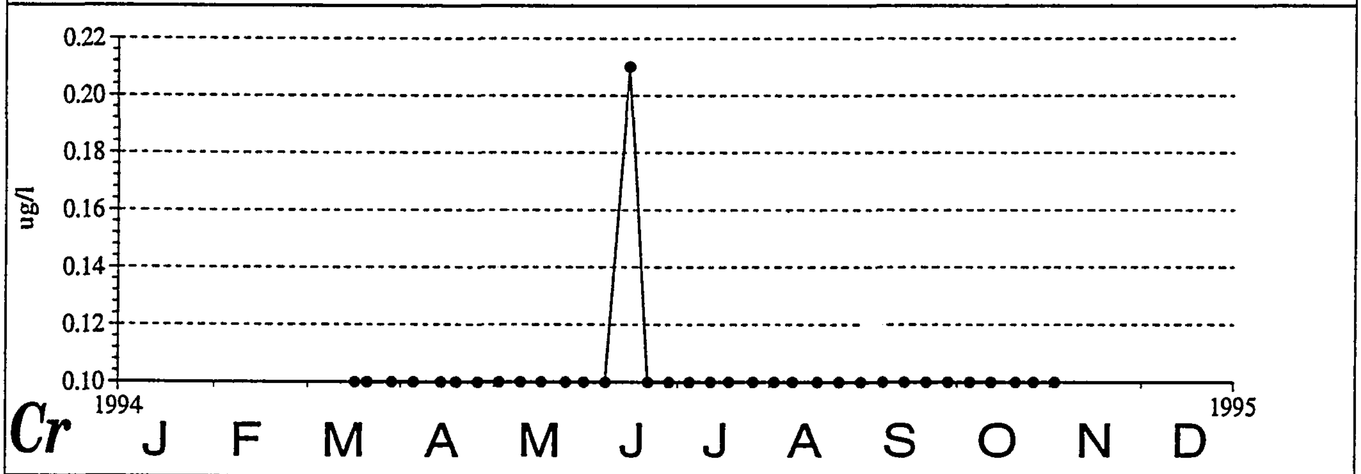

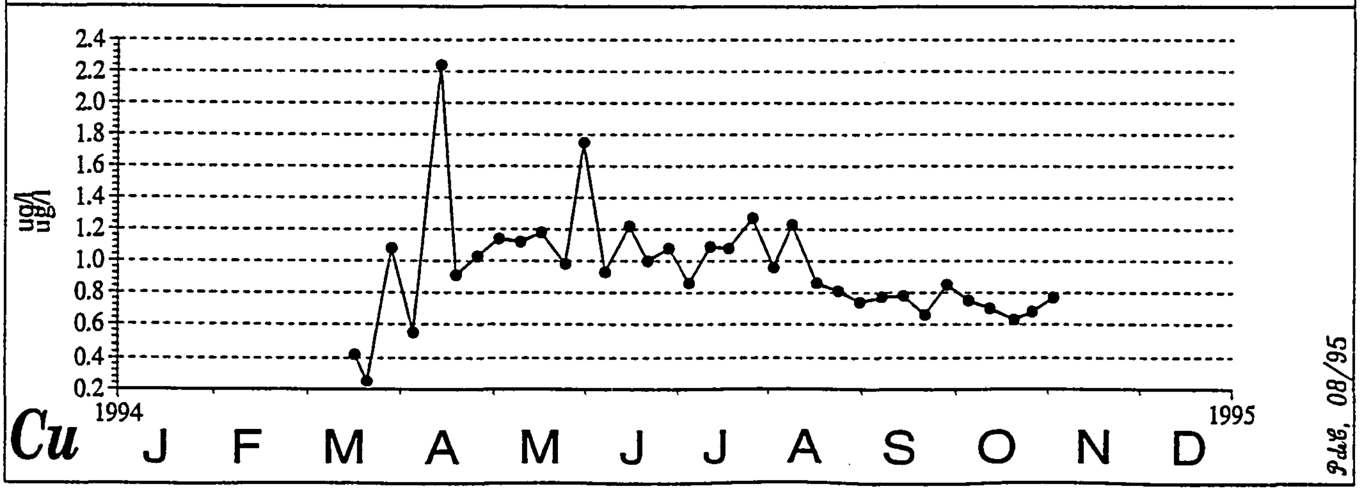

Kola Project, CKE, GTK, NGU, Catchment Study '94
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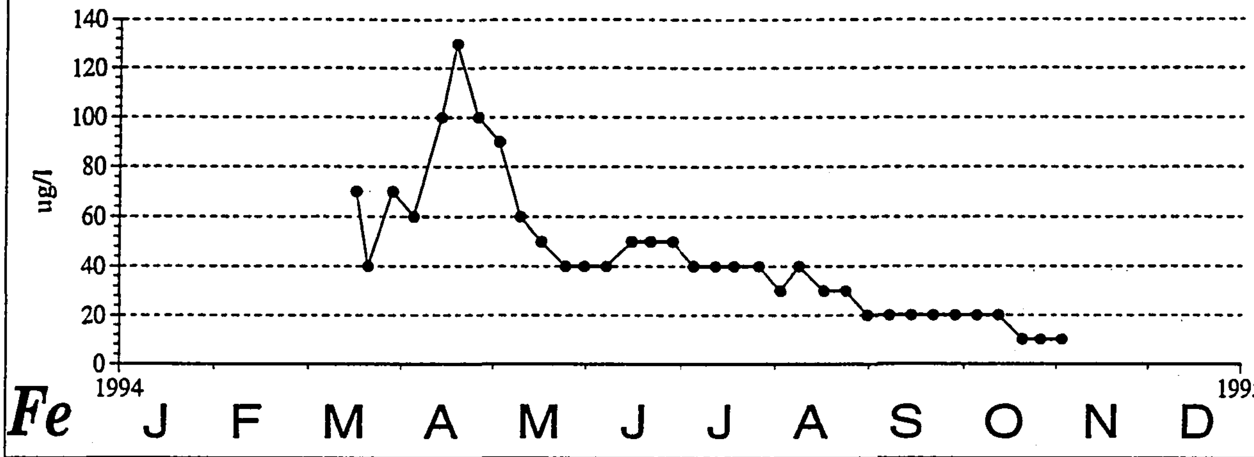
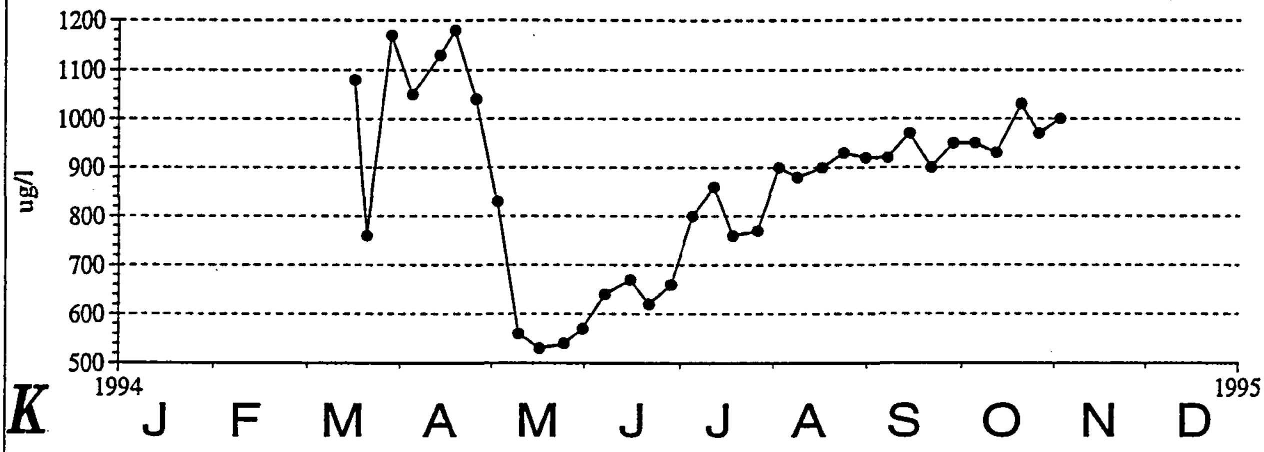
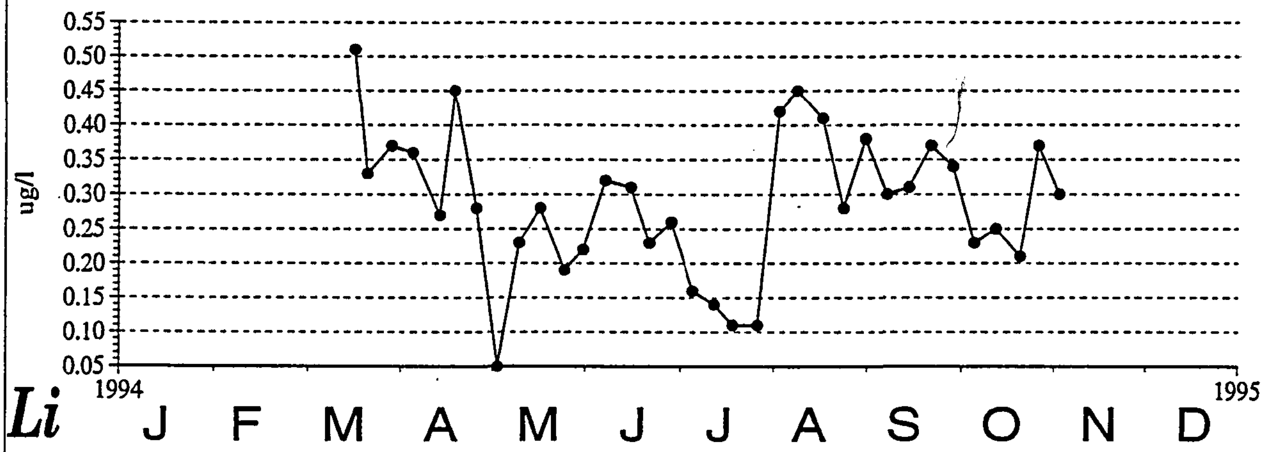
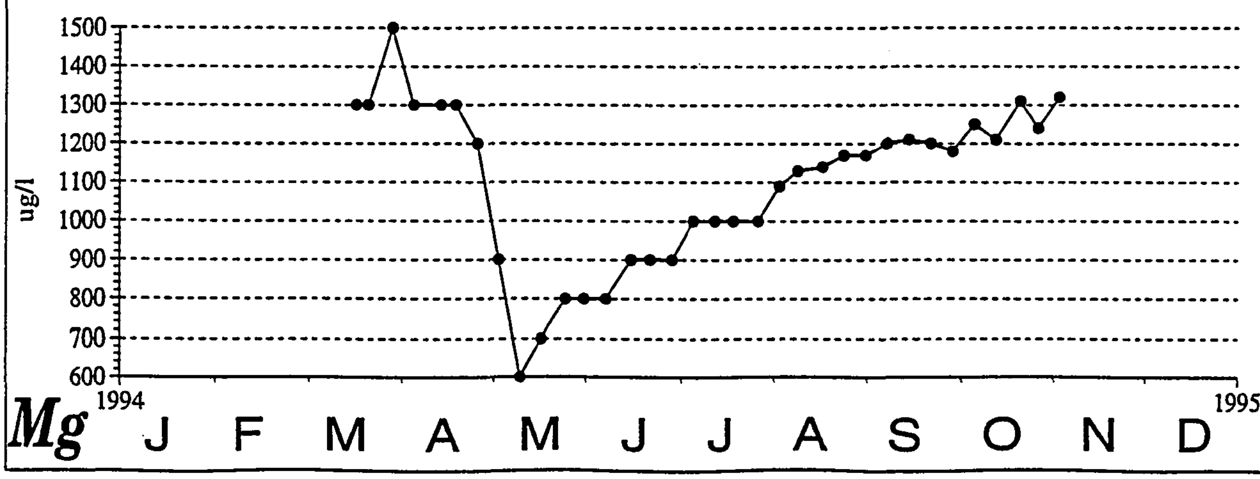
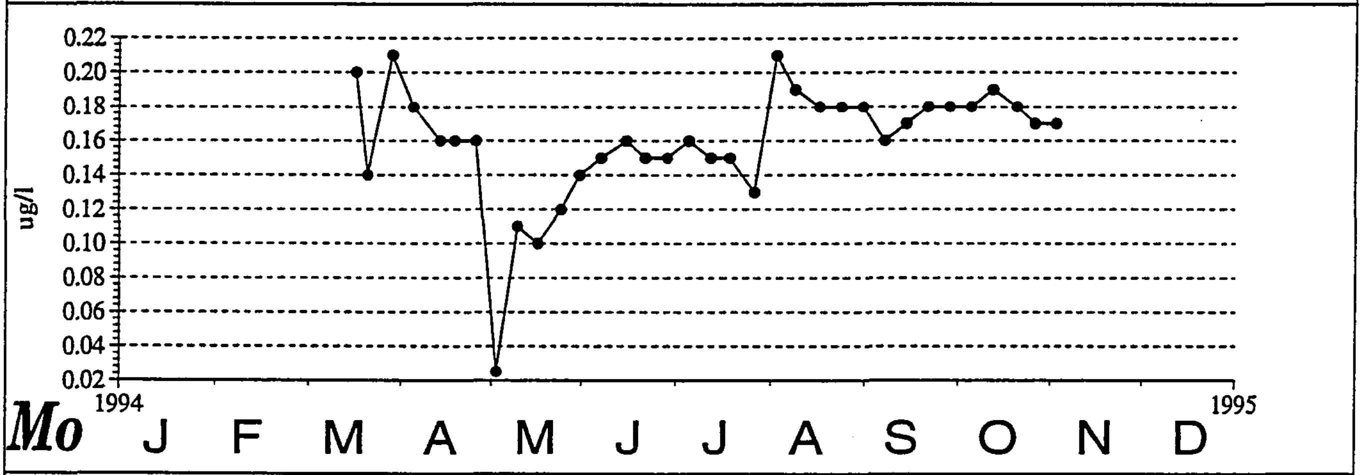


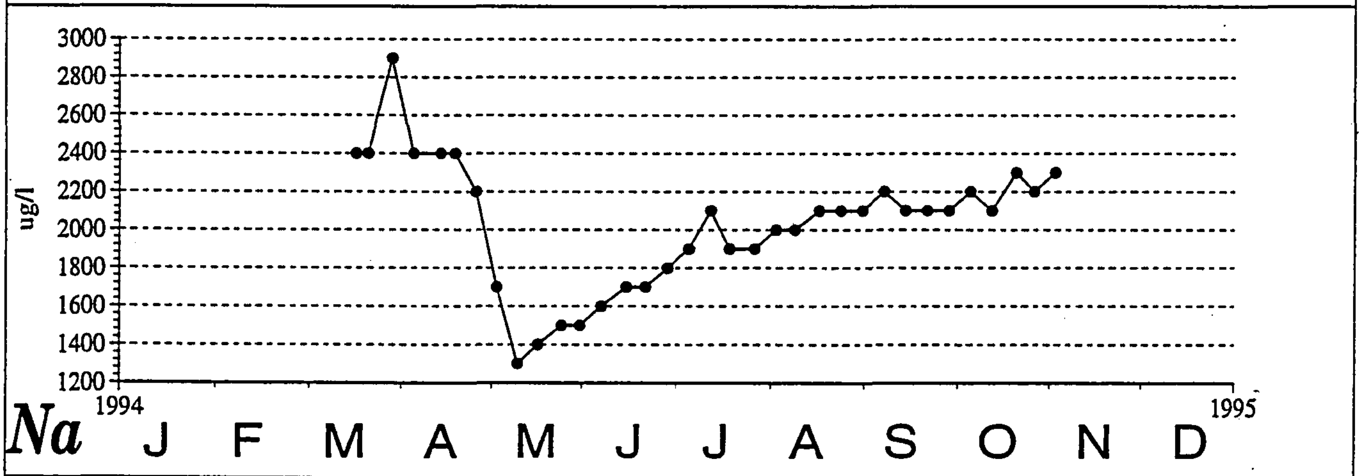


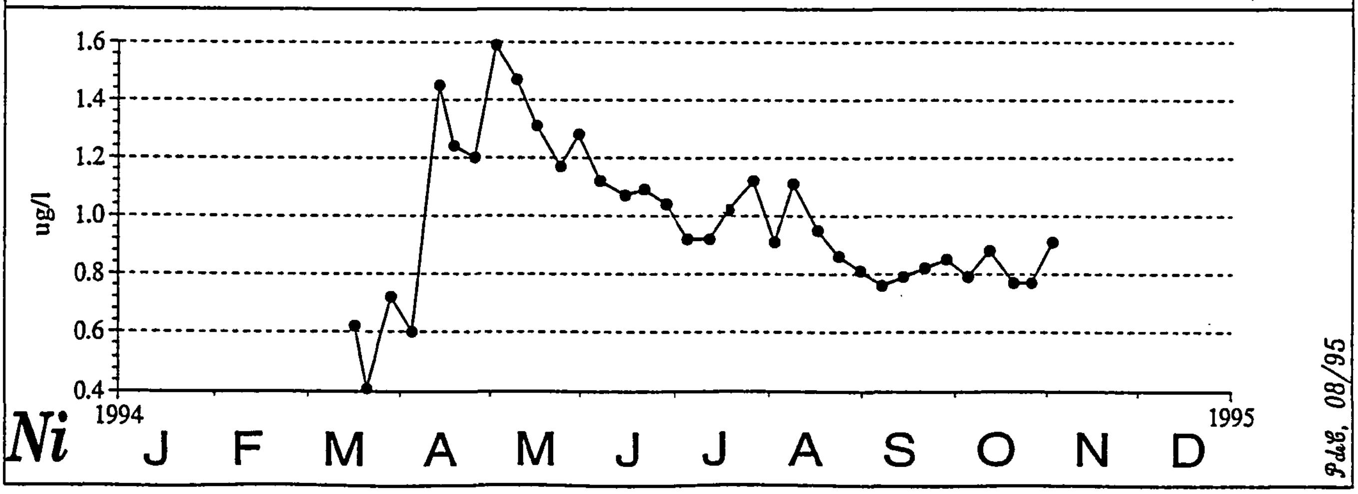




Kola Project, CKE, GTK, NGU, Catchment Study '94
STREAM WATER: Catchment 5







Pdg, 08/95

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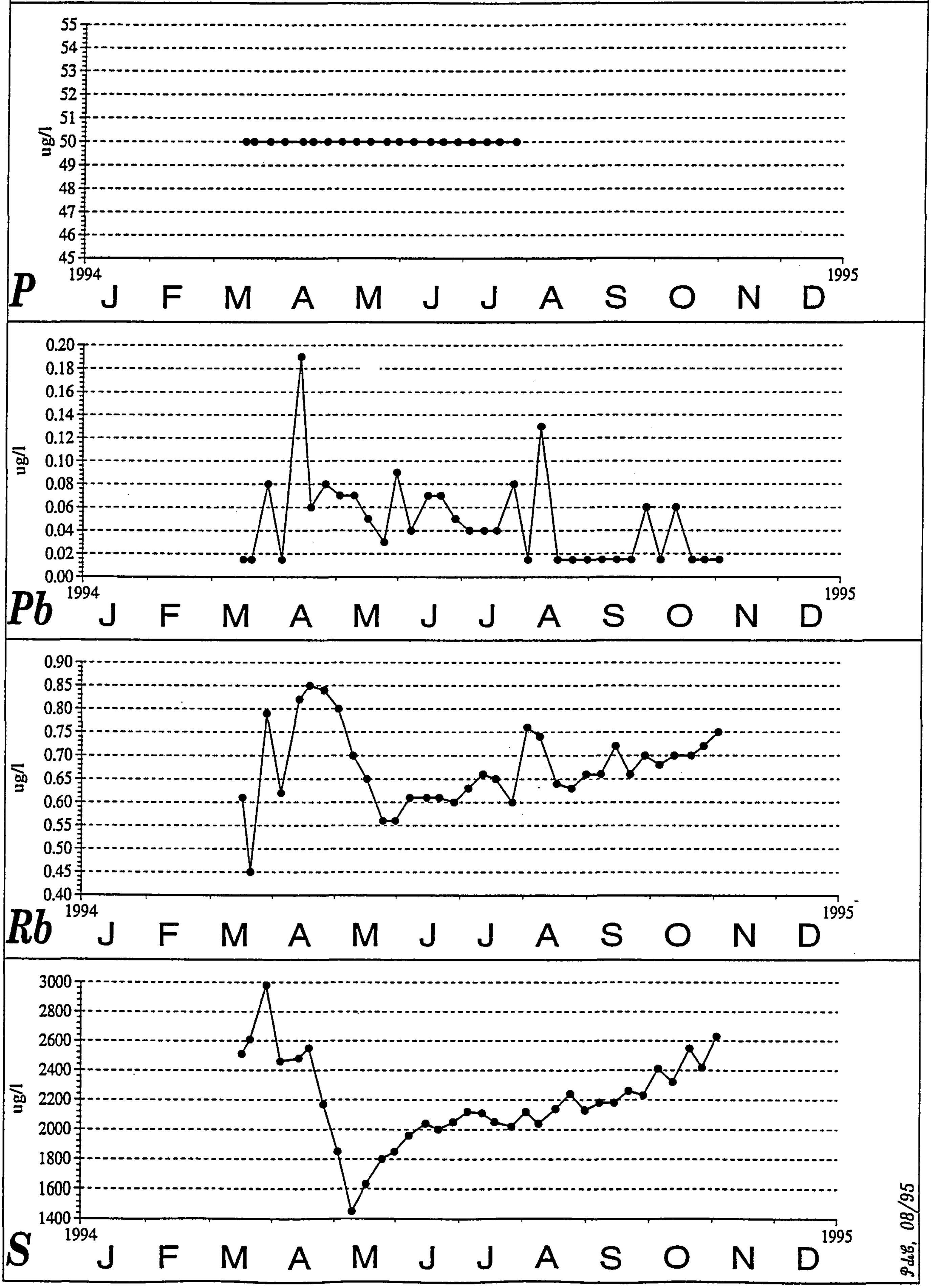

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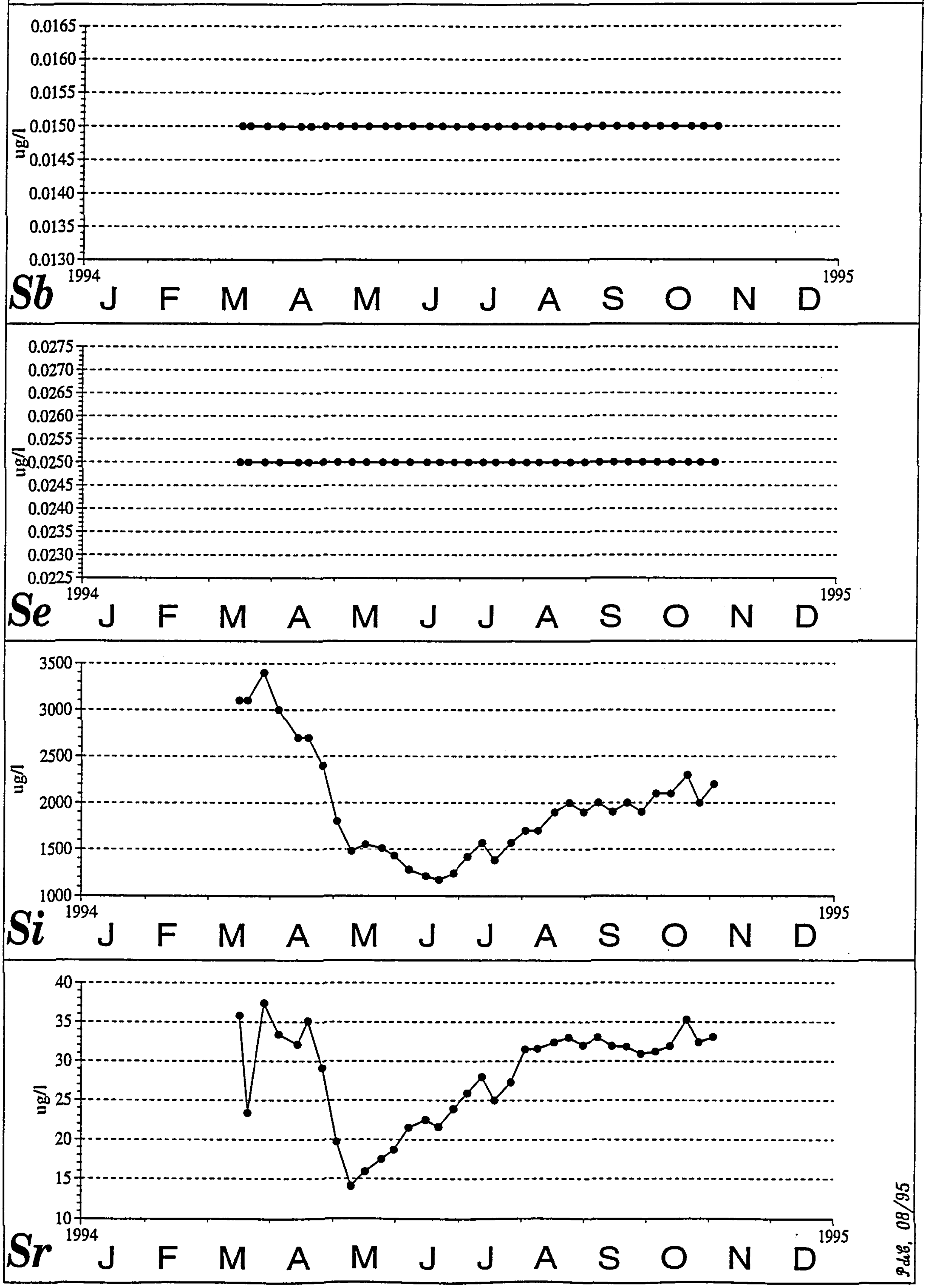
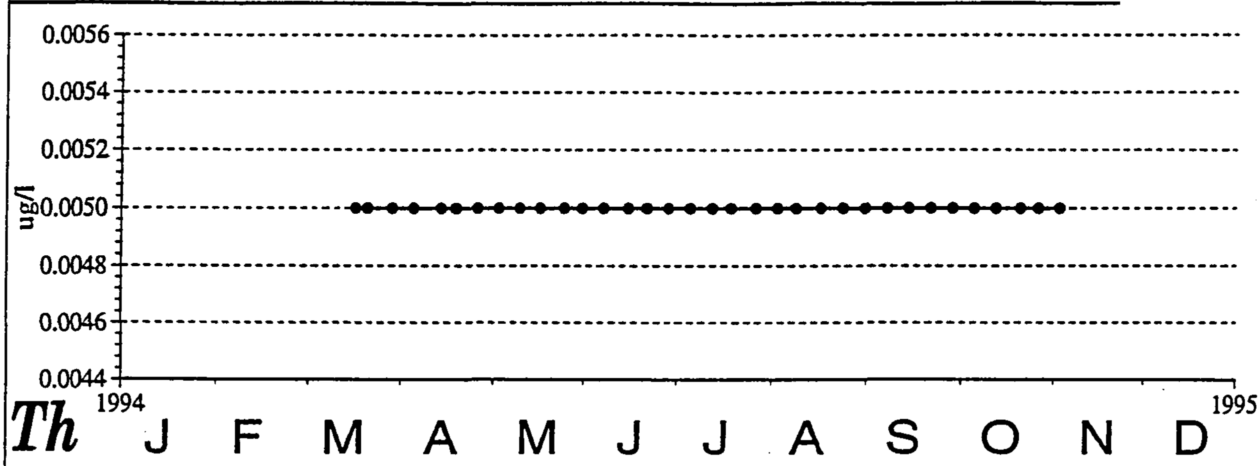
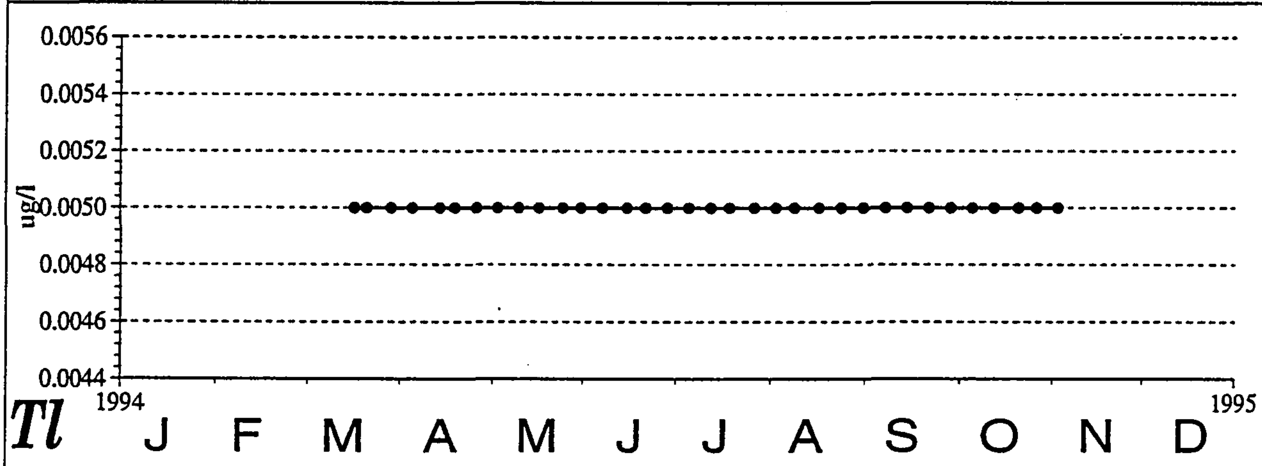
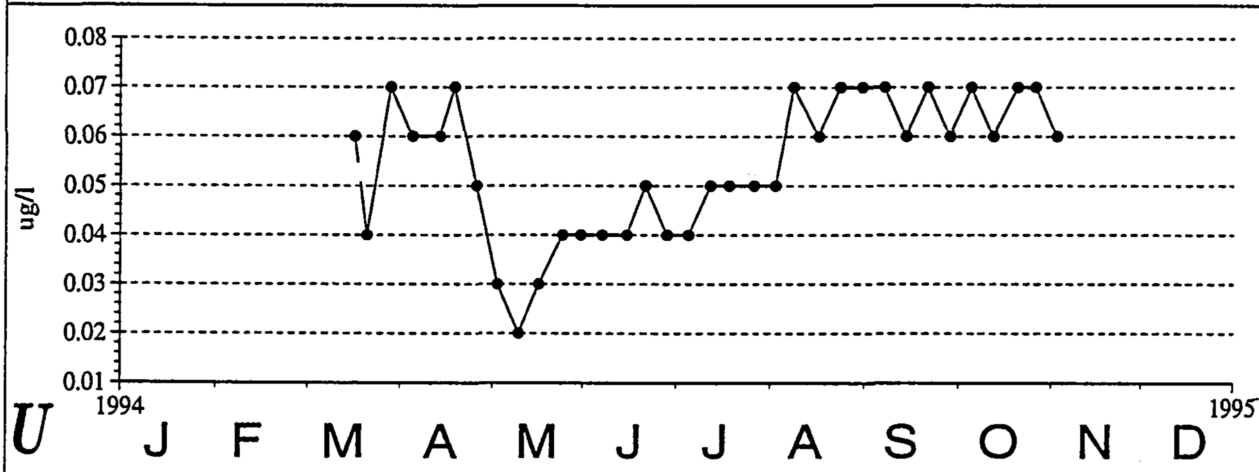
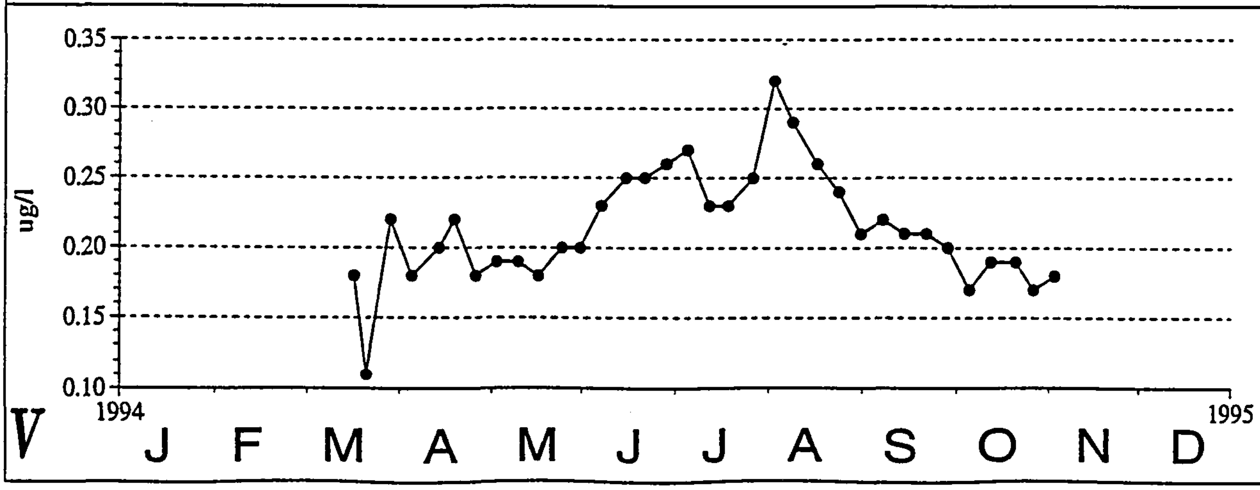


Kola Project, CKE, GTK, NGU, Catchment Study '94
STREAM WATER: Catchment 5









Pde, 08/95

Kola Project, CKE, GTK, NGU, Catchment Study '94
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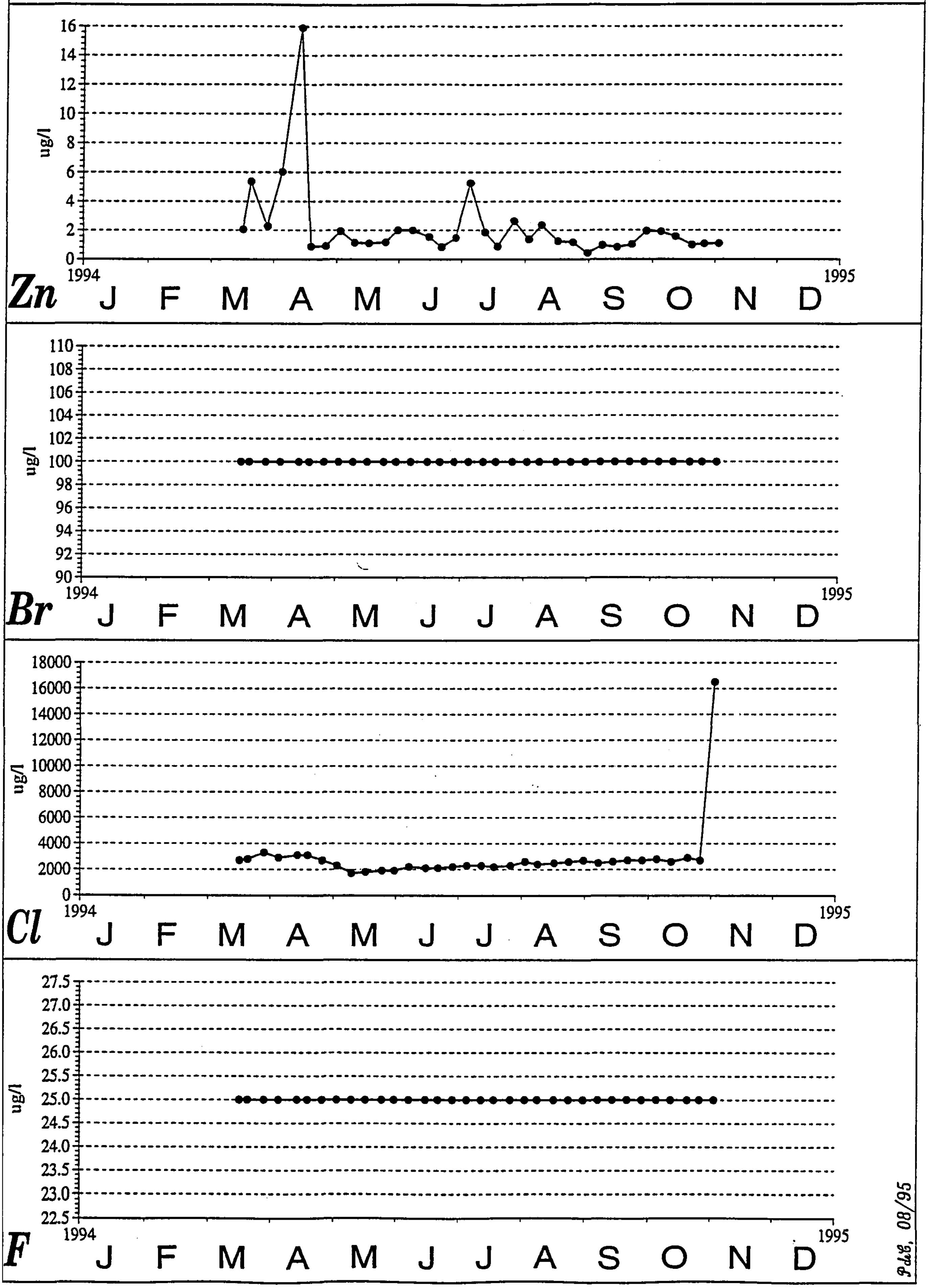
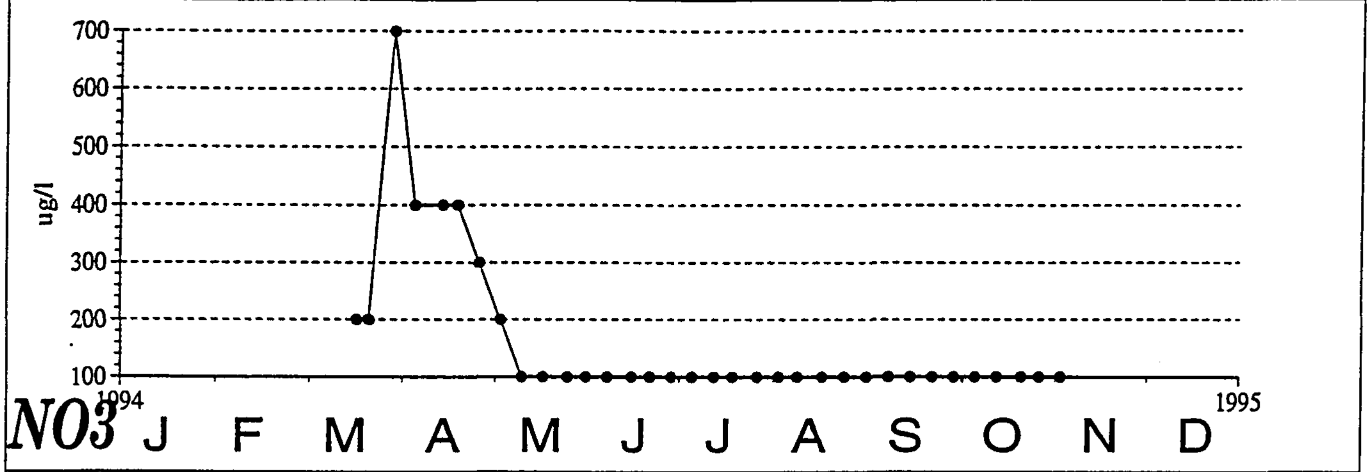
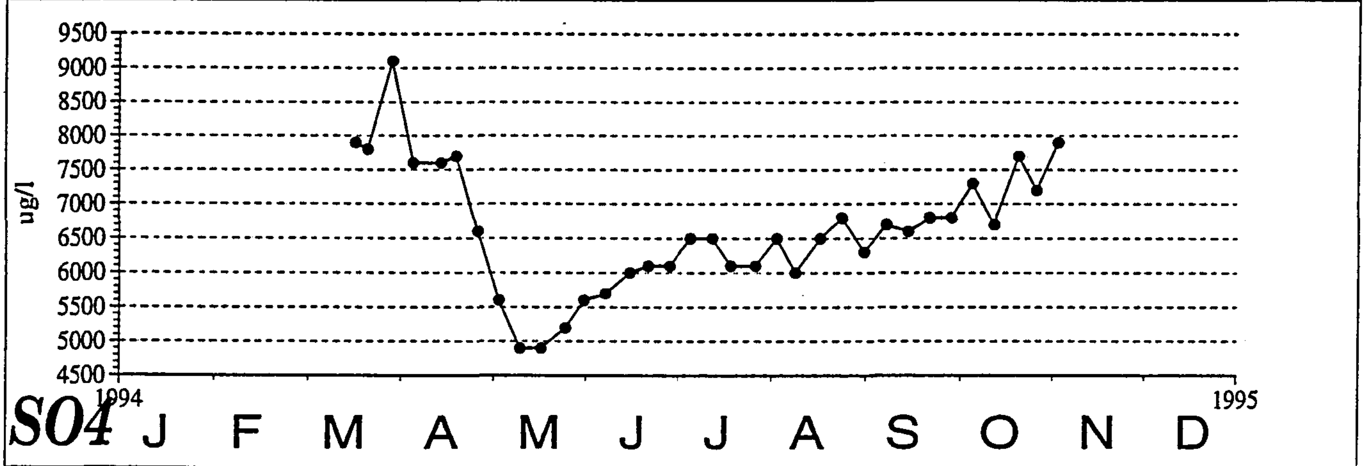
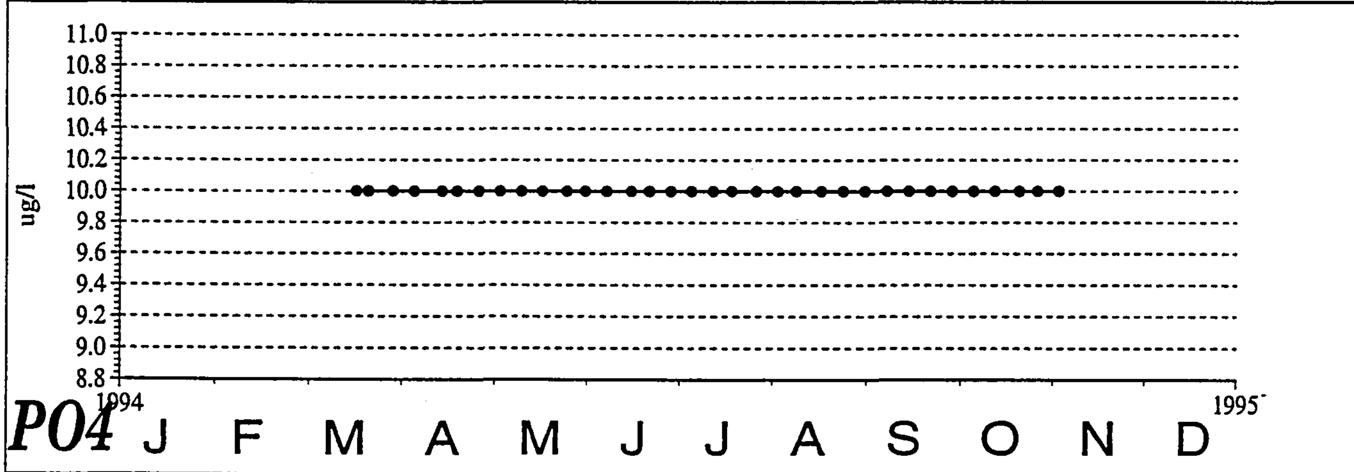


Kola Project, CKE, GTK, NGU, Catchment Study '94
STREAM WATER: Catchment 5







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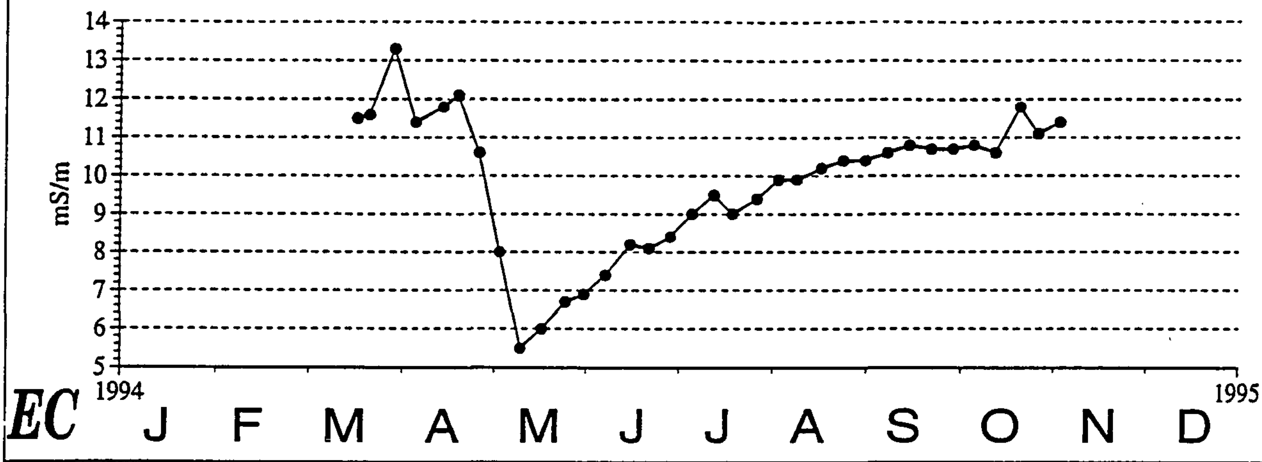
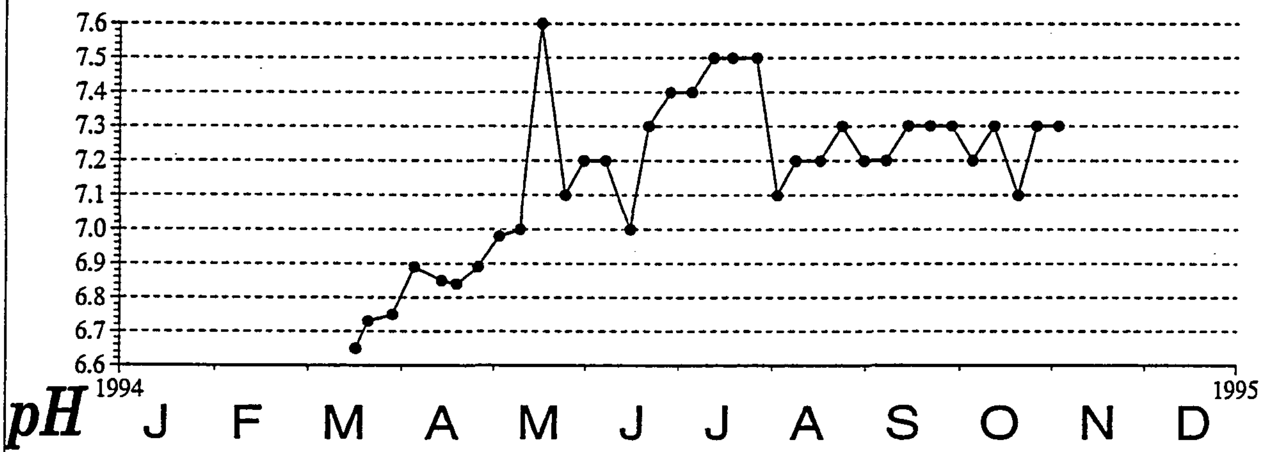




PdB, 08/95

Groundwater

by Øystein Jæger

Groundwater wells (Fig. 10) were installed in clusters of three at three different locations (loc. 42, 43, 44 - on Fig. 7) in the Skjellbekken catchment in August 1994. All three localities are in an area of glaciofluvial deposits in the lower part of the catchment. The three wells in each cluster were installed with screens in the lower, middle and upper part of the groundwater reservoir (Figs. 10-13). In addition, an observation well was installed southwest of the catchment. All the groundwater wells were constructed with white PEH tubing to avoid heavy metal contamination of the samples. Each of the nine wells was equipped with a small electric pump for sampling.

Groundwater was sampled for the first time on 20 and 21 September 1994 and the second time on 9 February 1995. From 11 April until 6 July 1995, groundwater was sampled weekly, and thereafter monthly. Sampling will continue monthly until December 1995. In addition to sampling, the water level has been measured in each well.

Sampling methods are detailed in Äyräs & Reimann (1995), and analytical methods are described above and in Niskavaara (1995). Table 8 summarizes the analytical results for the first groundwater samples (September 1994). Detailed results are given in Appendix. The rest of the results will be presented as a separate report when all the analyses are available.

Allard (1995) suggested a range of composition of 'background' groundwater for 8 trace elements (heavy metals). Table 8 compares his median 'background' values with the median Skjellbekken groundwater composition.

Table 8. Comparison of typical, median 'background' values for heavy metals in groundwater (from Allard, 1995) with the median content in Skjellbekken groundwater

Element (µg/l)	'background' median	Skjellbekken median
Cr	0.2-1	<0.2
Ni	0.5	**0.68**
Cu	1-3	0.61
Zn	10-15	2.04
As	0.5-0.9	0.37
Cd	0.03-0.1	<0.03
Hg	0.1	n/a
Pb	0.08-0.5	0.14

From Table 8, it is clear that only for Ni does the groundwater at Skjellbekken exceed the world-wide 'background' values. This is also the case for stream water (see elsewhere in this report),m but there is much less Ni in groundwater (1.36 times the 'background' value) than in stream water (3.06 times the 'background' value). Pb in groundwater at Skjellbekken is within the 'background' range, but other elements (no data available for Hg) are below the 'background' values for groundwater (Allard, 1995).

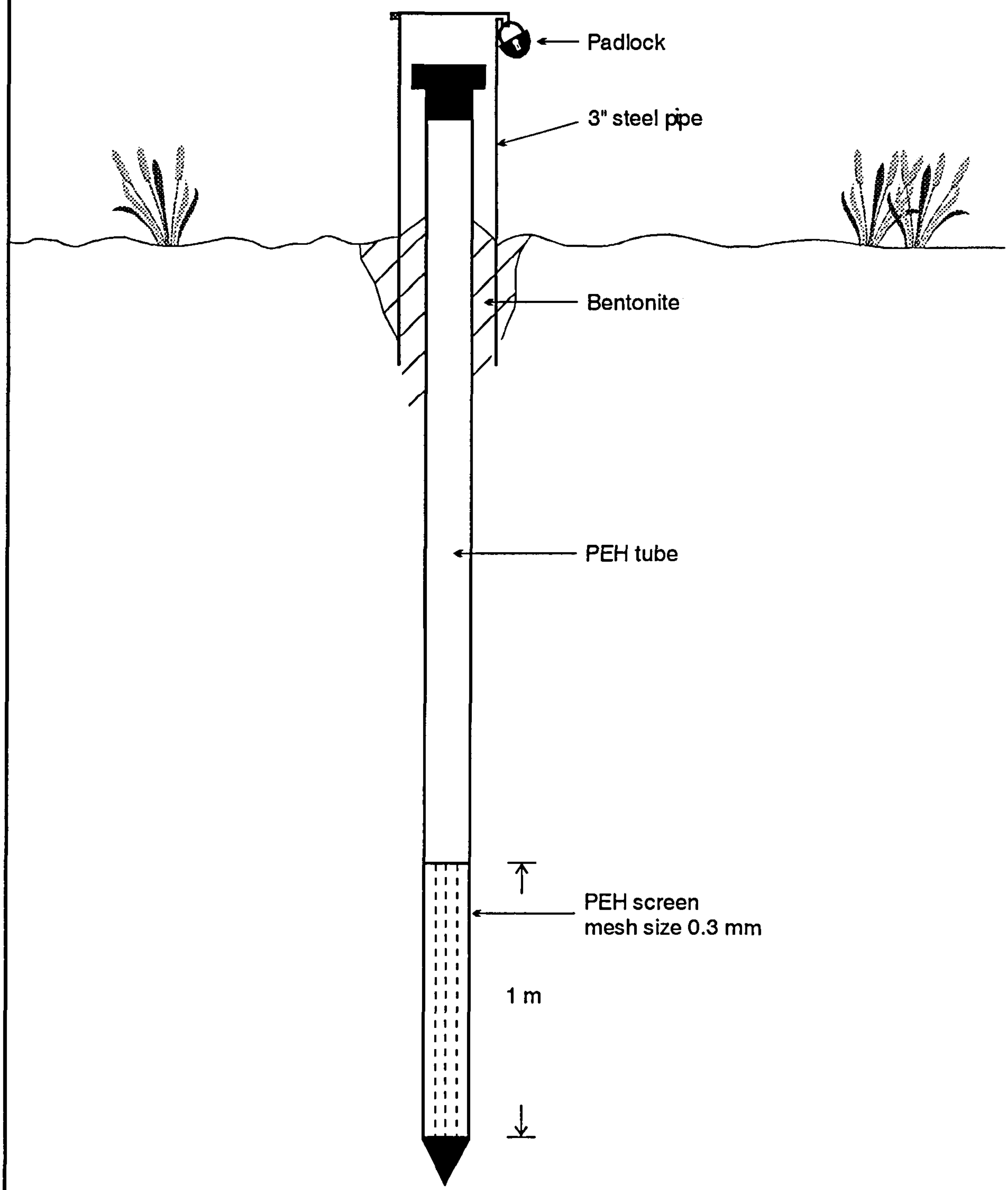
The composition of the groundwater is remarkably similar to that of the stream water, with the notable exception of Co, Mo, Mn and PO_4, which are more abundant in the groundwater, and the concentration of Fe, which is higher in the stream water.

Table 8B Summary of groundwater data (in µg/l, except pH in pH-units, and EC in mS/m). Values below detection limit set to ½ detection limit.

	Min	25th %ile	**Med**	Mean	*1 S.D.*	75th %ile	Max
Ag	0,005	0,005	**0,005**	0,01	*0,01*	0,02	0,03
Al	1,15	10,2	**14,1**	57,61	*93,23*	37,7	281
As	0,05	0,2	**0,37**	0,91	*1,14*	0,81	3,06
B	0,99	2,17	**2,65**	2,93	*1,72*	3,48	6,7
Ba	2,33	6,1	**7,04**	9,73	*5,91*	15,2	20,1
Be	0,15	0,15	**0,15**	0,15	*0,00*	0,15	0,15
Bi	0,01	0,01	**0,01**	0,01	*0,00*	0,01	0,01
Br	50	50	**50**	50,00	*0,00*	50	50
Ca	2100	3400	**6200**	10733,33	*8795,45*	16100	24000
Cd	0,015	0,015	**0,015**	0,02	*0,01*	0,015	0,05
Cl	2290	2380	**2590**	2762,22	*550,34*	3010	4010
Co	0,05	0,1	**0,22**	0,55	*0,76*	0,62	2,31
Cr	0,1	0,1	**0,1**	0,25	*0,29*	0,1	0,87
Cu	0,23	0,35	**0,61**	1,16	*1,73*	0,71	5,69
F	25	25	**62,3**	51,81	*26,24*	74,2	83,1
Fe	5	5	**5**	42,22	*100,75*	10	310
K	480	1790	**2050**	2267,78	*1180,11*	2600	4280
Li	0,05	0,25	**0,36**	0,48	*0,39*	0,54	1,39
Mg	460	700	**1730**	1343,33	*678,80*	1800	2230
Mn	5,7	11,9	**21,1**	24,78	*16,88*	30,8	53,6
Mo	0,025	0,79	**1,59**	2,68	*3,22*	4	10,4
Na	2300	2300	**3000**	2955,56	*622,72*	3200	4200
Ni	0,37	0,5	**0,68**	1,29	*1,29*	1,66	4,3
NO3	25	25	**114**	164,78	*172,04*	210	474
P							
Pb	0,015	0,015	**0,14**	0,14	*0,12*	0,21	0,35
PO4	100	100	**100**	100,00	*0,00*	100	100
Rb	0,35	0,84	**1,41**	1,38	*0,74*	1,83	2,66
S	630	1150	**1940**	2546,67	*1990,19*	4560	5850
Sb	0,015	0,015	**0,05**	0,08	*0,08*	0,14	0,23
Se	0,025	0,025	**0,025**	0,03	*0,00*	0,025	0,025
Si	2500	3300	**3700**	3866,67	*881,76*	4500	5200
SO4	2030	3730	**6190**	8337,78	*6611,63*	14800	19600
Sr	10,5	15	**28,9**	25,54	*12,34*	36,8	42,1
Th	0,005	0,005	**0,005**	0,03	*0,06*	0,01	0,19
Tl	0,005	0,005	**0,005**	0,01	*0,00*	0,01	0,01
U	0,005	0,05	**0,07**	0,18	*0,22*	0,22	0,71
V	0,15	0,24	**0,33**	0,40	*0,23*	0,52	0,87
Zn	1,12	1,67	**2,04**	2,76	*2,06*	3,07	7,85
pH	6,4	7,1	**7,13**	7,22	*0,41*	7,53	7,71
EC	3,5	4,1	**7**	8,76	*5,09*	13	15,8

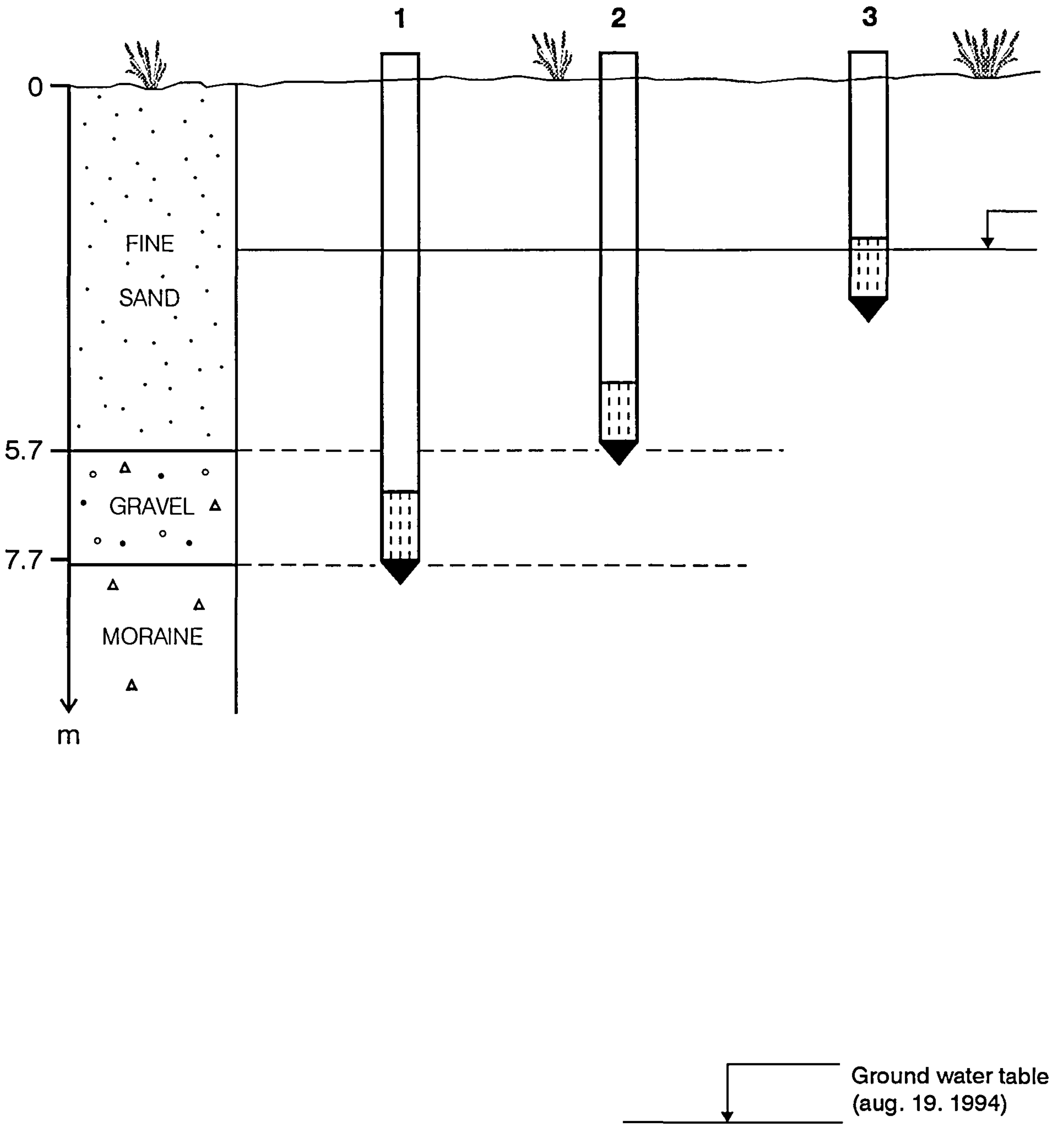
SKJELLBEKKEN

2" GROUND WATER WELL



SKJELLBEKKEN

GROUND WATER
• STATION 42



SKJELLBEKKEN

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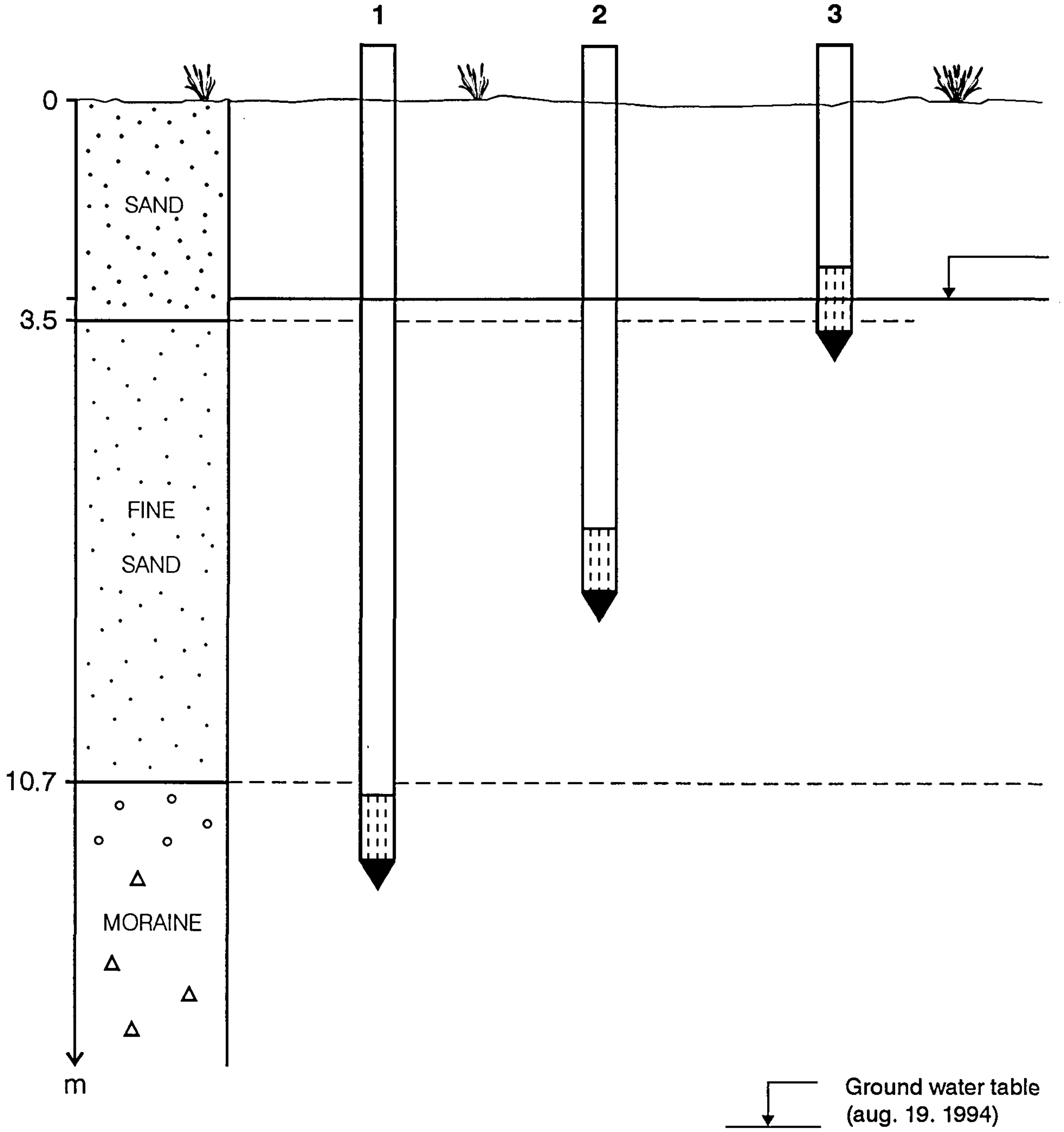
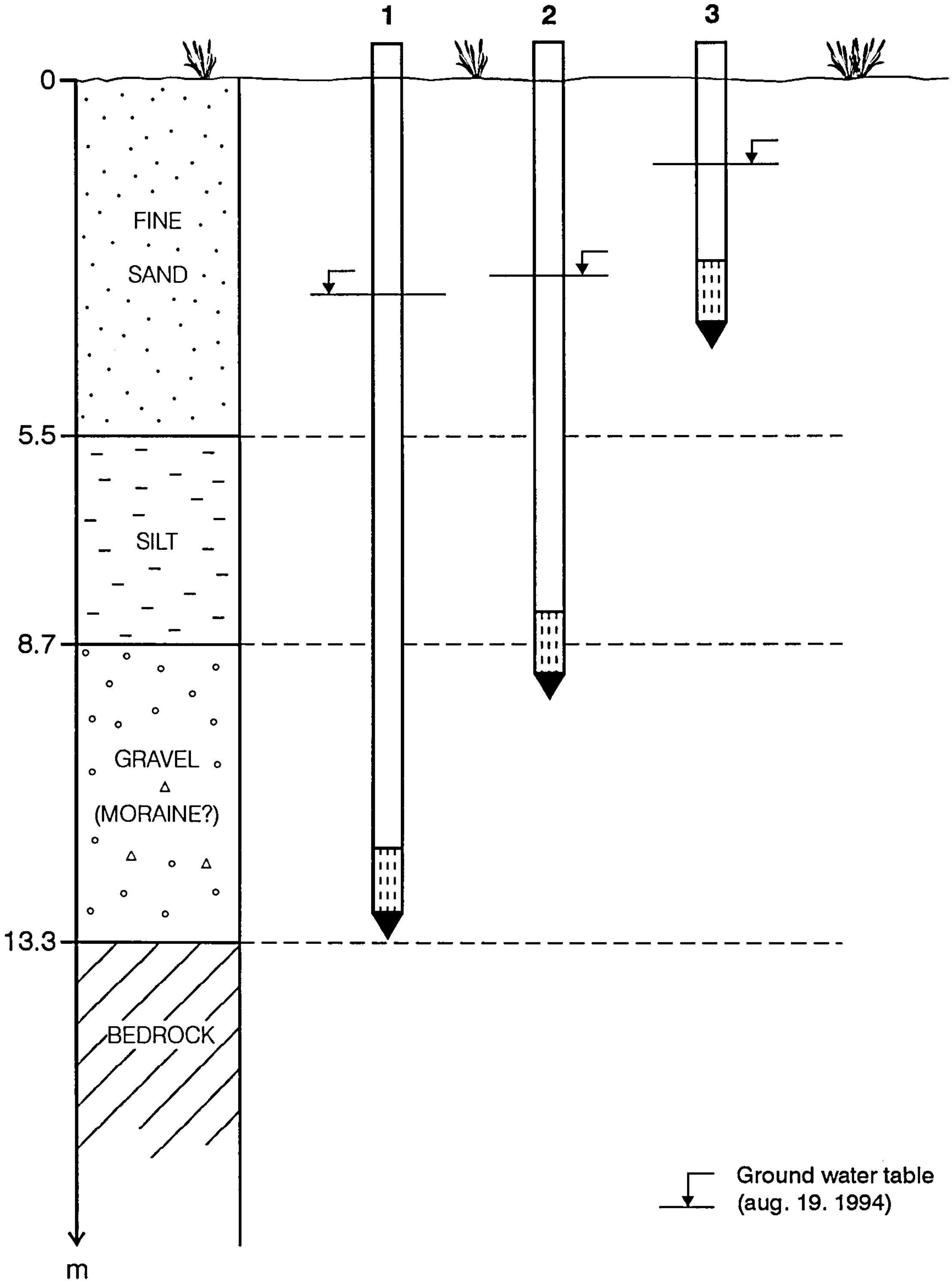
• STATION 43



SKJELLBEKKEN

GROUND WATER
• STATION 44



Organic stream sediments

by Jo H. Halleraker

Organic stream sediments (popularly called "mud") were sampled three times in 1994 (May, July and September), at five different locations, each at 3 - 5 sites over a distance of 100 m of the river system in the catchment (see Äyräs and Reimann, 1995 for details). This medium consists of organic-rich well-decayed, suspended material, mainly sedimented in gently flowing stretches of the river.

A statistical summary of the organic stream sediment data, as analysed by GTK, is presented in Table 9, and the raw data are in Appendix. The values of Ag, Be, Bi and Sb were below the detection limits and these elements are therefore excluded in Table 9. Compared to the organic stream sediment data from the other seven catchments sampled in 1994, Skjellbekken had the lowest median values of Hg, P and Pb, and among the lowest values of Al, As, Ba, Cd, Cr, Cu, Fe, La, Mn, Mo, Na, Ni, Se, Sr, Th, Tl, U and Zn. The values of Cr, K, Rb and S were in the middle range. Skjellbekken had the highest median values of Li and Sc, and among the highest values of Ca, Mg and Ti.

Table 9. Summary of organic stream sediment data in mg/kg (ICP-MS, ICP-AES and HAAS analysis, conc. HNO_3 -extraction). * values below the detection limit are given as half the detection limit for statistical calculations.

Table 9. Analytical results of organic stream sediment

	Min	25th %ile	Mean	Median	St.Dev.	75th %ile	Max
Al	9280	10400	12436	12200	2341	13900	16600
As	2.96	6.755	17.04	9.92	14.95	24.55	51.5
B	<3	<3	<3	<3	<3	<3	10
Ba	51	73	129	86	104	135	442
Ca	5660	6565	10945	8770	5623	13900	21600
Cd	0.12	0.185	0.40	0.27	0.27	0.595	0.91
Co	6.4	10.4	15.00	11.8	7.75	18.4	35.8
Cr	25.5	27.55	32.52	32	5.67	35.9	43
Cu	23	38.65	54.19	47	23.24	71.7	102
Fe	11600	22800	26920	24700	10325	29300	55900
Hg	0.020	0.030	0.070	0.040	0.050	0.095	0.180
K	730	1055	1330	1310	359	1640	1980
La	9.1	13.1	16.34	14.4	5.82	18.6	30.1
Li	4.6	9.1	10.40	10.6	3.13	12.15	14.9
Mg	2700	4940	6070	6240	1849	7120	9360
Mn	199	432	1841	902	2349	2190	9110
Mo	0.37	0.44	1.12	0.86	0.82	1.58	3.27
Na	180	220	242	240	40	275	310
Ni	19.8	26.55	39.58	33	17.07	49.5	73.2
P	483	639	823	682	329	810	1600
Pb	5.57	6.055	7.38	6.56	1.81	8.175	10.9
Rb	5.63	7.605	11.13	11.1	4.17	13.65	18.1
S	726	1295	2432	1930	1378	3505	5130
Sc	3.6	4.45	5.25	4.9	1.24	6	8
Se	<1	<1	3.04*	1.75	2.96*	5.01	8.33
Si	260	290	308	310	30	325	370
Sr	14.9	16.2	33.57	20.9	25.58	31.9	83.2
Th	1.5	2.02	2.58	2.68	0.67	2.995	3.81
Ti	625	1200	1321	1430	322	1565	1630
Tl	<0.2	<0.2	0.11*	0.1	0.05*	0.1	0.31
U	1.18	1.365	2.90	2.7	1.62	4.16	5.8
V	26.4	44.45	54.23	48.9	19.98	65.15	95.8
Y	7.2	8	10.23	8.2	3.38	12.35	16.6
Zn	44.1	65	94.73	68.4	52.16	116.5	246

Moss

by Jo H.Halleraker

The three uppermost annual shoots of the terrestrial mosses, *Hylocomium splendens* and *Pleurozium schreberi*, were sampled in May and September 1994 at 8 locations spread over the catchment. Every effort was made to avoid mixing the samples with soil or litter, and places underneath trees, bushes, and dense vegetation were avoided wherever possible. For details on sampling see Äyräs and Reimann (1995)..

Table 10 sumarizes the moss data for the total analysis of 38 elements as analysed by GTK (for details on analysis see this report (chapter on sample media, field procedures...) and Niskavaara, 1995).For comparison, moss data from the whole of Norway (Norden, 1990) are given in Table 10. The raw data are given in Appendix. The results from the Skjellbekken catchment are presented graphically in the form of boxplot comparisons in Figure 15

Compared to similar moss data from the rest of Norway as shown in Table 10, the mosses in the Skjellbekken catchment display lower median (and mean) values for Al, B, Cr, Fe, Mg, Mo, Na, Pb, Sr and V. The median values are approximately (+/- 1.5 times) the same for Ba, Ca, Cd, Cr, Mg, Rb and Zn.. The Skjellbekken data are slightly higher for As, Mn and Hg (1.6 - 2.2 times), and significantly higher for Co, Cu and Ni.

Ag, Be, Bi, La, Li, Sb, Se, Th, Tl, U and Y were below the detection limits in all the samples. K, P, S, Si and Ti were not presented by Berg (1993) or Steinnes et al. (1993). The national median value was much higher than Skjellbekken for Na, Pb, Fe and Al (6, 4.8, 4.4 and 3.8 times), whereas the opposite was the case for Ni, Cu and Co (16.3, 3.9 and 3.6 times). Low sodium levels are probably due to distance, aspect and wind direction to the sea, whereas low lead levels are due to little traffic in this remote part of the Pasvik valley. Ni, Cu and Co are known to be the main heavy metal emissions from the Russian smelters. Even though Skjellbekken is so situated that major depositions from the smelter do not occur, episodic events influence the chemistry of the moss. Enrichment factors in excess of 100 were found in snow samples close to the smelters compared to the background locations for Ni, Cu and Co in the pilot studies for this project (Reimann et al. 1995).

The local variations are calculated as the relative standard deviation (mean/st.dev x 100%) for the elements for which there were no detection limit problems. S, V and K showed little variation (10 - 15 %), As, Cu, Mg and Mo varied from 15 - 20 %, Ba, Hg, Fe, Pb, Rb and Sr from 20 to 30 %, Al, B, Cr, Mn and Ti from 30 to 40 %, and there were very large variations for Zn (44%), Na (72 %) and Si (76 %). All the locations sampled twice in 1994 contained more Si and Zn in September than in May.

Since the topsoil data showed a very high local variation in S, it is surprising that the variation in the S content in moss is one of the lowest observed.

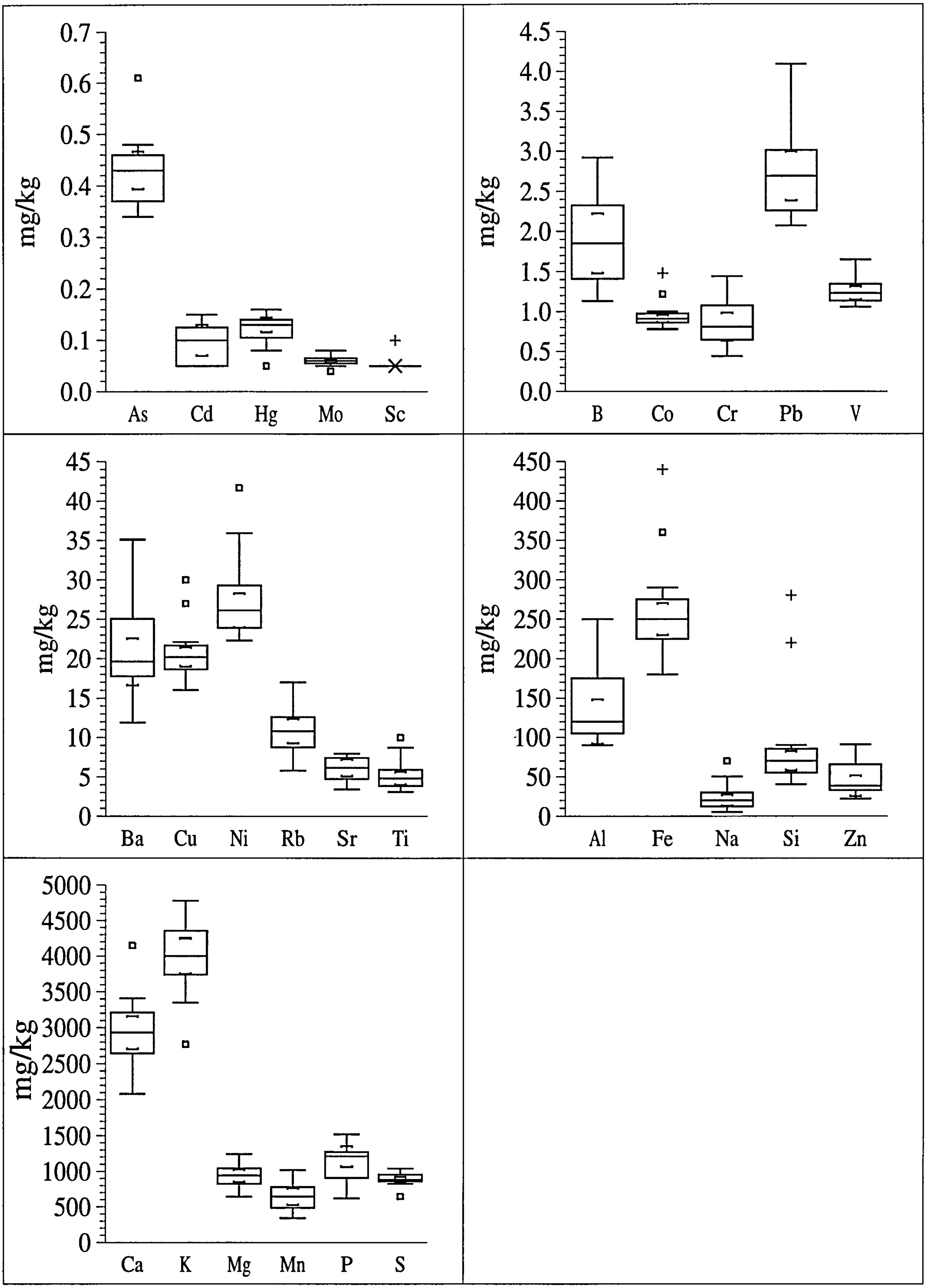


Figure 14: Boxplot comparison of the analytical results from the moss samples in catchment 5. The elements are sorted according to concentration ranges.

Table 10: Summary of moss data (in mg/kg dry weight, ICP-MS and ICP-AES analysis, conc. HNO_3 extraction). *N_Median, N_Mean and N_St. dev* refer to the values obtained in 1990 from 495 *Hylocomium splendens* samples regularly distributed over Norway and analysed by ICP-MS for some of the elements (Berg 1993).

	Min	25th %ile	Mean	Median	St.Dev.	75th %ile	Max	*N_Mean*	*N_Med*	*N_St.Dev*
Ag	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2			
Al	90	105	140	120	45.90	175	250	*500*	*430*	*390*
As	0.34	0.37	0.43	0.43	0.07	0.46	0.61	*0.36*	*0.27*	*0.32*
B	1.13	1.41	1.91	1.85	0.60	2.325	2.92	*3.6*	*3.1*	*2.2*
Ba	11.9	17.75	21.21	19.6	5.96	25.05	35.1	*27*	*15*	*24*
Be	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	*0.02*	*<0.02*	
Bi	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	*0.04*	*0.03*	*0.05*
Ca	2080	2645	2915	2930	531	3210	4150	*3100*	*2800*	*120(*
Cd	0.05	0.05	0.09	0.1	0.04	0.125	0.15	*0.19*	*0.13*	*0.26*
Co	0.78	0.86	0.95	0.91	0.18	0.975	1.48	*0.39*	*0.25*	*0.74*
Cr	0.44	0.645	0.88	0.81	0.30	1.075	1.44	*1.2*	*0.9*	*1.9*
Cu	16	18.65	20.83	20.2	3.57	21.65	30	*7.1*	*5.2*	*13*
Fe	180	225	261	250	65.45	275	440	*640*	*1100*	*470*
Hg	0.05	0.105	0.12	0.13	0.03	0.14	0.16	*0.09*	*0.06*	*0.06*
K	2770	3740	3991	4000	553	4355	4780			
La	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	*0.56*	*0.44*	*0.48*
Li	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	*0.27*	*0.22*	*0.19*
Mg	640	825	925	940	162	1045	1240	*1300*	*1200*	*460*
Mn	342	487.5	638	643	197	781	1020	*350*	*300*	*280*
Mo	0.04	0.055	0.06	0.06	0.01	0.065	0.08	*0.2*	*0.16*	*0.15*
Na	<10	12.5	26.00	20	19.01	30	70	*150*	*120*	*100*
Ni	22.3	23.9	27.65	26.1	5.26	29.3	41.7	*3.4*	*1.6*	*16*
P	620	908.5	1118	1210	264	1270	1520			
Pb	2.07	2.26	2.76	2.69	0.60	3.015	4.09	*14*	*13*	*7.9*
Rb	5.81	8.75	10.81	10.8	3.11	12.6	17	*12*	*10*	*8.2*
S	647	858.5	891	884	89.75	952.5	1040			
Sb	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	*0.14*	*0.09*	*0.12*
Sc	<0.1	<0.1	<0.1	<0.1	0.01	<0.1	0.1			
Se	<1	<1	<1	<1	<1	<1	<1			
Si	40	55	89.33	70	67.98	85	280			
Sr	3.42	4.74	6.02	6.15	1.63	7.41	7.93	*14*	*13*	*7.9*
Th	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	*0.11*	*0.08*	*0.12*
Ti	3.1	3.85	5.28	4.8	2.01	5.9	10			
Tl	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	*0.1*	*0.08*	*0.11*
U	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2			
V	1.06	1.135	1.26	1.23	0.17	1.345	1.65	*2.9*	*2.4*	*2.3*
Y	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	*0.3*	*0.22*	*0.26*
Zn	22.1	32.8	47.99	38.3	21.27	65.3	90.7	*42*	*36*	*39*

Topsoil

by Clemens Reimann

Topsoil samples were taken at four different times in 1994, starting in winter (March/April) with frozen topsoil. The last samples were taken in September 1994. In winter and spring all 25 stations were sampled, in summer and autumn only half of the stations were sampled. Sampling methods are detailed in Äyräs and Reimann (1995), and sample preparation and analytical methods in this report and/or Niskavaara (1995). The frozen topsoil samples from the winter season were kept frozen at all times and were freeze-dried prior to analysis. This data set is used as the reference data set for catchment 5 in the following text.

Tab. 11 summarizes all the analytical results from the freeze-dried winter samples. The raw data are in Appendix. All median values are at the lower end of results from comparable soil samples from other parts of the world. Even the variability between different localities within the catchment is surprisingly low considering the large differences in bedrock lithologies within this catchment. The maximum values (outliers) for Ag, Mo and V are unusually high. Since these three elements show some high analytical results in the bedrocks as well, the observed «anomalies» in the topsoil can be attributed to geogenic sources. It remains a question why the very high As values observed in Quaternary deposits and some bedrock samples as well as in the stream water samples find no expression in the topsoils.

Figure 15 summarizes the analytical results from topsoil samples taken at different times of the year. These diagrams, of course, include two different sources (at least) of variability: sampling and seasonal. That there are some problems with the comparability of sampling is best seen in the diagram for carbon (C), where the September samples show much lower C contents than the rest of the samples. The other three sampling times are surprisingly closely comparable in terms of the carbon content of the samples. In September, a «new» team took the soil samples - illustrating that not even a thorough field manual can avoid such problems. The September data should thus not be used for further interpretations of «seasonal» effects.

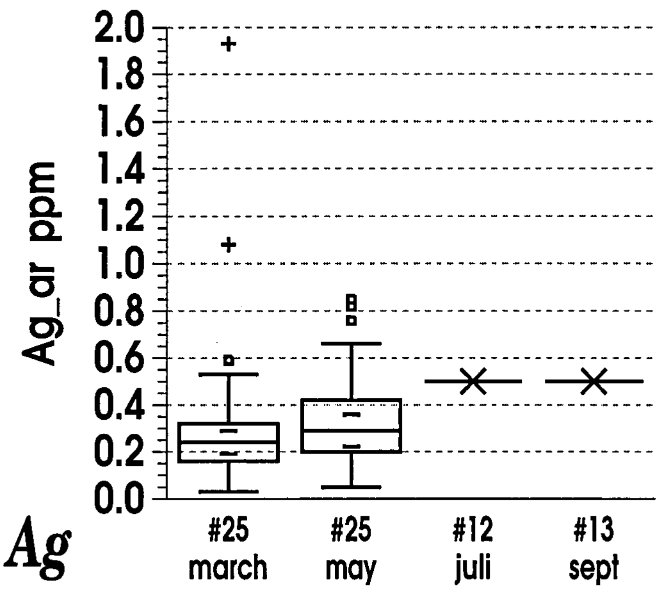
A number of elements show lower median values and less variability in May than in March: Al, As, Cd, Cr, Fe, Sc,Ti and V. Very few show higher median values and a greater variability in the spring samples: Ag, Ba, Pb (total content) and Sb. It is interesting to note that increased Pb levels can be observed in the summer precipitation as well (Reimann et al. 1995). A more thorough discussion of these results, including a study of the partioning of elements between the two leaches used, is planned for the international project report.

Tabell 11: Analytical results of topsoils 0-5cm, <2mm fraction, conc. HNO_3 extraction.

Element	Unit	Method	Min	25th %ile	Mean	Median	St.Dev.	75th %ile	Max
Ag_ar	mg/kg	512U	0,03	0,16	0,34	0,24	0,398	0,32	1,93
Al_aa	mg/kg	201P	8	39	134	67	124	257	416
Al_ar	mg/kg	512P	460	1230	2909	2380	2320	3880	11300
As_aa	mg/kg	512U	0,050	0,050	0,050	0,050	0,000	0,050	0,050
As_ar	mg/kg	512U	0,40	0,70	1,45	0,80	2,600	1,20	13,70
B_aa	mg/kg	201P	0,05	0,05	0,06	0,05	0,051	0,05	0,30
B_ar	mg/kg	512P	1	4	4	5	1,58	6	7
Ba_aa	mg/kg	201P	6	12	16	15	7,70	18	45
Ba_ar	mg/kg	512P	17	29	44	39	29,24	50	167
Bi_ar	mg/kg	512U	0,04	0,08	0,10	0,09	0,031	0,12	0,16
C	%	820L	7	17	29	28	14,80	43	53
Ca_aa	mg/kg	201P	223	571	2137	1100	2785	2030	11800
Ca_ar	mg/kg	512P	510	1310	3304	1950	3744	3180	17000
Cd_aa	mg/kg	201P	0,03	0,10	0,23	0,2	0,166	0,33	0,76
Cd_ar	mg/kg	512U	0,05	0,13	0,28	0,24	0,234	0,40	1,16
Co_aa	mg/kg	201P	0,20	0,29	0,49	0,45	0,254	0,63	1,22
Co_ar	mg/kg	512P	1,1	1,9	3,33	2,5	2,295	3,8	9,1
Cr_aa	mg/kg	201P	0,06	0,09	0,18	0,15	0,107	0,27	0,43
Cr_ar	mg/kg	512P	1,2	2,4	6,55	5,1	5,310	8,6	20,3
Cu_aa	mg/kg	201P	0	0	0,12	0	0,440	0	2
Cu_ar	mg/kg	512P	7	11	22	20	16,62	24	90
Fe_aa	mg/kg	201P	2	5	133	16	425	77	2150
Fe_ar	mg/kg	512P	760	2460	9980	4150	16376	8650	75100
H	%	820L	1,2	2,7	4,25	4,1	1,951	6	7,2
Hg_ar	mg/kg	512H	0,07	0,11	0,17	0,15	0,070	0,22	0,29
K_aa	mg/kg	201P	114	328	543	521	266	750	963
K_ar	mg/kg	512P	300	500	744	800	240	900	1100
La_ar	mg/kg	512P	0,35	1,2	2,83	2,1	2,097	3,6	22,5
Li_aa	mg/kg	201P	0,025	0,025	0,03	0,025	0,000	0,025	0,025
Li_ar	mg/kg	512P	0,35	0,35	1,12	0,35	1,095	1,9	4,7
Mg_aa	mg/kg	201P	46	173	328	291	212	432	846
Mg_ar	mg/kg	512P	500	690	1486	920	1466	1290	6600
Mn_aa	mg/kg	201P	14	42	133	89	208	127	1070
Mn_ar	mg/kg	512P	52	108	341	151	839	203	4310
Mo_aa	mg/kg	201P	0,025	0,025	0,03	0,025	0,021	0,025	0,13
Mo_ar	mg/kg	512P	0,5	0,5	1,20	0,5	3,051	0,5	15,8
N	%	820L	0,3	0,6	0,88	0,9	0,367	1,1	1,7
Na_aa	mg/kg	201P	10	21	39	33	21,72	54	87
Na_ar	mg/kg	512P	40	70	88	90	24,15	100	130
Ni_aa	mg/kg	201P	1	3	3	3	1,58	4	7
Ni_ar	mg/kg	512P	8	17	27	27	11,47	33	52
P_aa	mg/kg	201P	22	44	65	61	31,59	95	135

Element	Unit	Method	Min	25th %ile	Mean	Median	St.Dev.	75th %ile	Max
P_ar	mg/kg	512P	219	456	570	586	175	686	995
Pb_aa	mg/kg	201P	0,3	2,6	3,2	3,0	1,145	4,0	5,3
Pb_ar	mg/kg	512P	6,1	8,2	9,6	9,1	2,255	11	13,9
S_aa	mg/kg	201P	25	59	79	77	29,20	104	122
S_ar	mg/kg	512P	277	578	914	881	464	1180	2190
Sb_aa	mg/kg	201U	0,25	0,25	0,26	0,25	0,050	0,25	0,5
Sb_ar	mg/kg	512P	0,06	0,09	0,12	0,1	0,049	0,12	0,31
Sc_ar	mg/kg	512P	0,05	0,2	0,69	0,3	0,839	0,8	4
Se_ar	mg/kg	512U	0,11	0,23	0,39	0,32	0,233	0,45	1,15
Si_aa	mg/kg	201P	5	10	14	14	5,058	17	22
Si_ar	mg/kg	512P	170	210	240	240	39,31	260	320
Sr_aa	mg/kg	201P	2	4	8	6	7,64	9	41
Sr_ar	mg/kg	512P	3	7	14	10	14,40	16	78
Te_ar	mg/kg	512U	0,01	0,02	0,02	0,02	0,013	0,03	0,06
Th_ar	mg/kg	512P	2,5	2,5	2,5	2,5	0,000	2,5	2,5
Ti_aa	mg/kg	201P	0,025	0,14	0,40	0,25	0,399	0,52	1,44
Ti_ar	mg/kg	512P	19	108	334	247	283,64	544	1100
V_aa	mg/kg	201P	0,03	0,06	0,19	0,09	0,394	0,14	2,04
V_ar	mg/kg	512P	2	7	26	13	42,33	28	214
Y_ar	mg/kg	512P	0,1	0,4	1,0	0,6	0,800	1,2	3
Zn_aa	mg/kg	201P	5	11	15	14	7,89	18	36
Zn_ar	mg/kg	512P	13	24	39	33	22,17	49	98
pH_dest	units	pH-Elec	3,81	3,97	4,22	4,13	0,409	4,30	5,65
pH_CaCl2	units	pH-Elec	2,5	2,9	3,2	3,1	0,514	3,3	5
El_cond	µS/cm	Cond.	41	77	112	119	42	138	197
F'	mg/kg	IC	0	34	42	41	23	54	109
Cl'	mg/kg	IC	0	37	65	54	39	92	179
NO2'	mg/kg	IC	0	0	0	0	0	0	0
Br'	mg/kg	IC	0	0	0	0	0	0	0
NO3'	mg/kg	IC	0	3	84	4	395	7	1978
PO4'''	mg/kg	IC	0	76	243	232	184	390	558
SO4''	mg/kg	IC	0	82	129	130	69,41	175	280
LOI	%	GRA	16	39	58	57	25,46	85	94

Ag



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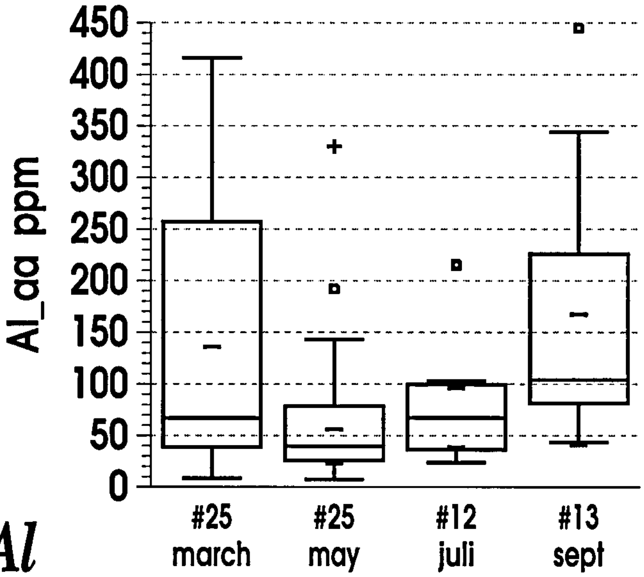

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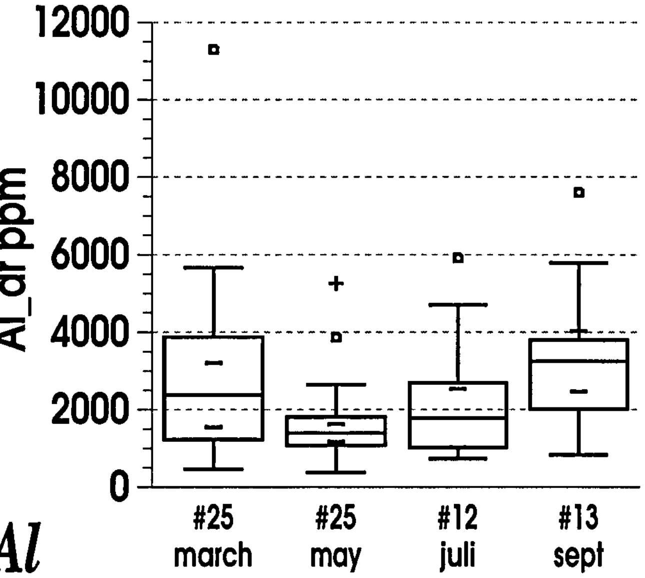
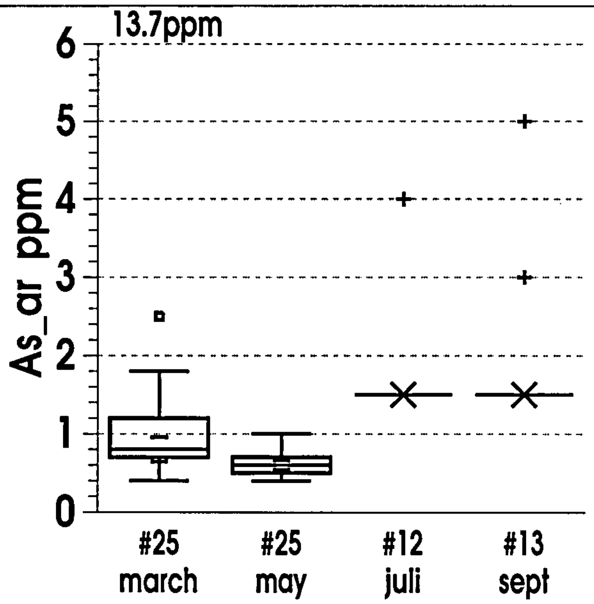


Al

As



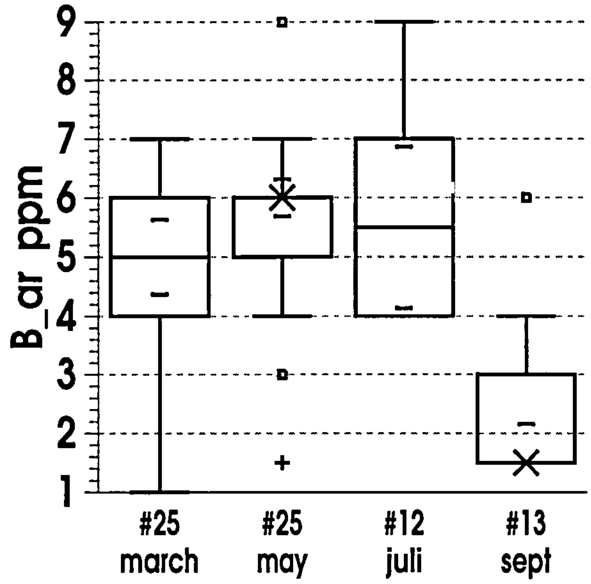
As

Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia

B



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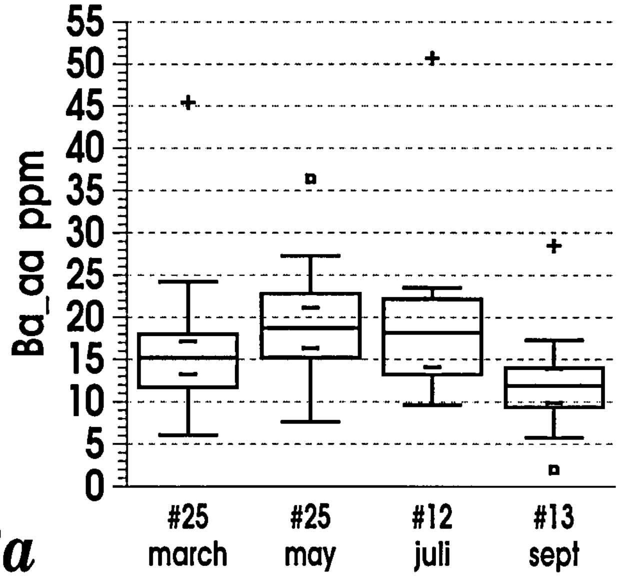
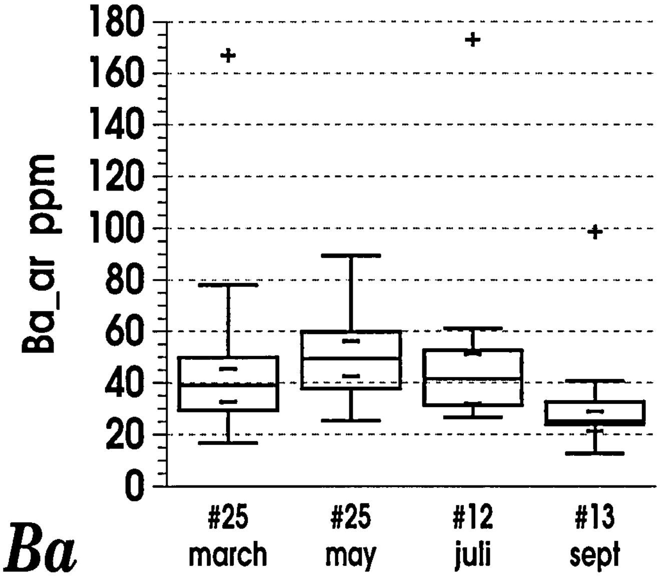
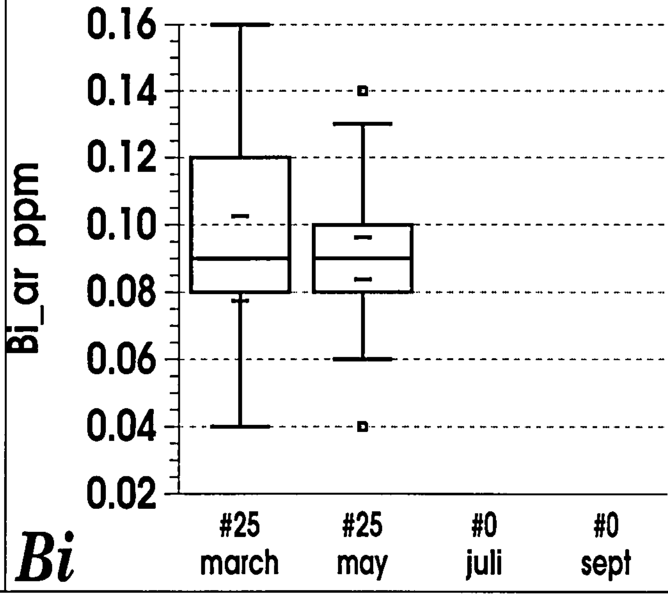


Ba



Ba

Bi



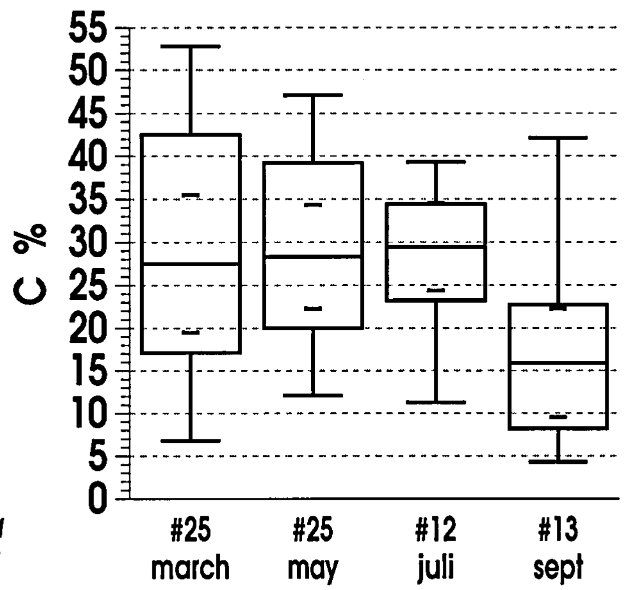
Bi

Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia

C



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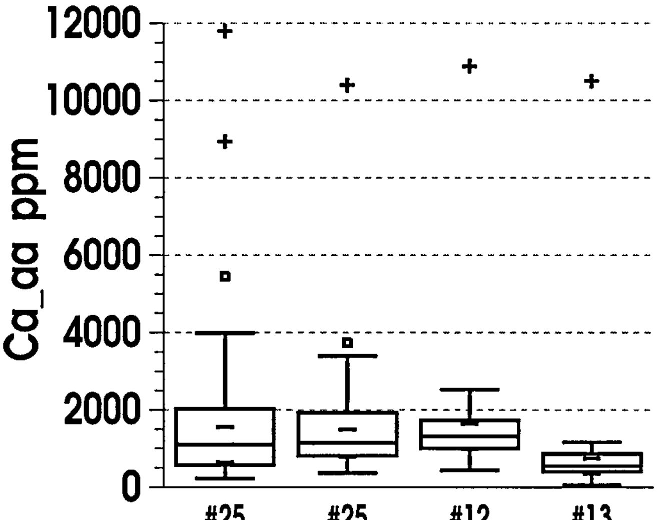

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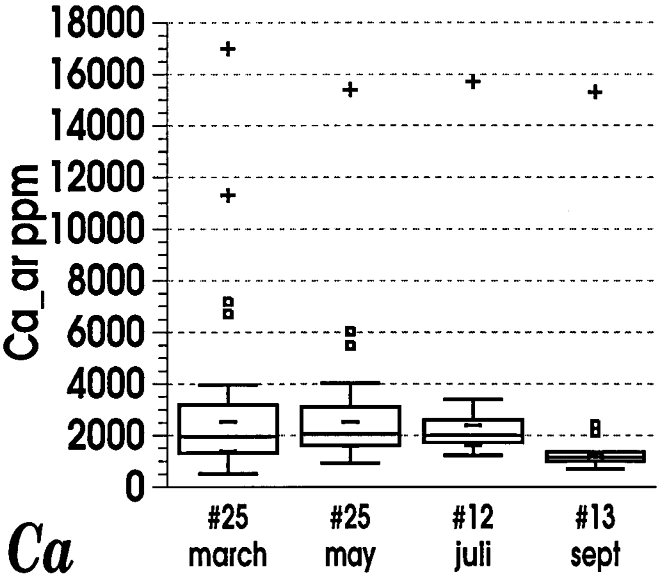

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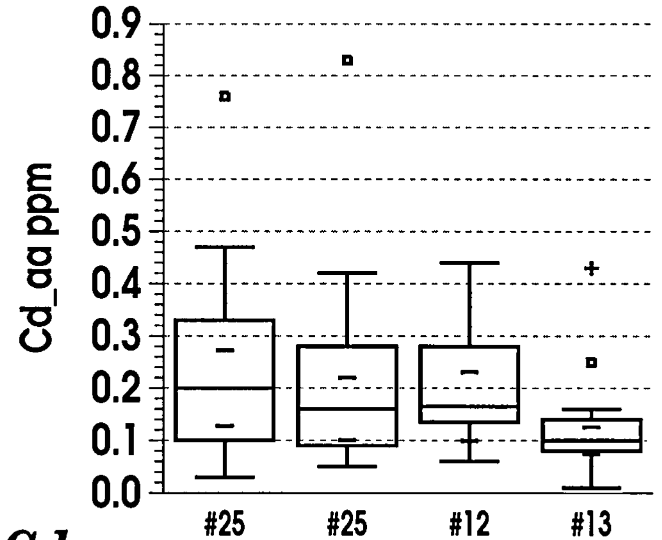

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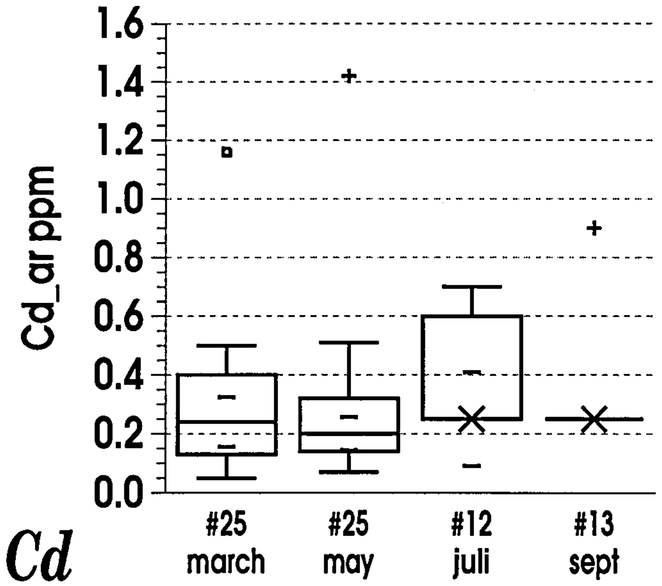
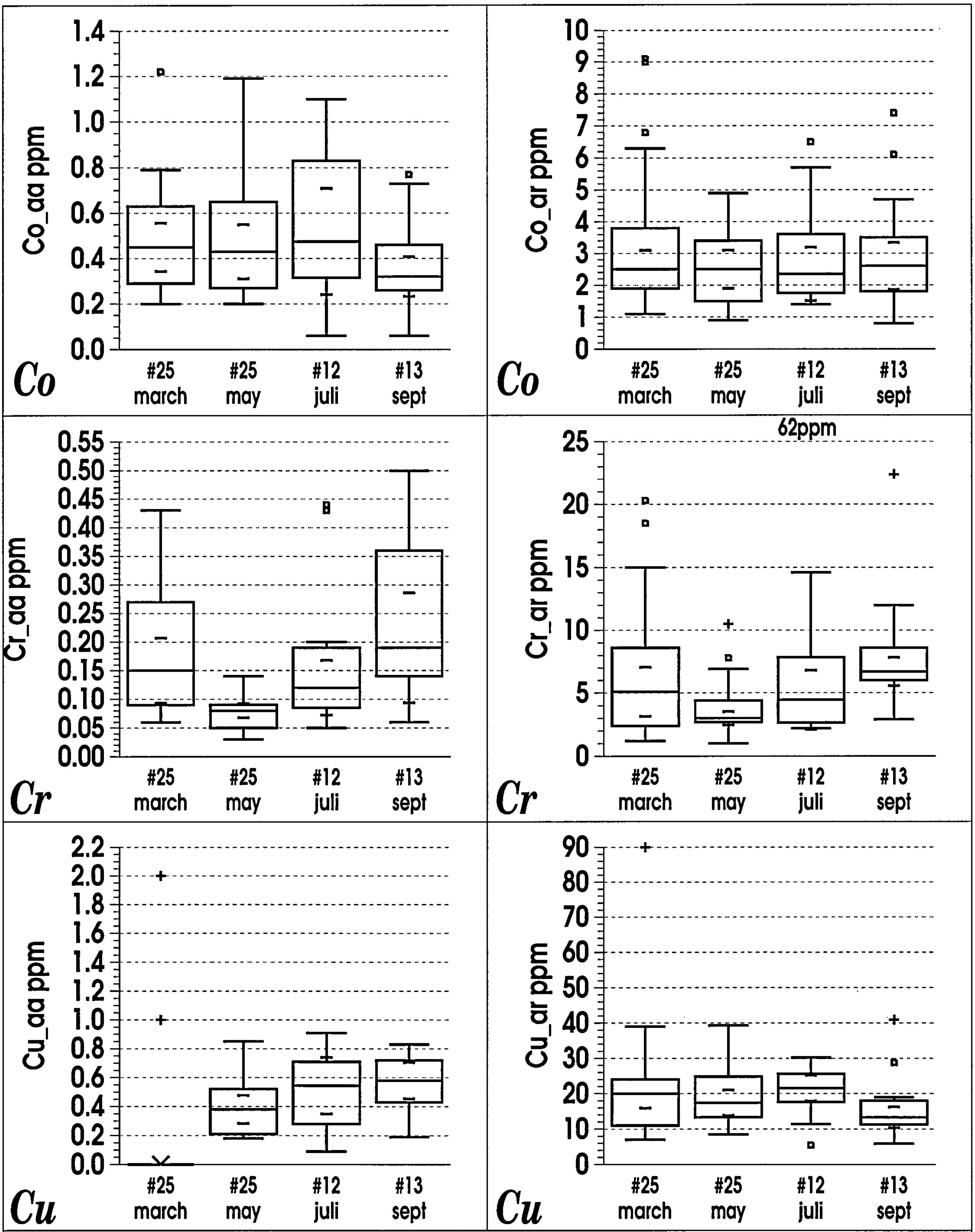


Cd

Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

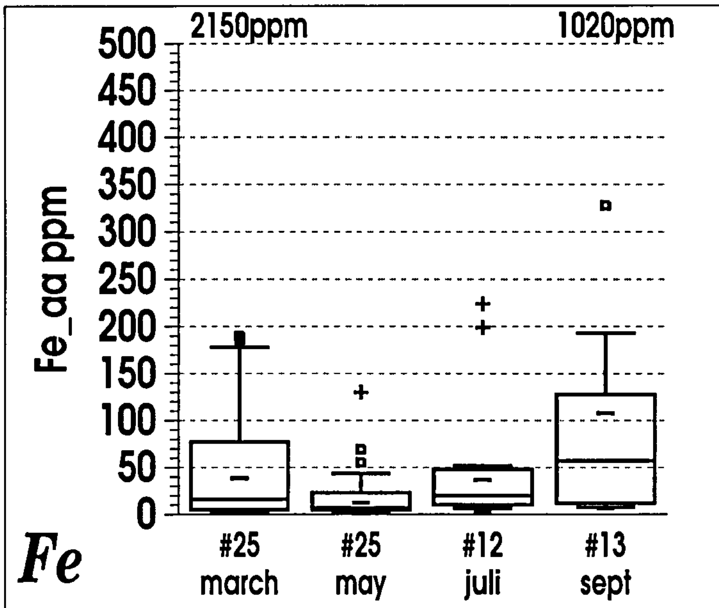
Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia

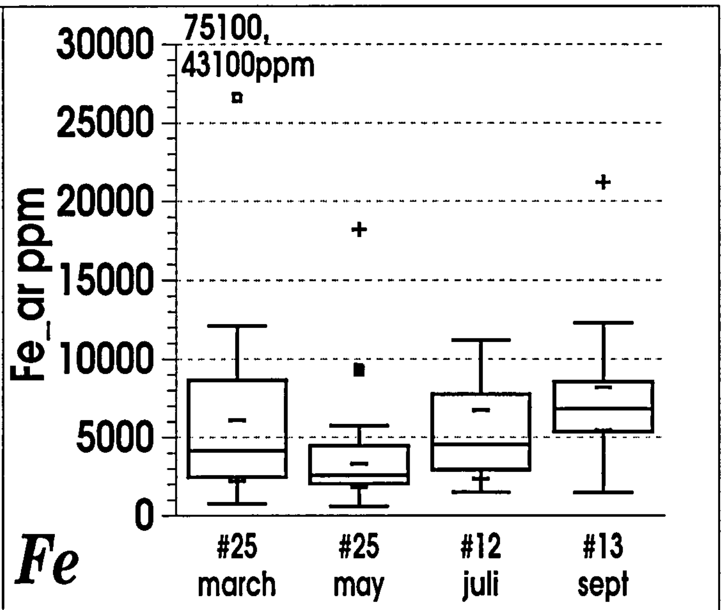


Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia





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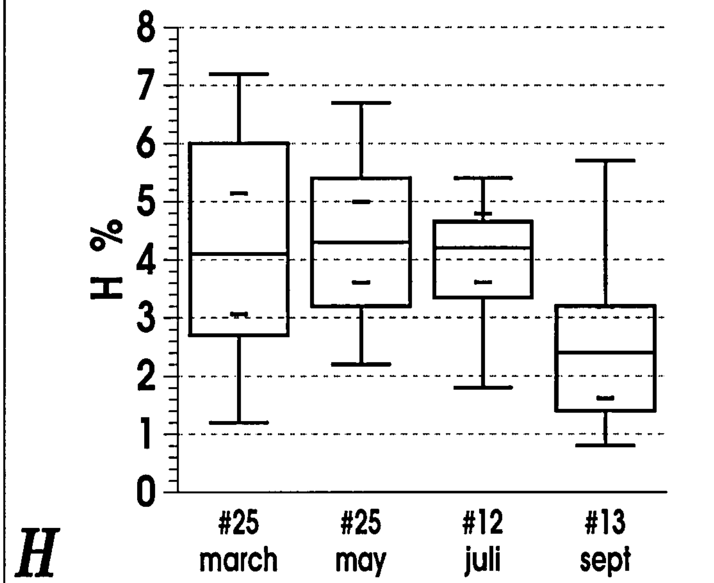

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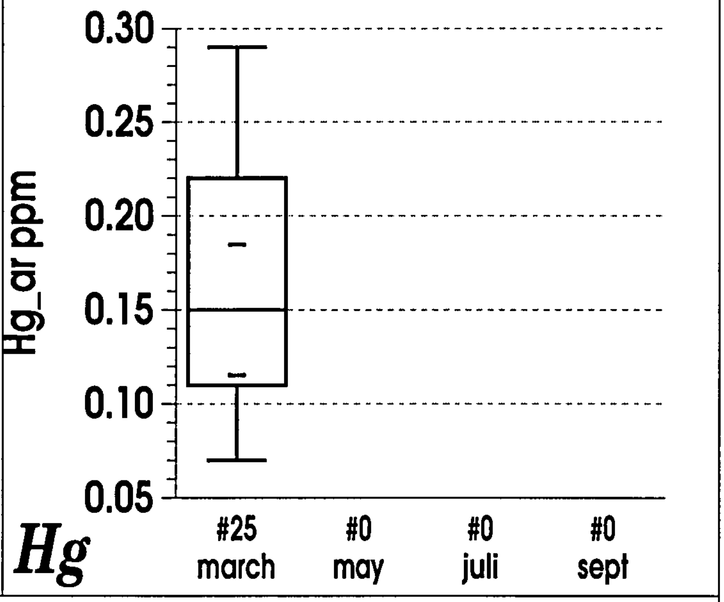
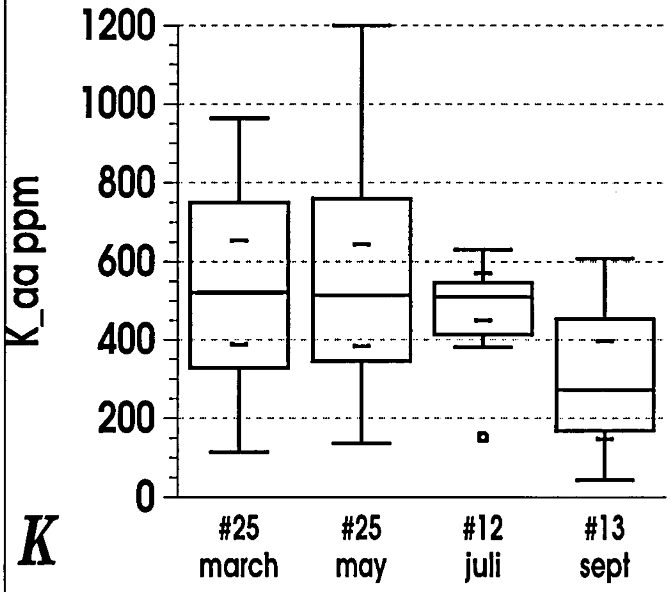
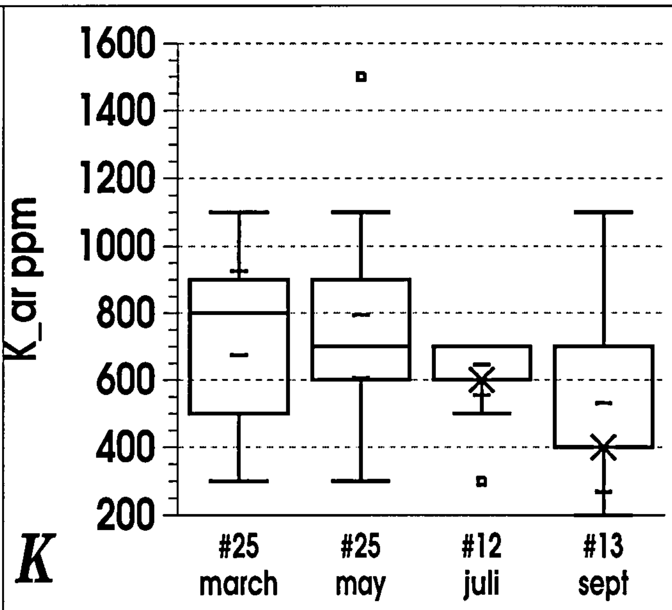


Kola Project CKE-GTK-NGU; catchment study 1994

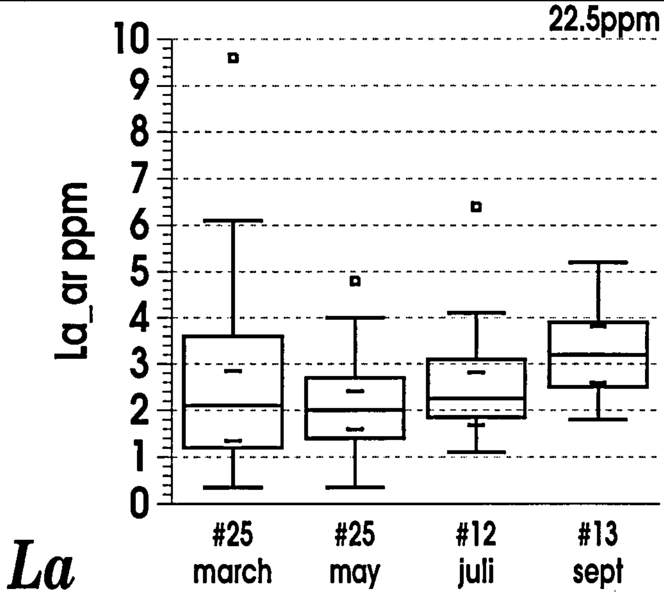
Catchment 5 - Skjellbekken (Norway) - TOPSOIL

Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia

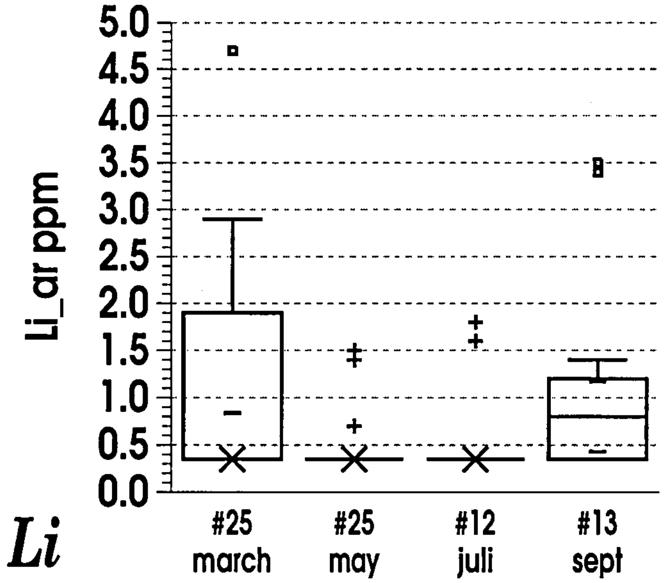




La



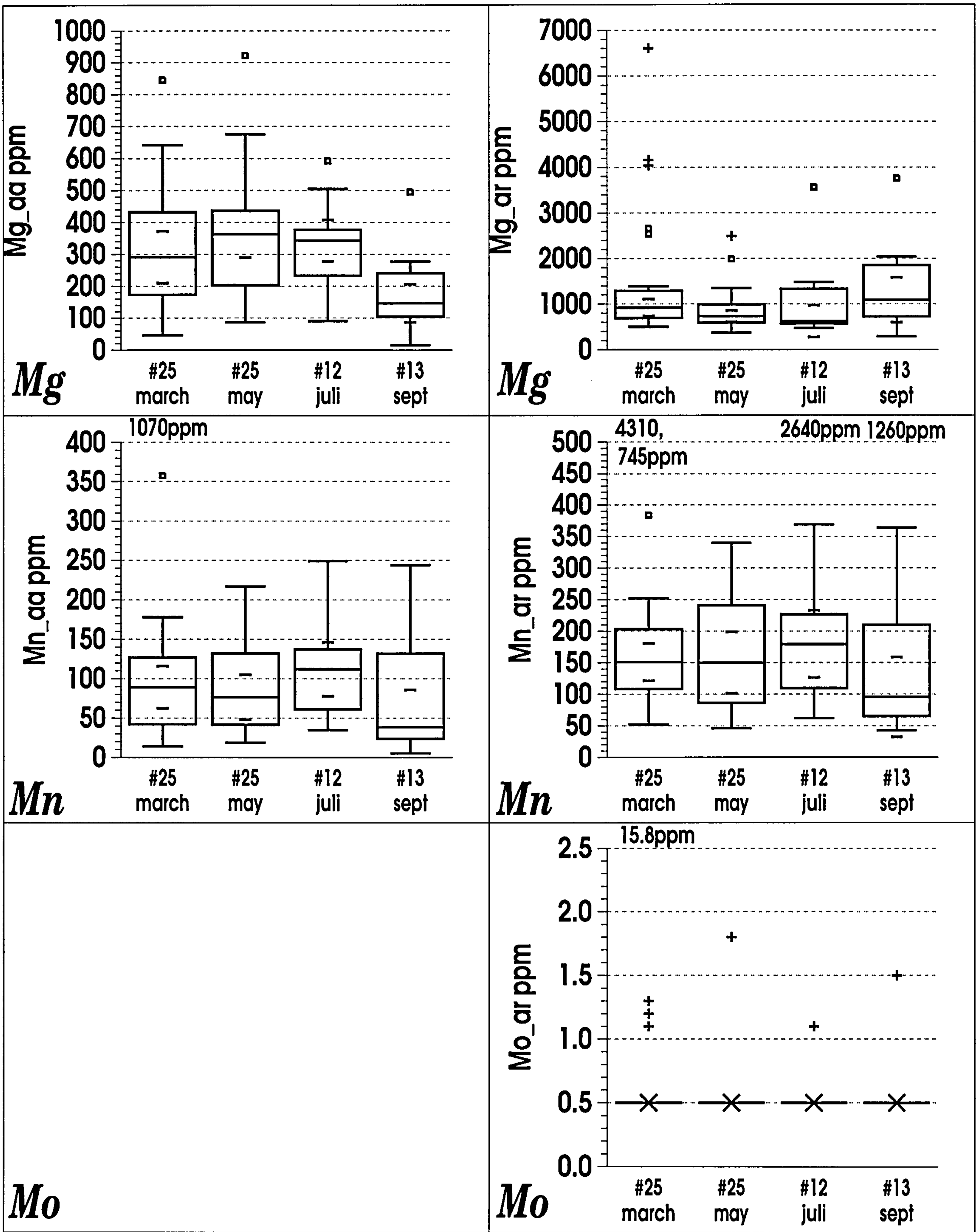
Li



Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

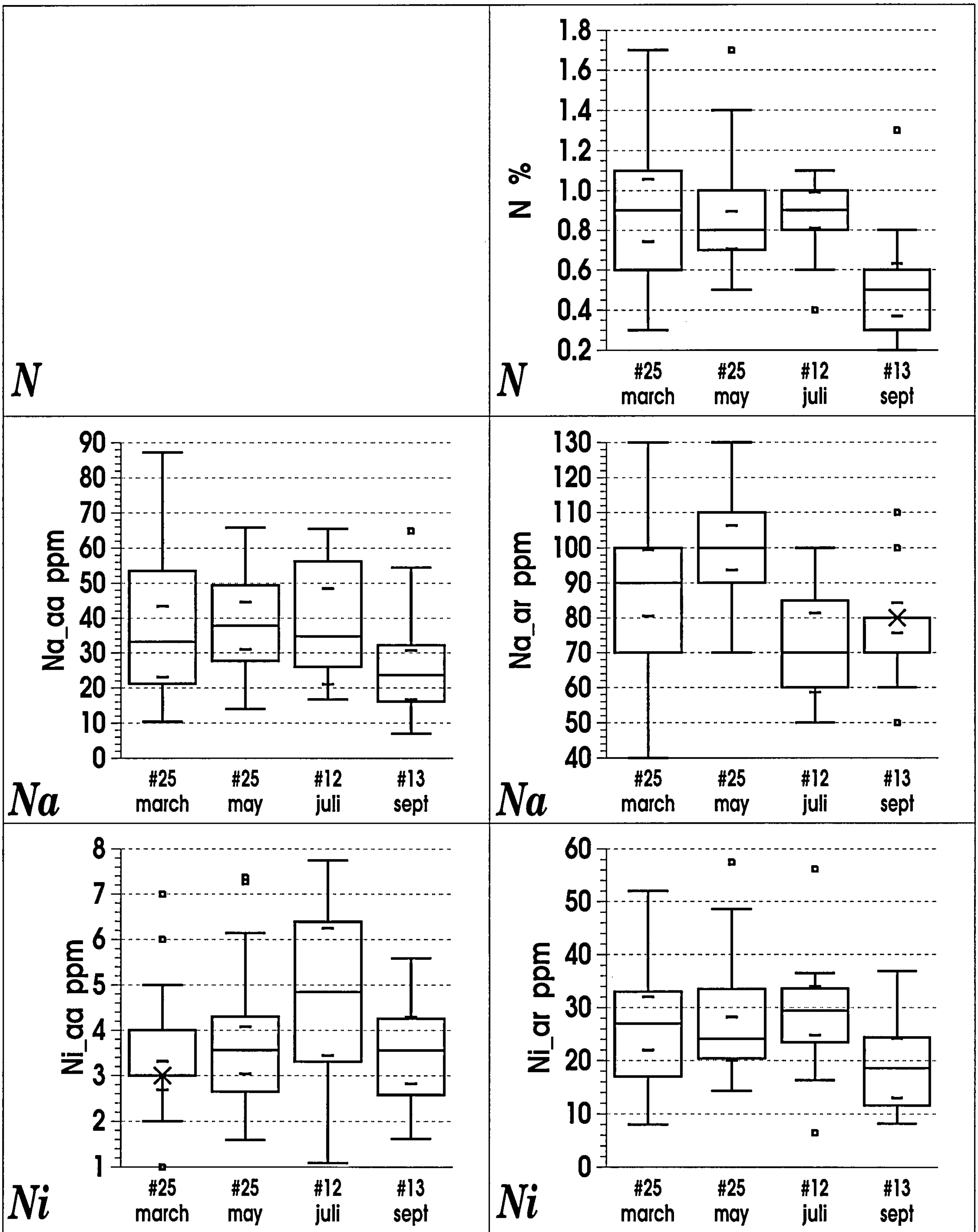
Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia



Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

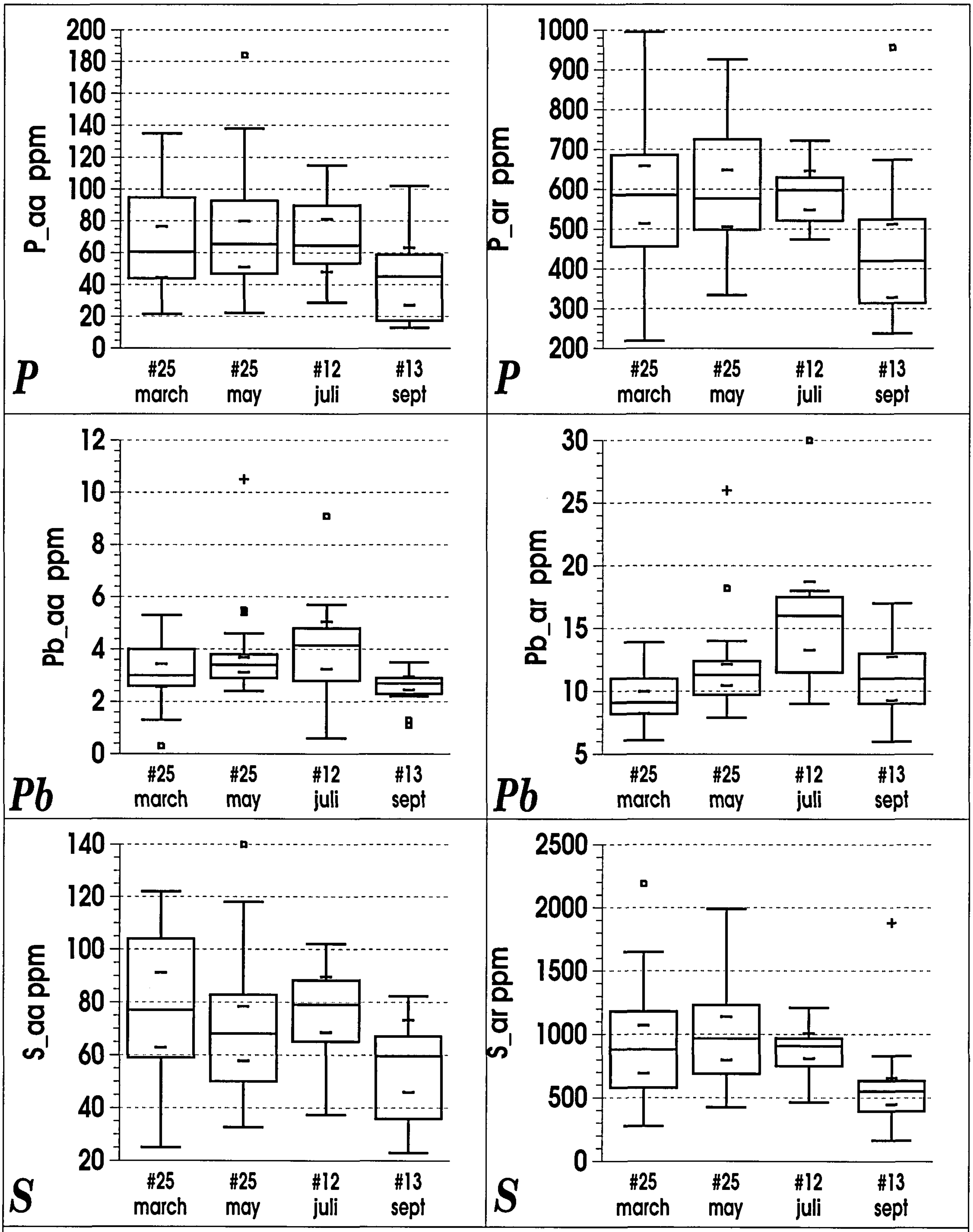
Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia



Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia

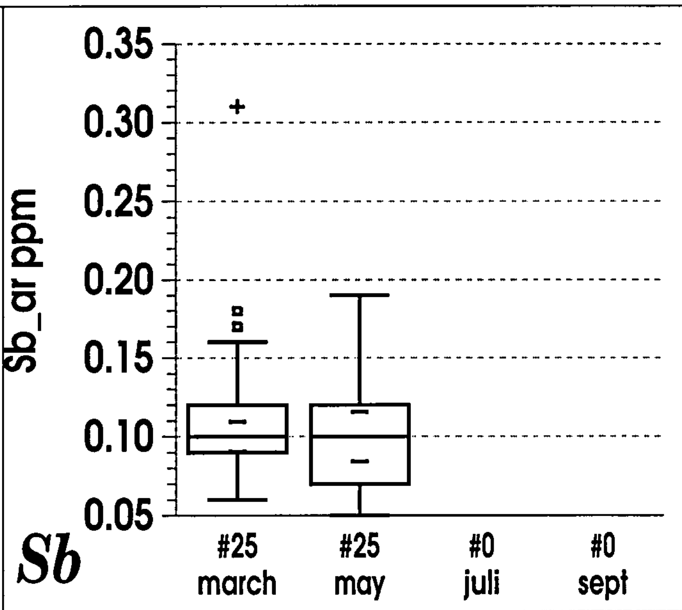


Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

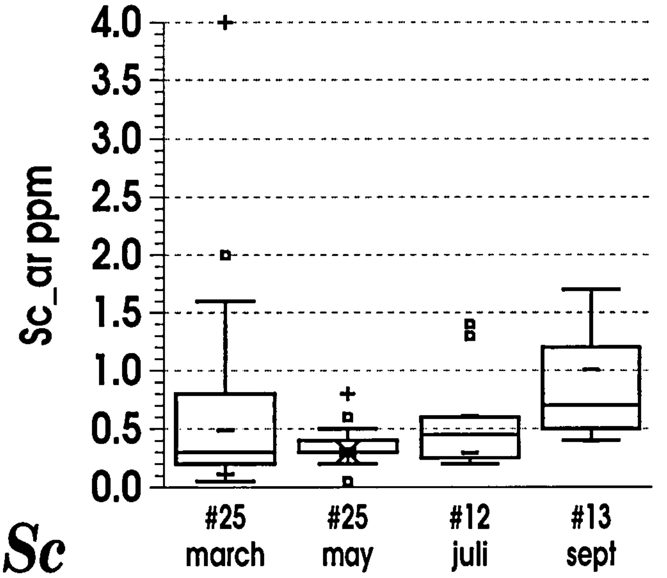
Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia

Sb



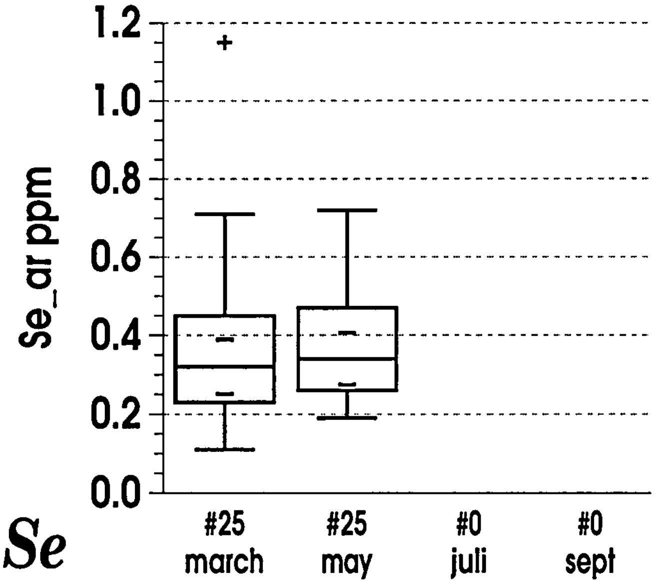
Sb

Sc



Sc

Se

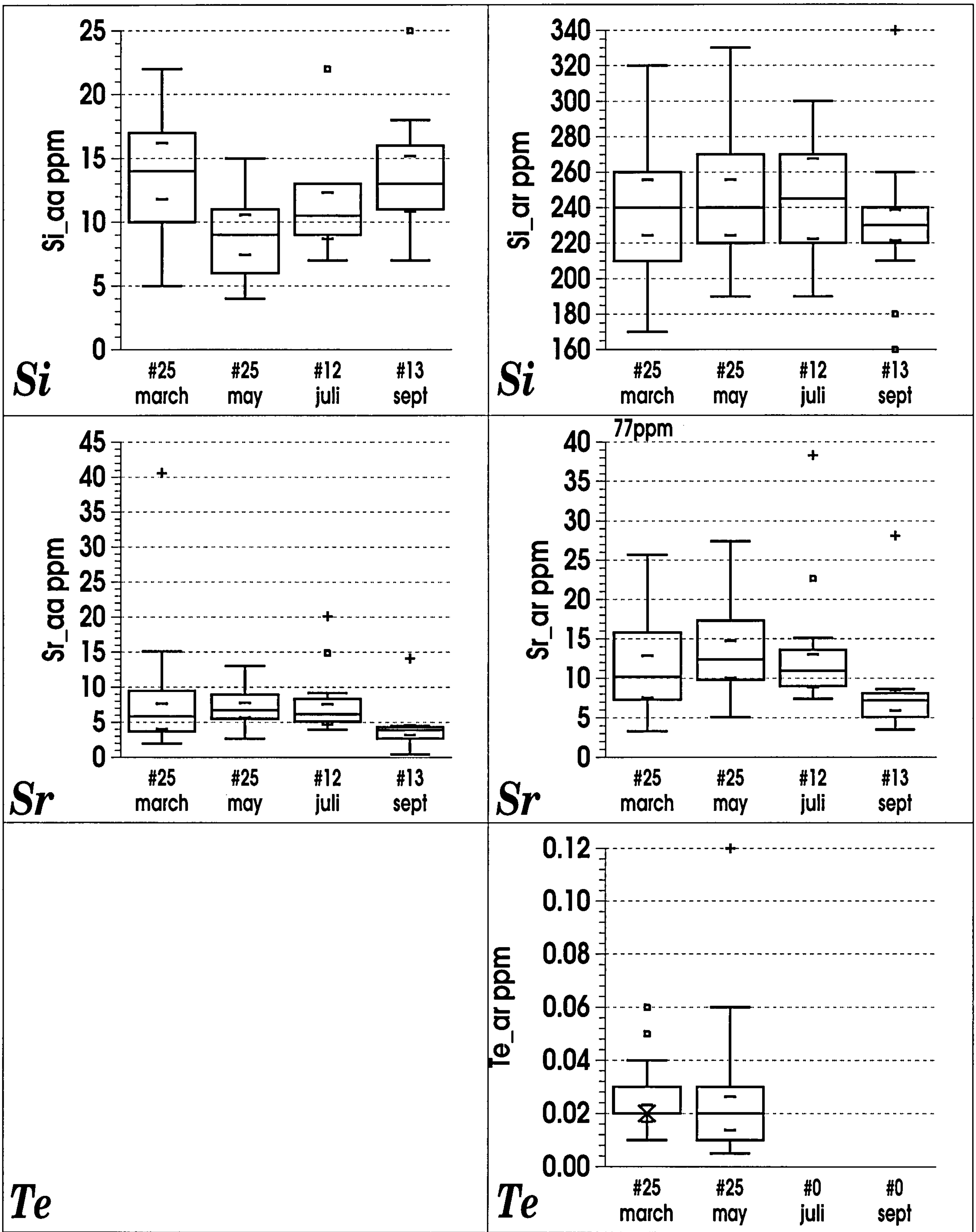


Se

Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia



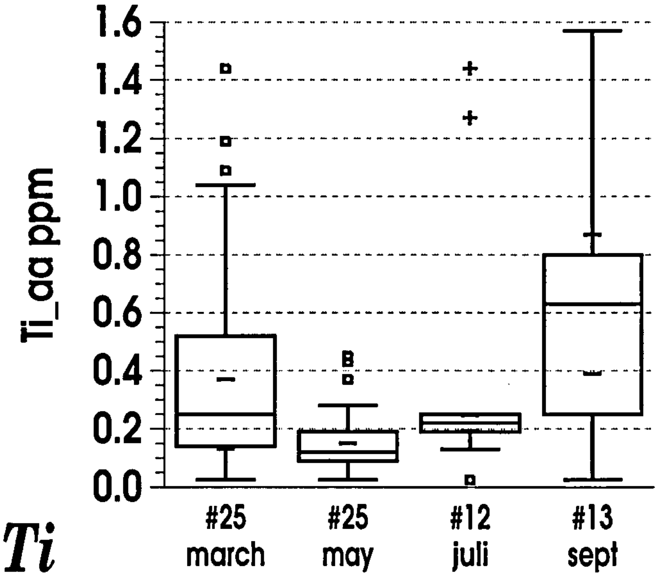
Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

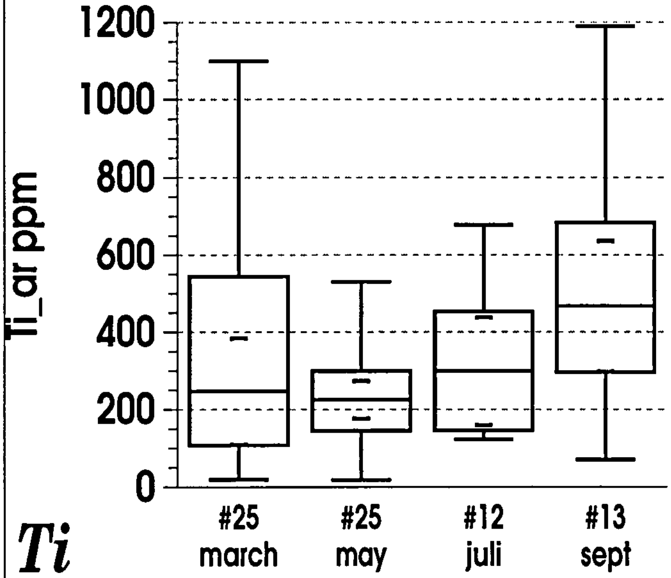
Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia

Th

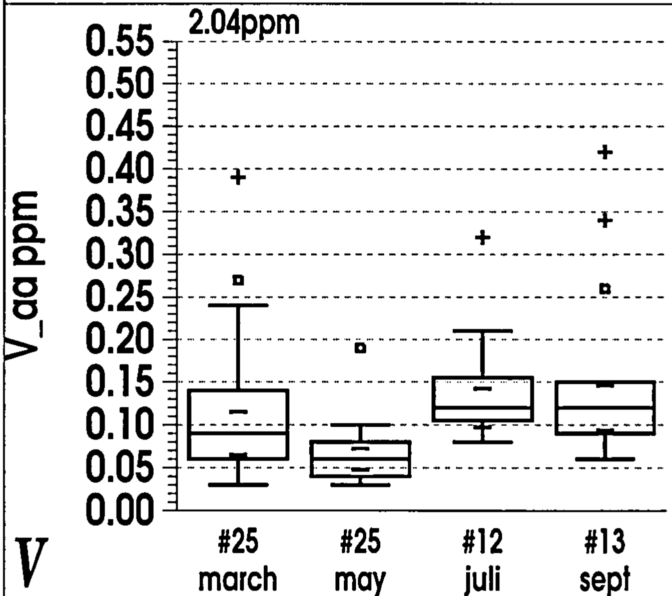
Th



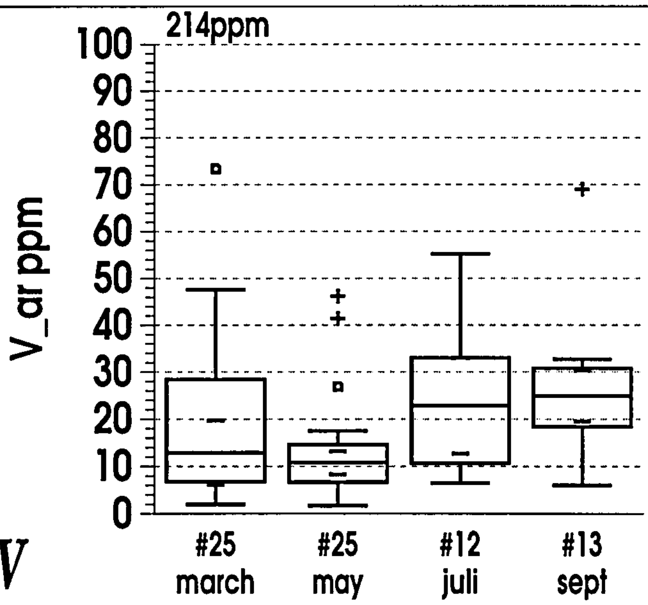
Ti



Ti



V



V

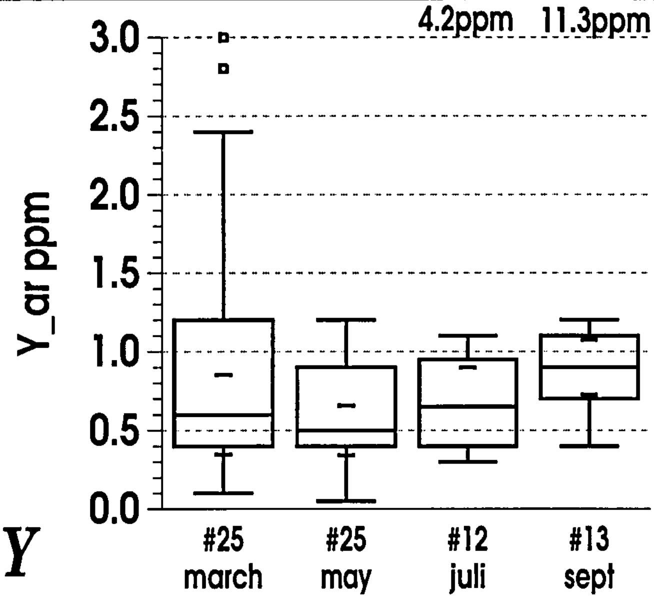
Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

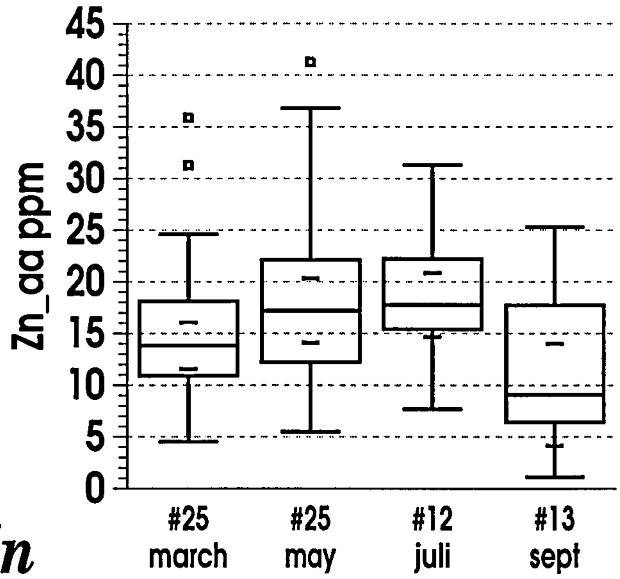
Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia

Y

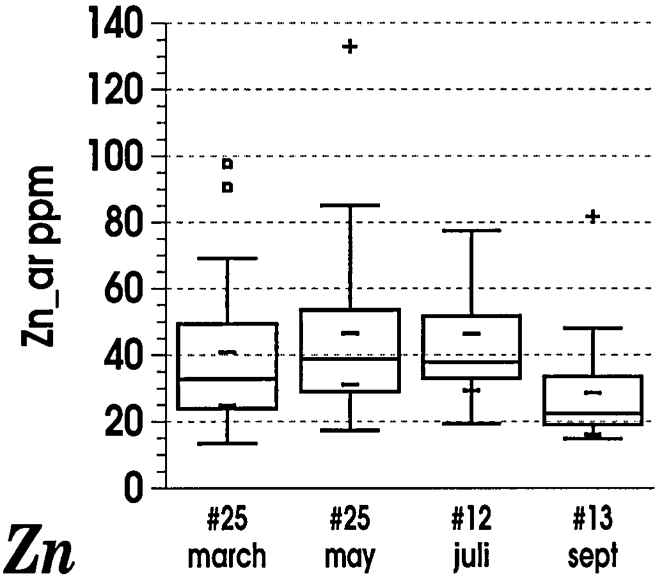
Y



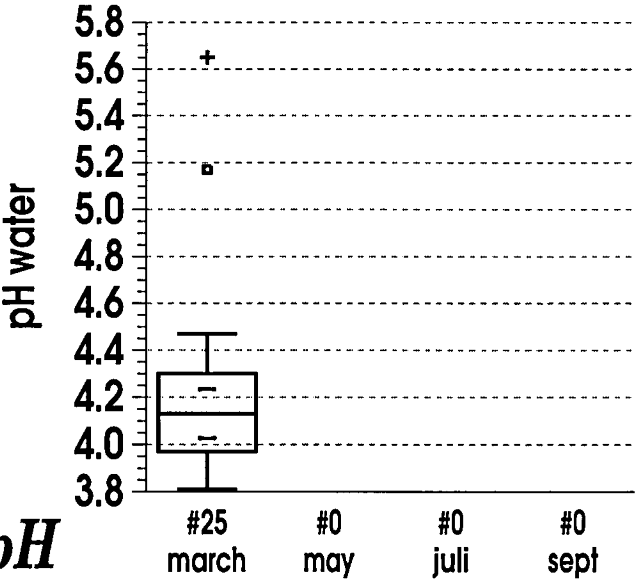
Zn



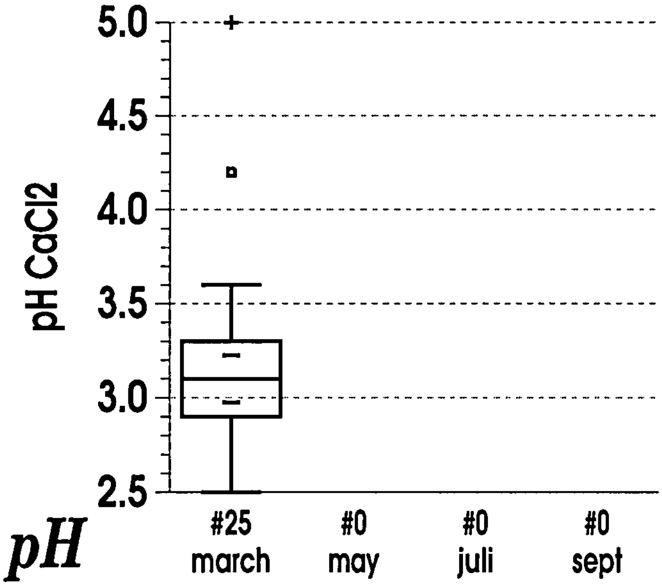
Zn



pH



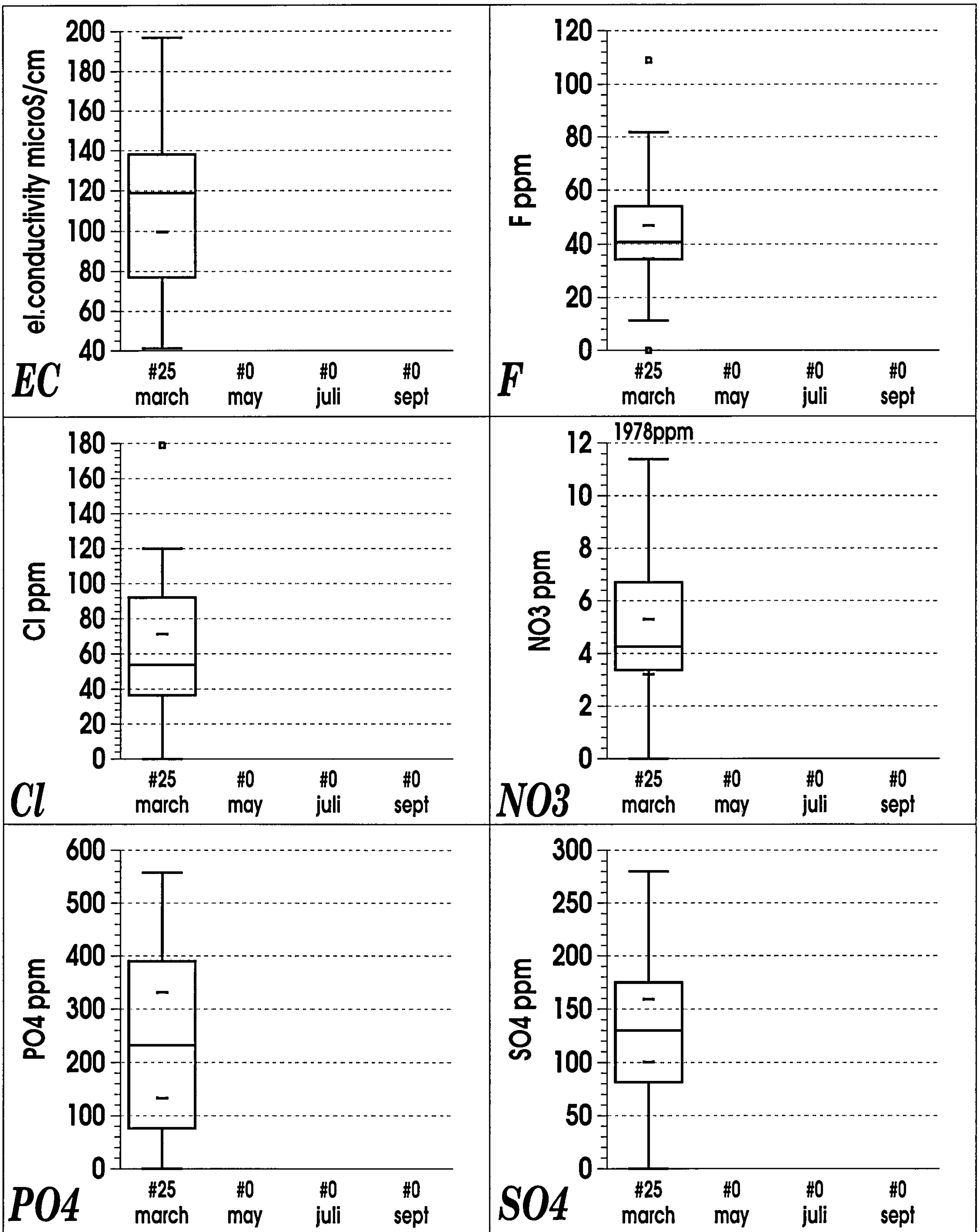
pH



Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia



Kola Project CKE-GTK-NGU; catchment study 1994

Catchment 5 - Skjellbekken (Norway) - TOPSOIL

Seasonal variations - _aa:=ammonium acetate, _ar:=aqua regia

Podzols

by Galina Kashulina

Podzols were among the media sampled during fieldwork on the Kola Ecogeochemistry project in 1994.

Aims and methods

Five podzol profiles were dug at the Skjellbekken catchment. The sampling sites were selected to reflect the variation in lithologies in the catchment. Brief, general information about the sampling site is given in Table 12. The sampling procedure followed the field manual prepared by Äyräs & Reimann (1995). Two profiles, P37 and P40, were dug with an excavator.

Soil samples were taken from the main genetical horizons and subhorizons: O, E, B1, B2, BC1, BC2 (BC3, BC4) and C. Horizon C was not reached in P41 due to the very high content of stones and gravel. The total number of soil samples was 42, 6 from organic horizons and 36 from mineral horizons.

The major morphological features of the profiles are given in Table 13. More detailed information about the sampling sites and profiles, accompanied by colour photographs of the forest, ground vegetation and soil profiles, will be given in a separate report.

The soil texture was only determined for some samples. Fractions of less than 2 mm for all samples and less than 0.5 mm for some separate samples were used for analysis. A full list of the parameters determined in the soil samples, along with the analytical methods used, is in Table a in the Appendix. The types of analyses chosen were not specifically pedological because of the geochemical orientation of the project, but they gave us the very rare opportunity of obtaining information about a very large range of elements. A total of 47 elements were determined, 16 of which were rare elements.

Results and discussion

All the analytical results are given in the Appendix (Podzol). Data concerning the total content of C, N, H will not be discussed here, because roots were not removed from the samples and two different laboratories using similar techniques obtained different results. Data on the total content of sulphur will not be discussed either, because the methods used gave even lower values than those obtained when S was extracted by aqua regia and nitric acid.

Total content of major elements

The total content of major elements and their distribution in the mineral part of the profiles are, in their main features, typical for this type of soil and parent material (Table 15). The prevailing element is silicon. SiO_2 makes up 60-75% of the ash content, Fe_2O_3 and Al_2O_3 about 20%, CaO and MgO about 5-8%, and K_2O and Na_2O about 4-5%. However, there is some variation in the total content of the major elements in the soils, which may be connected with local variations in the genesis of the parent material between and, even, within profiles.

Profile P38, formed on fluvioglacial sand, is characterized by having the highest contents of SiO_2, Na_2O and K_2O, and the lowest contents of Fe_2O_3, TiO_2, MnO, PO_3 and SO_3, and also by showing the smallest degree of eluvial-illuvial differentiation of the elements within the profile.

Profile P40, formed on altered ablation and basal till probably underlain by andesitic bedrock, is characterized by having the lowest content of SiO_2, the highest contents of Al_2O_3, MgO, TiO_2 and MnO, one of the highest contents of Fe_2O_3, CaO and P_2O_5, and one of the highest degrees of eluvial-illuvial differentiation of the elements within the profile.

Most of the chemical peculiarities in profile P41 are connected with the presence of weathering, S- and Fe-rich, black schist fragments in the eluvial horizon. This profile is characterized by having the highest content of Fe_2O_3 in the eluvial horizon and, at the same time, the highest degree of iron precipitation in the illuvial horizon. The content of Fe_2O_3 in the Bs1 horizon is 18% and exceeds Al_2O_3. This profile also has the highest content of SO_3 in all the mineral horizons.

That the content of Al_2O_3, MgO, CaO, K_2O and Na_2O in the mineral part of profile P41 is lower than in any of the other profiles from Skjellbekken can be explained by the more intensive weathering processes throughout this profile and their leaching out of the profile, connected with the creation of acidic products from weathering of black schist in the upper part of the profile. The chemistry of this profile is extremely interesting. However, black schist occurs in a very small part of the area and cannot play a major role in the geochemistry of the Skjellbekken catchment.

The processes forming the chemistry of the organic layer are more complicated. The content of major elements in the organic horizons (estimated on the basis of nitric acid extraction) varied more from one profile to another than in the mineral horizons. Only K, Mg and S vary by less than twice (Appendix, Table h). The content of other elements in the organic horizon here varies by 2-10, and even more, times. In common with the mineral horizons, the organic horizons of profiles P38 and P40 predetermine the degree of variation of parameters discussed here, i.e. if P38 has the highest content of Si, P40 has the lowest content and the other profiles have intermediate values. The organic horizon of P38 has the highest contents of ballast elements (Si, Al, Fe and Ti) and the lowest contents of the most important nutrients (Ca, K, Mn, P and S).

The presence in the E horizon of profile P41 of black schist fragments rich in S and Fe also leads to an extremely high content of iron in the organic horizon, but does not influence the content of sulphur.

Water extraction

pH

The distribution with depth of pH values for water suspension (1:10 and 1:20 W:V ratio for the mineral and organic horizons, respectively) within the profiles at Skjellbekken shows a quite typical pattern, increasing gradually downwards (Table 14). Organic horizons are most acidic (pH 4.4) and the pH variation between profiles is only 0.1 pH units.

The lowest pH gradient within the mineral part of a profile was found in P38 and was only 0.8 pH units, ranging from 5.3 (in the E horizon) to 6.1 (in the C horizon). The steepest gradient, 1.6 pH units, was found in P41. *In situ* weathering of black schist fragments strongly acidifies the eluvial horizon of this profile, which has a lower pH value than any corresponding horizon in other profiles from Skjellbekken, and also than profiles from the most polluted Monchegorsk catchment. Nonetheless, the influence of acidification did not show up in the lower part of this profile. P40 appears to be the most acidic profile at Skjellbekken, especially the C horizon which was more acid than the C horizon in all the other catchments investigated.

Conductivity

The conductivity of water extracted from the soil samples (Table 16) only reaches a significant level in organic horizons, where it is 60-150 μS/cm; it is considerably lower in mineral horizons (4-30 μS/cm). Two patterns of distribution with depth are seen in the profiles. P38 and P41 show a gradual decrease with depth, whereas P37, P39 and P40 show a second, small maximum in the upper part of the illuvial horizon.

P38 has the lowest conductivity values of any profile here. The organic and Bs1 horizons from P40 have the highest conductivity values, namely 146 and 20 μS/cm, respectively. In the eluvial horizons, the highest conductivity (33 μS/cm) was found in P41.

Inorganic anions in the extracted water

The content of NO_2' and Br' in the water extraction was below the detection limits. The maximum contents of F', Cl', PO_4''' and SO_4'' were always found in the organic horizon of the profiles (Table 17). The maximum content of NO_3' was usually in the middle part (B or BC horizons). F', PO_4''', and sometimes Cl', were only found in the uppermost part. Only SO_4'' and NO_3' anions were present in all mineral horizons.

The main inorganic anion in the organic horizons was PO_4'''. Its content varied from 90 to 700 mg/kg, the smallest value being in P38 and the highest in P40. The proportion of PO_4''' in the sum of all the inorganic anions varied from 45 to 80% equivalents. SO4" followed in second place with a content varying from 60 to 200 mg/kg. The proportion of SO_4'' in the anion composition was only 9-20% equivalents and sometimes less than those of F' or Cl'.

The content of all the anions in the mineral part of the profiles is very low and their composition varies with depth. In the upper part of the profiles (E and B horizons), either SO_4'', PO_3''' or NO_3' may dominate. In the lower part (BC and C horizons), SO_4'' is usually strongly dominant. NO_3' is sometimes quite abundant in BC horizons.

P41 has S-rich weathering material in its E horizon, and is not only characterized by having the highest content of SO_4'' in the water extraction. This profile also has the highest content of Cl' among the profiles from this catchment.

Exchangeable base cations

In the organic horizons of profiles, the highest sum of the main cations extracted by 1 M NH4Ac (pH 4.5) was 5-15 meq/100 g (Table C). The sum of the main extractable cations in mineral horizons was less than 1 meq/100 g.

In the organic horizons, 1 M NH4Ac (pH 4.5) extracted more than 60% of the total content of Ca and K (extracted by nitric acid) and slightly less of Mg and Na. The main extractable cation was Ca; Mg and K have smaller proportions. The role of Na is negligible, mainly 1-2% of the cation sum.

The content of extractable cations in the mineral horizons was very low. NH4Ac (pH 4.5) extracted only a very small part of the total content of cations. Extractable Ca, Mg and Na were present in all the mineral horizons; K was only present in the eluvial horizons. Ca dominated as an extractable cation in the mineral part, too. Its proportion varied from 40 to 80% of the cation sum.

Profile P37 had the highest sum of extractable cations, followed by P41. The lowest content of extractable cations was found in P38.

Total content of micro-elements

The total content of micro-elements in the organic horizons was determined after digesting the samples with nitric acid in a microwave oven (Appendix, Table k). Aqua regia extraction was used for the mineral horizons (Appendix, Table e). The content of micro-elements in the organic horizons varied by 2-4 times from one profile to another, except for Mo and V, the content of which varied by more than 10 times. The content of Zn and Ba varied from about 20 to more than 80 mg/kg; Ni from 20 to 44, Pb and Sr from 9 to 20; V from 5 to 26; Cr from 2 to 9; Co from 1.2 to 2.2 mg/kg.

The content of Mo in the organic horizons was mainly very low, only 0.2-0.3 mg/kg, but P41 showed a sharp increase up to 4.7 mg/kg. This profile was also characterized by having the highest contents of V, Ni, Cr and Cu, and one of the highest contents of Ba, Co and Zn.

In the mineral part of the profiles, the content of all the micro-elements, except for Pb and Ba in all the profiles and Mo, Pb and V in P41, is at its minimum in eluvial parts (Appendix, Table e). The highest content of micro-elements was mainly found in the lower part of the profiles. At the same time, there was some variation in the content of micro-elements between horizons in a single profile, which might indicate changes in the parent material within the profile.

The content of Zn in the mineral part of profiles from Skjellbekken varied from 4 to 75 mg/kg, V from 13 to 92, Cu from below the detection limit (0.5 mg/kg) to 64, Ni from 1 to 57, Cr from 5 to 35, Ba from 5 to 75, Co from 0.8 to 20, Sr from 2 to 14 and Pb from 0.6 to 3.7 mg/kg. A content of Mo in excess of the detection limit (1 mg/kg) was only found in profile P41.

Total content of rare elements

This project gave the quite rare opportunity of obtaining information about the content of rare elements in the soils. In the organic horizons at Skjellbekken, the contents of Be, Bi, Se, Tl and U, except for profile P41, and of Sb, except for profile P40, were lower than the detection limits (Appendix, Table l). The contents of B, Cd, Hg, La, Li, Rb and Th varied by about 2 times. The variation in the contents of Ag, As, Sc and Y was greater, especially Ag (about 20 times). Profile P41 showed the highest contents of As and U, P37 the highest contents of Ag, B and Th, and P40 the highest contents of Cd, Sb and Rb.

In the mineral horizons, a content of B in excess of the detection limit was only found in one sample (profile P38, B1 horizon). Th was found only in the lower part of profiles P39 and P40 (Appendix, Table f). The contents of Hg, Sb and Te were below the detection limits in most of the soil samples. In the profiles, only Sc, Se, Y and Cd (with the exception of P38) have the exact eluvial minimum. The distribution of all the other elements shows an irregular pattern in the profiles.

Profile P41 is characterized by having the highest content of most rare elements, especially As, Ag, Se and Sb. P40 has the highest content of Li, Sc and Y. Variations in the rare element content within individual profiles may also be useful for determining the origin of the parent material.

Conclusions

All the profiles from Skjellbekken largely show features that are typical for these types of soil and parent materials. At the same time, there are some irregular variations in the chemistry of the soils which may be connected with local variations in the origin of the parent material and, hence, the geochemical background between and, even, within profiles.

Five profiles are, of course, insufficient for a quantitative estimation of variation in geochemical background within the catchment, but the data nonetheless demonstrate that, within the area sampled, the geochemical background for the principal soil parameters investigated may vary by a factor of two as regards the content of most micro- and rare elements, and by even more for Mo, Pb, Ag, As and Sb.

The presence of weathering black schist fragments in P41 causes this profile to differ significantly in its content of most elements, especially Fe, S, Mo, V, As and U. The *in situ* weathering of black schist in the eluvial horizon results in an intensification of weathering processes in the lower part of the profile, but, nonetheless, does not cause base cation depletion and acidification here. Acidification in this profile was evident only in the E horizon itself.

Table 12. General information about the soil sampling sites.

Profile No	Coordi-nates, m.	Altitude, m	Topography	Bedrock type[1]	Parent material[2]	Vegetation type	Soil type[3]	Human effects
5 2134 P37	N: 7696550 E: 597200	95	Upper part of moraine hill	Amphibolitic gneiss*	Ablation / basal till	Green moss - shrubby birch forest with pine	Ferric podzol	Demaged epiphytic lichens and moss cover
5 2135 P38	N: 7697700 E: 597000	85	Glaciofluvial delta; flat top	Andesitic laves	Fluvioglacial sand	White lichen pine forest	Ferric podzol	Demaged ground lichen cover
5 2141 P39	N: 7699620 E: 597550	115	Moraine hill; flat top	Mica schist*	Ablation till / glaciolacustrine sand / basal till	Green moss - shrubby, sparse pine forest with birch	Ferric podzol	Demaged moss cover
5 2142 P40	N: 7699550 E: 596390	125	Moraine hill; flat top	Andesitic lavas, siltstone	Ablation / basal till	Green moss - shrubby birch forest with pine	Haplic podzol	Demaged moss cover
5 2142 P41	N: 7700450 E: 600100	120	Moraine hill; middle part of gentle slope	Black schist*	Ablation till mixed with weathering S-rich black schist / ablation till	Green moss - shrubby pine forest	Ferric podzol	Depressed moss cover

1. those with an asterisk were determined by L. Olsen in Quaternary pits located within a few metres of podzol pits; the remainder are taken from a geological map received from V. Melezhek.
2. types of Quaternary deposit and their changes within a profile.
3. field determination according to FAO classification (FAO/Unesco..., 1990).

Table 13

Profile number	Horizon	Average width, cm	Colour	Texture classes[1]
5 2134 P37	O	5	7.5 YR 3/4	-
	E	2	10 YR 7/8	-
	B1	15	7.5 YR 4/4	-
	B2	16	5 YR 4/6	-
	BC1	24	7.5 YR 4/6	-
	BC2	13	10 YR 4/6	-
	C1	10	2.5 Y 5/4	-
	C2	10	2.5 Y 4/2	-
5 2135 P38	O	1	5 YR 3/1	
	E	3	10 YR 5/2	Sand
	B1	8	7.5 YR 4/6	Sand
	B2	11	10 YR 5/6	-
	BC1	15	2.5 YR 5/3	Sand
	BC2	10	5 Y 5/1	-
	C1	10	5 Y 5/1	Fine loamy sand
	C2	17		-
5 2141 P39	O	4	7.5 YR 3/3	
	E	3	10 YR 6/1	Slightly stony, slightly gravelly, fine loamy sand
	B	14	7.5 YR 4/4	Slightly stony, slightly gravelly, loamy sand
	BC1	13	2.5 Y 5/6	Slightly gravelly, fine sandy loam
	BC2	17	5 Y 5/3	-
	BC3	20	5 Y 5/3	-
	C	10	5 Y 5/2	Slightly stony, slightly gravelly, fine sandy loam
5 2142 P40	O	6	7.5 YR 2.5/3	
	E	3	2.5 YR 5/2	Very stony, slightly gravelly, fine sandy loam
	Bhs	10	2.5 YR 3/6	Very stony, slightly gravelly, fine sandy loam
	Bs	9	2.5 YR 3/4	-
	BC1	7	7.5 YR 3/3	Very stony, gravelly, fine sandy loam
	BC2	11	10 YR 4/4	-
	BC3	18	2.5 Y 4/2	-
	BC4	18	2.5 Y 4/1	-
	C	10	5 Y 4/2	Very stony, gravelly, silty loam
5 2142 P41	O	3	7.5 YR 2.5/2	
	E	3	7.5 YR 3/1	Stony, gravelly sandy loam
	Bs1	15	7.5 YR 3/4	Stony, gravelly loamy sand
	Bs2	14	7.5 YR 3/4	-
	Bs3	14	7.5 YR 3/4	-
	Bs4	20	7.5 YR 3/4	-
	BC	10	7.5 YR 3/4	Stony, gravelly sand

1 - According to recommendations in the FAO guidelines for describing soil profiles (FAO, 1997)

Table 14 Acidity and major exchangeable cations content and composition in podzols for Skjellbekken catchment.

Profile No	Horizon	Depth of bottom, cm	pH H2O	Ca meq/100g	Mg meq/100g	K meq/100g	Na meq/100g	Sum meq/100g	Ca % of sum	Mg % of sum	K % of sum	Na % of sum
52134P37	O		4,4	8,0	2,2	1,6	0,1	11,9	67,0	18,9	13,3	0,8
52134P37	Ox		4,3	6,7	2,5	1,5	0,1	10,8	61,5	23,5	14,2	0,8
52134P37	Ex	2	5,1	0,27	0,12	0,09	0,02	0,50	52,75	24,2	18,8	4,2
52134P37	E	2	5,0	0,33	0,12	0,09	0,03	0,56	58,66	21,4	15,5	4,5
52134P37	B1x	17	5	0,48	0,11	0,00	0,02	0,60	79,17	17,6	0,0	3,2
52134P37	B1	17	5,2	0,57	0,11	0,00	0,02	0,70	80,95	16,1	0,0	2,9
52134P37	B2	33	5,5	0,30	0,03	0,00	0,01	0,35	86,46	9,3	0,0	4,2
52134P37	BC1	57	5,7	0,40	0,08	0,00	0,02	0,49	80,39	15,4	0,0	4,2
52134P37	BC2	70	6,1	0,20	0,06	0,00	0,01	0,27	73,68	21,5	0,0	4,9
52134P37	C1	80	6,1	0,15	0,03	0,00	0,01	0,19	77,31	17,7	0,0	5,0
52134P37	C2	90	6,3	0,18	0,04	0,00	0,01	0,23	77,05	17,8	0,0	5,1
52135P38	O		4,4	2,4	0,9	0,7	0,2	4,2	57,1	20,9	16,3	5,6
52135P38	E	3	4,9	0,11	0,06	0,06	0,04	0,26	43,31	21,1	21,6	14,0
52135P38	B1	11	5,3	0,02	0,01	0,00	0,01	0,05	49,92	24,0	0,0	26,0
52135P38	B2	21	5,6	0,01	0,00	0,00	0,01	0,02	60,80	10,6	0,0	28,6
52135P38	BC1	36	5,7	0,02	0,00	0,00	0,01	0,03	72,24	7,9	0,0	19,8
52135P38	BC2	46	6,0	0,02	0,00	0,00	0,01	0,03	71,99	7,1	0,0	20,9
52135P38	C1	56	5,9	0,03	0,00	0,00	0,01	0,04	73,75	4,9	0,0	21,4
52135P38	C2	73	6,1	0,04	0,01	0,00	0,01	0,05	70,28	9,6	0,0	20,1
52141P39	O		4,4	9,8	3,8	1,4	0,1	15,2	64,3	25,2	9,5	1,0
52141P39	E	3	5,3	0,16	0,09	0,06	0,02	0,32	48,08	26,6	19,1	6,2
52141P39	B	17	5,3	0,15	0,04	0,00	0,01	0,21	72,19	21,5	0,0	6,3
52141P39	BC1	30	5,8	0,10	0,02	0,00	0,01	0,14	73,97	16,5	0,0	9,6
52141P39	BC2	47	5,8	0,10	0,02	0,00	0,01	0,14	73,14	16,2	0,0	10,7
52141P39	BC3	67	5,8	0,06	0,02	0,00	0,01	0,09	67,22	17,4	0,0	15,3
52141P39	C	77	6,1	0,05	0,01	0,00	0,01	0,07	69,42	11,2	0,0	19,3
52142P40	O		4,4	9,9	3,4	2,1	0,2	15,6	63,3	22,1	13,4	1,3
52142P40	E	3	4,8	0,12	0,09	0,06	0,02	0,29	40,35	29,9	22,1	7,6
52142P40	Bhs	13	4,9	0,11	0,06	0,00	0,02	0,19	57,32	31,3	0,0	11,4
52142P40	Bs	22	5,3	0,16	0,03	0,00	0,02	0,21	79,47	12,5	0,0	8,0
52142P40	BC1	29	5,4	0,16	0,02	0,00	0,02	0,19	81,63	9,1	0,0	9,3
52142P40	BC2	40	5,7	0,15	0,01	0,00	0,02	0,18	82,88	6,6	0,0	10,5
52142P40	BC3	58	5,7	0,13	0,01	0,00	0,02	0,15	83,05	5,5	0,0	11,5
52142P40	BC4	76	5,9	0,12	0,01	0,00	0,02	0,15	80,09	7,4	0,0	12,5
52142P40	C	86	5,5	0,09	0,01	0,00	0,01	0,11	79,38	8,5	0,0	12,1
52142P41	O		4,3	5,5	2,9	1,8	0,3	10,5	52,5	27,9	16,8	2,7
52142P41	E	3	4,5	0,23	0,18	0,12	0,04	0,57	40,35	32,0	20,7	6,9
52142P41	Bs1	18	5,2	0,12	0,05	0,00	0,02	0,19	63,87	24,2	0,0	11,9
52142P41	Bs2	32	5,6	0,11	0,05	0,00	0,04	0,19	56,00	24,7	0,0	19,3
52142P41	Bs3	46	5,7	0,16	0,08	0,00	0,06	0,29	52,79	27,8	0,0	19,4
52142P41	Bs4	66	5,8	0,14	0,06	0,00	0,03	0,22	62,69	25,2	0,0	12,1
52142P41	BC	76	6,1	0,27	0,06	0,00	0,02	0,36	76,76	17,6	0,0	5,6

Table 15 Total content of the major elements in the mineral horizons of podzols from Skjellbekken catchment, % of ash.

Profile No	Horizon	Depth of bottom, cm	LOI % of d.w.	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	MnO	P2O5	SO3
5P37	E	2	3,04	75,27	11,97	2,94	1,12	2,53	2,73	1,56	0,69	0,05	0,04	0,01
5P37	B1	17	4,52	65,18	14,28	8,67	2,48	3,69	2,94	1,49	0,72	0,09	0,08	0,03
5P37	B2	33	5,04	64,48	15,30	7,47	2,55	3,98	3,26	1,39	0,66	0,11	0,13	0,03
5P37	BC1	57	4,43	62,54	15,66	8,55	2,94	4,32	3,13	1,25	0,76	0,12	0,14	0,03
5P37	BC2	70	1,97	64,08	14,83	7,85	2,87	4,62	3,18	1,17	0,75	0,11	0,17	0,01
5P37	C1	80	1,92	62,69	14,77	8,62	3,01	4,88	3,13	1,05	0,89	0,12	0,18	0,01
5P37	C2	90	2,35	64,93	14,97	6,86	2,72	4,61	3,28	1,33	0,68	0,10	0,18	0,01
5P38	E	3	6,30	76,97	11,12	2,88	1,21	2,73	2,76	1,14	0,36	0,04	0,04	0,02
5P38	B1	11	3,64	69,23	14,48	4,82	1,94	3,66	3,45	1,41	0,46	0,07	0,11	0,02
5P38	B2	21	1,60	70,27	14,08	4,40	1,88	3,81	3,55	1,31	0,41	0,07	0,10	0,01
5P38	BC1	36	1,25	69,54	14,13	4,65	1,99	3,84	3,50	1,45	0,45	0,08	0,11	0,01
5P38	BC2	46	1,04	68,68	14,12	5,10	2,23	4,01	3,29	1,50	0,49	0,08	0,12	0,00
5P38	C1	56	1,22	66,75	14,76	5,54	2,47	3,95	3,26	1,81	0,56	0,08	0,13	0,00
5P38	C2	73	1,12	67,36	14,77	5,49	2,44	4,00	3,37	1,73	0,54	0,08	0,14	0,00
5P39	E	3	1,74	74,86	11,89	3,88	1,22	2,66	2,97	1,22	1,03	0,08	0,03	0,01
5P39	B	17	4,34	66,14	14,30	8,32	2,31	3,63	3,08	1,20	0,76	0,10	0,07	0,03
5P39	BC1	30	3,63	65,38	15,39	6,92	2,50	4,09	3,21	1,27	0,74	0,10	0,09	0,03
5P39	BC2	47	2,24	65,92	14,79	6,89	2,48	4,14	3,25	1,29	0,76	0,10	0,08	0,02
5P39	BC3	67	1,67	65,92	14,60	6,95	2,53	4,25	3,24	1,27	0,77	0,10	0,12	0,01
5P39	C	77	1,23	65,42	14,51	6,80	2,49	4,36	3,27	1,37	0,75	0,10	0,17	0,01
5P40	E	3	2,26	76,69	11,75	2,45	0,91	2,21	2,60	1,66	0,83	0,05	0,04	0,01
5P40	Bhs	13	9,08	64,24	13,95	10,42	2,40	3,75	2,63	1,45	0,91	0,09	0,10	0,07
5P40	Bs	22	9,14	63,47	16,42	7,99	2,64	4,05	3,00	1,47	0,77	0,10	0,17	0,04
5P40	BC1	29	8,06	63,32	16,76	7,57	2,64	4,00	3,09	1,48	0,75	0,10	0,16	0,04
5P40	BC2	40	5,31	60,71	17,05	8,25	3,21	4,97	2,98	1,37	0,90	0,12	0,16	0,02
5P40	BC3	58	2,80	62,19	15,67	8,45	3,28	4,43	3,06	1,46	0,93	0,13	0,17	0,01
5P40	BC4	76	2,15	62,95	15,50	8,30	3,38	4,33	3,03	1,47	0,93	0,14	0,18	0,01
5P40	C	86	2,00	62,79	15,15	8,97	3,53	4,31	3,10	1,36	1,03	0,14	0,17	0,01
5P41	E	3	7,68	74,09	10,32	7,06	0,76	1,62	2,07	1,36	1,40	0,05	0,08	0,06
5P41	Bs1	18	6,68	58,79	13,05	18,30	1,89	2,91	2,54	1,25	0,85	0,09	0,18	0,19
5P41	Bs2	32	6,64	59,95	13,77	16,50	2,05	3,14	2,43	1,15	0,81	0,09	0,18	0,20
5P41	Bs3	46	5,32	61,77	13,61	14,20	2,22	3,37	2,70	1,17	0,80	0,10	0,16	0,18
5P41	Bs4	66	3,61	65,90	13,29	10,52	1,93	3,22	2,96	1,20	0,72	0,09	0,15	0,35
5P41	BC	76	2,60	68,28	13,12	8,57	1,71	3,15	3,13	1,10	0,68	0,09	0,11	0,29

Table 16 Conductivity and water extractable anions in podzols from Skjellbekken catchment

Profile		Depth of	EC		Anion contents, mg/kg d.w.				Anion composition, % equivalent				
No	Horizon	bottom, cm	µS/cm	F'	Cl'	NO3'	PO4'''	SO4''	F'	Cl'	NO3'	PO4'''	SO4''
52134P37	O		128,8	35,1	42,1	3,3	702,2	118,0	6,7	4,3	0,2	79,9	8,9
52134P37	E	2	18,4	2,1	0,9	7,0	9,5	11,2	14,2	3,3	14,5	38,0	29,9
52134P37	B1	17	19,1	0,0	2,2	8,7	0,0	15,5	0,0	11,9	26,7	0,0	61,4
52134P37	B2	33	9,2	0,0	0,6	14,9	0,0	8,1	0,0	4,2	56,1	0,0	39,7
52134P37	BC1	57	9,6	0,0	0,6	6,4	0,0	9,3	0,0	5,0	33,0	0,0	62,0
52134P37	BC2	70	6,2	0,0	0,0	1,0	0,0	5,8	0,0	0,0	11,9	0,0	88,1
52134P37	C1	80	4,9	0,0	0,0	0,9	0,0	3,9	0,0	0,0	15,6	0,0	84,4
52134P37	C2	90	4,8	0,0	0,0	0,7	0,0	3,6	0,0	0,0	13,4	0,0	86,6
52135P38	O		59,5	23,9	38,2	7,1	90,1	55,7	19,6	16,8	1,8	25,0	18,0
52135P38	E	3	14,1	0,0	5,5	3,7	4,4	9,3	0,0	28,6	11,0	0,0	35,4
52135P38	B1	11	7,9	0,0	3,7	3,9	0,0	14,9	0,0	22,0	13,3	0,0	64,7
52135P38	B2	21	5,0	0,0	1,5	3,0	0,0	8,8	0,0	15,5	17,6	0,0	66,9
52135P38	BC1	36	3,1	0,0	0,1	0,0	0,0	5,6	0,0	3,3	0,0	0,0	96,7
52135P38	BC2	46	2,2	0,0	0,0	0,0	0,0	3,2	0,0	0,0	0,0	0,0	100,0
52135P38	C1	56	2,1	0,0	0,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0	100,0
52135P38	C2	73	2,2	0,0	0,0	0,0	0,0	3,0	0,0	0,9	0,0	0,0	99,1
52141P39	O		128,5	30,6	64,9	2,0	582,1	108,6	6,7	7,6	0,1	76,1	9,4
52141P39	E	3	11,3	1,1	1,4	0,6	10,2	4,3	11,6	7,7	1,8	61,7	17,2
52141P39	B	17	11,7	0,0	2,1	1,6	0,0	11,6	0,0	18,5	7,7	0,0	73,8
52141P39	BC1	30	7,5	0,0	0,6	4,7	0,0	8,9	0,0	6,0	27,4	0,0	66,6
52141P39	BC2	47	6,7	0,0	0,0	1,4	0,0	11,4	0,0	0,0	8,8	0,0	91,2
52141P39	BC3	67	6,3	0,0	0,1	1,0	0,0	12,9	0,0	1,0	5,7	0,0	93,2
52141P39	C	77	3,3	0,0	0,0	0,0	0,0	4,0	0,0	0,0	0,0	0,0	100,0
52142P40	O		145,6	39,0	88,6	1,8	699,3	155,2	6,9	8,4	0,1	73,7	10,9
52142P40	E	3	18,7	1,1	1,0	0,6	10,8	9,2	9,3	4,4	1,4	54,2	30,7
52142P40	Bhs	13	20,8	2,0	3,2	3,5	0,0	22,7	14,6	12,5	7,8	0,0	65,1
52142P40	Bs	22	10,4	1,4	0,5	13,0	0,0	9,8	15,1	3,0	41,4	0,0	40,5
52142P40	BC1	29	9,3	0,0	0,4	14,3	0,0	6,2	0,0	2,9	62,4	0,0	34,7
52142P40	BC2	40	6,3	0,8	0,0	6,0	0,0	4,7	18,0	0,0	40,8	0,0	41,2
52142P40	BC3	58	4,3	0,0	0,0	1,2	0,0	3,4	0,0	0,0	21,7	0,0	78,3
52142P40	BC4	76	4,0	0,0	0,0	1,1	0,0	3,5	0,0	0,0	20,0	0,0	80,0
52142P40	C	86	3,8	0,0	0,0	1,0	0,0	2,6	0,0	0,0	22,5	0,0	77,5
52142P41	O		137,7	45,9	162,3	1,5	282,9	193,4	12,1	23,0	0,1	44,5	20,2
52142P41	E	3	33,0	3,3	4,5	0,5	10,7	18,7	17,0	12,2	0,8	32,4	37,6
52142P41	Bs1	18	12,2	1,5	3,0	1,0	0,0	15,9	15,4	16,7	3,1	0,0	64,8
52142P41	Bs2	32	10,5	0,5	5,4	3,1	0,0	26,0	3,7	19,6	6,6	0,0	70,1
52142P41	Bs3	46	12,8	0,0	8,6	1,7	0,0	24,2	0,0	31,5	3,5	0,0	65,0
52142P41	Bs4	66	9,5	0,0	3,7	0,9	0,0	19,1	0,0	20,5	2,7	0,0	76,8
52142P41	BC	76	6,8	0,0	0,0	0,8	0,0	12,3	0,0	0,0	4,6	0,0	95,4

Quaternary deposits

by Patrice de Caritat

Thirty-five Quaternary deposit samples (mostly till) were collected at 13 localities within the Skjellbekken catchment (Fig. 7). These samples came from different Quaternary units, but are considered together here. Sampling methods are detailed in Äyräs & Reimann (1995), and analytical methods are described above and in Niskavaara (1995). Summaries of the analytical results are presented in Tables 17 (GTK: ICP) and 18 (NGU: XRF). Detailed results are given in Appendices 9 and 10, respectively.

Compared with median analyses of tills from Finland (Koljonen, 1992), tills from Skjellbekken (median values) are enriched in Ca, Co, Cu, Fe, Mg, Sc, Si, Sr, Th and V, and have about equal contents (within a factor of 2) of Al, Ba, Cr, K, La, Li, Mn, Mo, Na, Ni, P, Pb, Ti, Y and Zn. The enrichments are probably due to the nature of the bedrock in and around the catchment, the bedrock including mafic rocks to carbonates as well as rock types containing sulphidic minerals.

Table 17 Summary of Quaternary deposit data (in ppm, except Al, Ca, Fe, K, Mg, Na and Si which are in %). ICP-AES-analysis, aqua regia digestion.

	Min	25th %ile	**Med**	Mean	*1 S.D.*	75th %ile	Max
Ag	0,50	0,50	**0,50**	0,50	*0,00*	0,50	0,50
Al	0,76	1,38	**1,63**	1,82	*0,84*	2,13	5,15
As	1,50	4,00	**6,00**	28,56	*104,96*	9,50	622,00
B	1,50	1,50	**1,50**	2,33	*1,34*	3,00	6,00
Ba	28,40	68,00	**92,60**	112,78	*63,06*	147,50	333,00
Ca	0,30	0,46	**0,51**	0,53	*0,14*	0,60	1,12
Cd	0,25	0,25	**0,25**	0,36	*0,51*	0,25	3,20
Co	5,10	12,90	**17,90**	22,38	*15,12*	26,00	76,20
Cr	10,40	27,20	**31,40**	36,35	*24,33*	35,55	160,00
Cu	16,30	58,15	**97,90**	101,21	*55,09*	133,00	256,00
Fe	1,17	2,56	**3,41**	4,13	*2,45*	5,03	12,50
K	0,05	0,17	**0,24**	0,29	*0,20*	0,31	0,98
La	14,60	19,85	**22,60**	24,22	*7,39*	28,70	47,70
Li	4,50	7,20	**8,60**	9,95	*5,47*	11,45	33,50
Mg	0,27	0,69	**0,98**	0,96	*0,41*	1,12	2,11
Mn	123	257	**319**	479,51	*393,49*	621	2240
Mo	0,35	0,35	**0,35**	1,05	*1,43*	1,20	6,90
Na	0,02	0,04	**0,04**	0,05	*0,02*	0,05	0,11
Ni	10,30	23,40	**33,30**	36,52	*19,42*	43,95	115,00
P	717	876	**1000**	1058,31	*354,61*	1095	2810
Pb	1,50	5,00	**6,00**	6,67	*2,70*	7,50	14,00
S	16	26	**37**	371,80	*743,50*	315	3590
Sb	2,50	2,50	**2,50**	3,07	*1,31*	2,50	7,00
Sc	2,50	5,05	**6,50**	7,64	*5,65*	8,55	36,70
Si	0,03	0,03	**0,04**	0,05	*0,03*	0,05	0,16
Sr	8,60	10,85	**14,30**	17,02	*8,09*	19,90	45,80
Th	5	9	**11**	11,71	*3,54*	14	23
Ti	665	1160	**1420**	1553,43	*576,57*	1815	3440
V	25,50	54,70	**75,70**	83,28	*50,27*	100,80	312,00
Y	6,40	9,60	**12,00**	13,00	*6,15*	13,60	33,60
Zn	18,50	43,35	**57,30**	65,79	*35,96*	81,35	180,00

Table 18 Summary of Quaternary deposit data (in %) - XRF analysis.

	Min	25th %ile	Med	Mean	*1 S.D.*	75th %ile	Max
SiO2	51,51	56,31	**58,33**	58,12	*3,03*	59,96	62,64
Al2O3	13,79	15,04	**15,24**	15,31	*0,72*	15,42	18,07
Fe2O3	6,83	7,75	**9,34**	9,71	*2,30*	10,94	15,62
TiO2	0,74	0,82	**1,03**	1,04	*0,23*	1,24	1,49
MgO	2,76	2,9	**3,27**	3,32	*0,43*	3,65	4,21
CaO	1,30	4,34	**4,64**	4,42	*0,76*	4,83	5,14
Na2O	1,94	2,99	**3,10**	3,06	*0,42*	3,19	4,62
K2O	1,16	1,34	**1,44**	1,52	*0,28*	1,66	2,45
MnO	0,08	0,11	**0,12**	0,14	*0,05*	0,17	0,29
P2O5	0,18	0,2	**0,23**	0,24	*0,07*	0,24	0,61
LOI	1,20	1,56	**1,92**	2,48	*1,38*	3,28	6,52
Sum	98,25	99,23	**99,34**	99,36	*0,41*	99,56	100,49

Bedrock

by Patrice de Caritat

Bedrock samples were collected from17 localities in the Skjellbekken catchment and its immediate vicinity. They were analysed both at GTK (primarily with ICP-AES) and at NGU (with XRF). Sampling methods are detailed in Äyräs & Reimann (1995), and analytical methods are given above and/or in Niskavaara (1995). The analytical results are summarized in Tables 19 and 20, while results are given in Appendices 11 and 12, respectively.

Compared with upper continental crust values (given in Koljonen, 1992), bedrock samples from Skjellbekken (median values) are depleted in K, and have about equal contents (within a factor of 2) of Cu, Li, Ni, P and Zn. Note that this comparison cannot be carried out for other elements due to the different extraction methods used (aqua regia vs. total content). Another remarkable feature of the bedrock data is the high maximum As content recorded (21 mg/kg) even with the aqua regia (i.e., partial) leaching method (average continental crust total As content is 1.8 mg/kg). Bi, Cd, Co, Cr, Cu, Mn, Ni, V and Zn show a similar behaviour. This suite of elements contains many of the contaminants deposited on the surface in this area after originating in anthropogenic or technogenic activities. It may therefore be difficult to distinguish with absolute certainty whether these elements, when found in surficial media, have a geogenic or technogenic derivation.

Table 19: Summary of bedrock data (in mg/kg) ICP-AES analysis, aqua regia digestion.

	Min	25th %ile	**Med**	Mean	*1 S.D.*	75th %ile	Max
Ag	0,01	0,03	**0,06**	0,22	*0,32*	0,19	0,93
Al	1680	11600	**18200**	18705,29	*9912,18*	25300	37400
As	0,05	0,05	**0,20**	1,94	*5,08*	1,10	21,20
B	1,50	1,50	**1,50**	1,59	*0,36*	1,50	3,00
Ba	2,20	40,70	**74,50**	96,45	*87,03*	160,00	305,00
Bi	0,01	0,01	**0,07**	0,11	*0,11*	0,17	0,38
Ca	270	3180	**14000**	40701,76	*79207,88*	32000	303000
Cd	0,01	0,05	**0,10**	0,48	*1,21*	0,15	4,98
Co	1,10	10,60	**16,60**	19,42	*13,21*	24,50	51,30
Cr	2,80	28,10	**47,60**	62,11	*53,11*	87,60	176,00
Cu	1,10	25,30	**50,50**	96,44	*108,79*	142,00	338,00
Fe	7030	28200	**54500**	63395,88	*45787,19*	95200	182000
Hg	0,01	0,01	**0,01**	0,02	*0,02*	0,03	0,06
K	100	600	**5000**	6470,59	*6158,41*	10300	18800
La	0,90	4,40	**18,70**	17,31	*13,29*	27,40	42,80
Li	1,00	8,30	**15,50**	16,71	*11,55*	22,60	36,30
Mg	540	11500	**15200**	14643,53	*8437,92*	16700	39400
Mn	58,70	318,00	**459,00**	633,81	*533,77*	781,00	1840,00
Mo	0,50	0,50	**0,50**	2,94	*3,66*	5,00	13,30
Na	20	150	**230**	355,29	*346,32*	420	1160
Ni	2,50	21,70	**27,60**	51,52	*58,04*	45,00	222,00
P	86	298	**643**	1060,59	*2004,73*	790	8680
Pb	0,30	1,30	**3,60**	3,14	*2,11*	4,60	7,30
S	30	251	**887**	7205,53	*10384,97*	17400	28600
Sb	0,01	0,01	**0,02**	0,05	*0,05*	0,05	0,18
Sc	0,20	3,00	**5,70**	7,62	*6,12*	8,70	21,00
Se	0,01	0,04	**0,17**	1,83	*3,02*	2,30	10,10
Si	160	230	**290**	297,06	*102,58*	340	590
Sr	1,60	11,60	**23,90**	38,10	*43,87*	40,40	166,00
Te	0,01	0,01	**0,03**	0,12	*0,18*	0,21	0,54
Th	2,50	2,50	**11,00**	10,56	*6,08*	16,00	18,00
Ti	50,80	238,00	**1760,00**	1829,13	*1545,46*	2760,00	4540,00
V	5,20	51,10	**82,10**	104,79	*76,68*	149,00	263,00
Y	3,00	6,20	**10,20**	13,49	*9,86*	18,40	40,40
Zn	13,00	35,40	**65,00**	108,93	*162,72*	95,20	713,00

Table 20: Summary of bedrock data (in %), XRF-data.

	Min	25th %ile	**Med**	Mean	*1 S.D.*	75th %ile	Max
SiO2	15,92	49,09	**55,18**	55,56	*15,71*	63,32	93,46
Al2O3	0,31	9,51	**13,01**	10,84	*5,40*	14,03	17,45
Fe2O3	1,51	5,48	**8,24**	9,97	*6,18*	13,01	25,70
TiO2	0,05	0,50	**0,91**	0,97	*0,72*	1,55	2,32
MgO	0,30	2,23	**2,68**	3,27	*2,16*	3,17	9,61
CaO	0,13	2,09	**4,00**	7,46	*10,49*	8,43	42,38
Na2O	0,05	0,77	**2,09**	2,12	*1,48*	3,22	4,96
K2O	0,01	0,38	**1,43**	1,39	*1,12*	2,34	3,04
MnO	0,01	0,07	**0,12**	0,22	*0,38*	0,22	1,66
P2O5	0,02	0,08	**0,18**	0,25	*0,42*	0,19	1,86
LOI	0,50	0,95	**3,80**	6,79	*9,11*	6,85	34,43
Sum	97,13	98,53	**98,88**	98,83	*0,64*	99,06	100,14

Use of transplanted mosses and ion-exchange resins in aquatic heavy metal pollution studies in two catchment areas in NE Norway (Skjellbekken) and NW Russia (Monchegorsk)

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INTRODUCTION

Naturally growing mosses have been used with success in environmental studies (especially in mo-nitoring of atmospheric pollution) since the late 1960'ies, and in the aquatic environment they - andother plants - have become increasingly important as water purifyers. This study, which forms partof a Ph.D. project at the Norwegian Institute of Technology, concerns the use of transplanted terres-trial mosses (*Hylocomium splendens* and *Sphagnum fuscum*) as monitors of aquatic heavy metal pollution (e.g. Ni, Cu and Co) from the nickel-smelter activity on the Kola Peninsula. As metal up-take in mosses is governed by ion-exchange processes, conventional ion-exchange resins have also been used in this study for comparison.

Twice during 1994 samples of transplanted terrestrial mosses, ion-exchange resins and de-ionized water (see below) were emplaced in two streams in the low-contamined Skjellbekken catchment and in the highly contaminated Monchegorsk catchment for 1 to 81 days. The first experiment coincided more or less with snow melting in the two catchment areas (high water flow), whereas the secondexperiment was carried out in the dry summer season (low water flow).

METHODS AND PROCEDURES

Mosses :

Moss samples were collected in a low-contaminated area in the vicinity of Trondheim, central Nor-way in the early spring of 1994 (*Hylocomium splendens* from dry woodland and *Sphagnum fuscum* from swampy wetland). After cleaning in the laboratory the moss samples for experiment 1 were split into two batches, which were placed in de-ionized water and 0.5 M hydrochloric acid respec-tively for about 24 hours before neutralization (batch 2), drying and weighing into 2 g samples. The experiment with both live (~ untreated) and dead (acid-washed) mosses was done in order to test for any biological fractionation in the metal uptake. No such effect was observed for either of the moss species, so in experiment 2 only acid-washeu mosses were used.

In experiment 1 moss samples were placed in hair-nets to ensure maximum hydraulic contact, but the mosses collected a lot of detrital and colloidal material - especially in the Skjellbekken catch-ment (up to 50 wt% in *Sphagnum fuscum*) - so in experiment 2 moss samples were placed in perme-able 1½-inch dialysis membranes with de-ionized water and pore diameters of 24 Å, preventing passage of any high-molecular species (i.e. colloids).

Ion-exchange resins :
Two types of ion-exchange resins were used in both experiment 1 and 2 : A cation-exchange resin (Dowex 50W-X8 on H^+-form) and a chelating ion-exchange resin (Metalfix / Chelex 100 both on Na^+- form). The Metalfix resin used in experiment 1 proved to be a bad choice, since it decom-posed partly during transport before use, so for experiment 2 the well-reputated Chelex 100 resin was chosen instead.

10 g samples of moist untreated ion-exchange resin were used in experiment 1, corresponding to a dry weight of about 5 g for both the Dowex 50 and the Metalfix resins. In experiment 2 sample sizes were raised to 20 g, corresponding to a dry weight of about 10 g and 5 g respectively for the Dowex 50 and the Chelex 100 resins. In both experiment 1 and 2 the ion-exchange resins were placed in 1-inch dialysis membranes with de-ionized water.

De-ionized water :
In order to get information on the stream water chemistry at certain times (besides weekly stream water sampling in the two catchments), dialysis membranes with only de-ionized water were used in both experiment 1 and 2 alongside with the mosses and the ion-exchange resins.

All the samples mentioned above were tied to 45x35 cm plexi-glass frames (see fig. 1), which were placed vertically in the streams for periods of 1, 3, 9, 27 and 81 days in both experiment 1 and 2. After exposure and subsequent extraction of metals samples were analysed for 30 standard elements by ICP-AES at NGU.

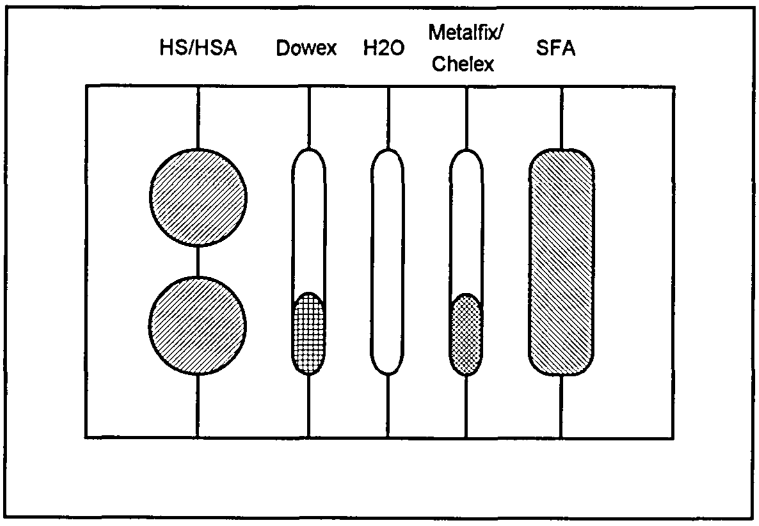

Fig. 16 Schematic presentation of sample setup in experiment 1 (left - middle) and experiment 2 (middle - right). HS = *Hylocomium splendens*, HSA = acid-washed *Hylocomium splendens* and SFA = acid-washed *Sphagnum fuscum*.

RESULTS AND DISCUSSION

Mosses

:

The metal contents in *Hylocomium splendens* (HS) and *Sphagnum fuscum* (SF) from experiment 1 in both the Skjellbekken and the Monchegorsk catchments are from 1.5 to 10 times larger than those of experiment 2, suggesting a substantial fraction of colloidally associated metal during snow mel-ting. Consequently, only data from experiment 2 will be considered in the following. The two moss species show markedly different, though consistent, metal uptake patterns, indicating differences in the surface charge groupings on the mosses. Thus, SF shows a low uptake of polyvalent metals such as Al, Fe, Cr, V and Y compared to HS (2 - 4 times lower uptake). Likewise, HS shows a low up-take of the alkaline earth metals - especially Mg, Ca and Sr - compared to SF (1.5 - 3 times lower uptake). Uptake of divalent transition metals such as Mn, Zn, Ni, Cu and Co is also higher in SF than in HS (1.1 - 2.8 times higher), although the Ni-, Cu- and Co-uptake patterns of the two mosses are very similar. The alkali-metals Na and K show contras- ting behaviour - the Na- content being higher in SF than in HS and vice versa for K.

For most metals (except the divalent transition metals) both HS and SF quickly reach a saturation level, whereafter only slight enrichments or even loss of metal occur (after 1-3 days in the Monche-gorsk catchment and 1-9 days in the Skjellbekken catchment depending on moss species). This be-haviour determines both the level of preference and the binding strength for a given metal in either moss species. Thus, based on the maximum uptake of metals and the corresponding stream water composition, the following sequence of metal prefe-rences for HS under oxidizing near-neutral con-ditions can be established : Al > Fe >> Cu >> Ni >> Co > V+Cr > Ba >> Zn+Mn+Ca+Sr > Mg > Na > K. The similar sequence for SF runs : Al >> Fe > Cu >> Ni > Co+Ba > V > Ca+Mn+Sr > Mg > Zn >> Na > K. The sequences are mainly based on the Russian data, since the heavy metal pollu-tion level and the number of polluting metals generally is higher in the Monchegorsk catchment, gi-ving the analyses a statistically higher significance.

Both moss species have proven to be very effective sieves for a wide range of metals, more or less irrespective of the preferences mentioned above. Thus, both HS and SF show extreme Al-enrich-ment after only a few days in the Skjellbekken and the Monchegorsk catchments (20,000 - 30,000 times the average stream water composition). The lowest enrichments are seen for the alkali-metals, which are only concentrated 50 - 300 times. Seen overall, HS seems to produce the most consistent and reliable results of the two mosses, although SF is able to pick up lower pollution signals for se-veral of the analysed metals (i.e. takes up more metal).

Ion-exchange resins :

The Dowex 50 (CE) and Chelex 100 (CH) resins - like the mosses - show pronounced differences in metal uptake (the uptake patterns for the partly decomposed Metalfix resin used in experiment 1 are somewhat erratic, and they will not be considered here). Thus, the CE resin shows a lower uptake of polyvalent metals such as Al, Fe, Ti, V and Ce than the CH resin (1.5 - 4.5 times lower). Uptake of the divalent transition metals Mn, Zn, Ni, Cu and Co is also lower on the CE resin than on the CH resin (1.2 - 4 times lower). The uptake of the alkaline earth metals Mg, Ca, Sr and Ba is very si-milar for the two resin types, whereas uptake of the alkali-metals Na and K is significantly higher on the CE resin than on the CH resin (3.5 times higher for K). Resulting from these data - again based on the maximum metal uptake and the corresponding stream water composition - the following se-quences of metal preferences can be established for the CE and CH resins respectively under oxidi-zing near-neutral conditions: Na+K > Ca+Mg+Ba > Sr > Ni+Co+Mn >> Cu >> Fe > Zn > V+Cr+Al and Ni+Co > Mn >> Ca+Ba > Cu > Mg +Sr > Zn > K > Fe > Al > V+Cr >> Na.

The ion-exchange resins have taken up much less metal than expected, suggesting some kind of ki-netic or other influence. Thus, enrichments factors are only from ≤ 80 - 3,000 for the CE resin (Al - Na+K) and 300 - 7,100 for the CH resin (Al - Ni).The larger particle size of the CE resin compared with the CH resin (300 - 850 μm versus 150 - 300 μm) is believed to be responsible for the overall lower metal uptake on the CE resin (larger particles give lower specific surface area), whereas the contrasting uptake of the alkali-metals on the CE and CH resins probably reflects a dependence on the type of exchangeable ion (Na^+ versus H^+).

Although the metal preference sequences for the mosses and the ion-exchange resins mentioned a- bove give some indications of their metal uptake capacity (since the maximum uptake of several of the analysed metals occurs after 81 days of exposure), a more reasonable picture of the competition between the metals is probably obtained by normalizing the uptake data to shorter periods of expo-sure. Table 1 shows the metal enrichment factors for the mosses and the ion-exchange resins after 1-3 days of exposure. The corresponding metal preference sequences goes : HS = Al > Fe >> V+Cr >> Ni+Co+Ba > Cu > Mn+Ca+Sr > Mg > Zn > K+Na, SF = Al >> Fe >> V > Ba+Ni > Mn+Cu+Ca +Sr+Co > Mg+Zn >> Na > K, CE = Na >> K >> Mg > Ni+Co+Mn+Ca > Fe+Sr+Ba > Cu > Zn > Cr+V+Al and CH = Ba > Ni+Co > Mg+Mn+Sr+K+Ca >> Cu+Zn > Fe > Cr+V+Al >> Na. By com-paring the metal preference sequences it is obvious that the divalent transition metals - and especially Cu - loses in the short term competition with the other metals. Thus it follows that exposure times have to be customized to the metal(s) of interest.

Element	HS	SF	CE	CH
Al	30,127 [*1]	21,240	< 1.5	< 1.5
Fe	26,976 [*1]	11,153	85	92
Cr	3,241 [*1]	< 1,887	< 19	< 19
V	3,366 [*1]	2,151	< 8.5	-
Cu	802	1,291	53	196
Ni	1,277	1,640	117	1,049
Co	1,122	1,165	116	1,044
Mn	682	1,375	108	943
Zn	253	724	18	179
Mg	414	884	134	975
Ca	660	1,256	98	848
Sr	659	1,261	76	936
Ba	1,041	1,742	69	1,197
Na	119 [*1]	310 [*1]	1,733	-
K	46 [*1]	186 [*1]	467	879

Table 21 Metal enrichment factors for mosses and ion-exchange resins after 3 days of exposure (ex-cept for metals marked [*1], which reach a maximum/local maximum after 1 day of exposure). HS =*Hylocomium splendens*, SF = *Sphagnum fuscum*, CE = cation-exchange resin (Dowex 50) and CH =chelating ion-exchange resin (Chelex 100).

De-ionized water :

The analyses of de-ionized water from the dialysis membranes correlates well with the stream water composition for metals typically occurring as free ions (i.e. alkali- and alkaline earth metals), but large deviations are seen for a lot of the other metals,which typically occur as hydroxy- and other complexes. Some of these deviations are positive, probably reflecting the different analytical resolution of the analytical equipment used (ICP-MS for stream water samples versus ICP-AES for the de- ionized water), since stream water samples are filtered through 0.45 µm filters before analysis and pore diameters of the dialysis membranes are about 24 Å - i.e. the uptake in the dialysis membranes should be lower at all times.

PERSPECTIVES AND FUTURE RESEARCH

The outlined use of transplanted mosses offers several advantages over conventional methods in en-vironmental studies. First of all, the method is cheap and relatively simple, and because of the supe-rior ion-exchange capacity of the investigated mosses, even low metal concentrations can be detected by standard analytical procedures (e.g. ICP-AES and AAS). Frequent and costly stream water sampling and ICP-MS analyses can hereby be avoided. Furthermore, the high preference for and uptake capacity of the divalent transition metals in both HS and SF make them especially suited for heavy metal pollution studies. The ion-exchange resins, on the other hand (and especially the CE re-sin), show a low uptake of most of the analysed metals compared to the mosses, probably relating to a generally low water flow in both catchments (≤ 0.1 m/s in the Skjellbekken catchment in the sum-mer season). Higher flow rates might enhance metal uptake on the resins up to the moss levels, but their prices preclude them from being an realistic alternative to the mosses. Use of de-ionized water in dialysis membranes provides a good control on the labile low-molecular phases in stream water, but samples need to be analysed by ICP-MS - especially in low-contaminated areas - making it an unduely expensive method.

Future research will - through field and laboratory experiments - be focused on the effects of factors like stream velocity and absolute concentrations on the metal uptake in the investigated mosses. The resulting empirical relations will then - if possible - be used in mineral deposit exploration. Use of (other?) ion-exchange resins might also be employed in these experiments as references to the moss data.

Remote sensing

by Tor Erik Finne

NORUT has used multitemporal satellite imagery to study vegetation changes in two areas, Nikel - Zapoljarny (approx . 7000 km^2) and Monchegorsk (approx. 6500 km^2). The size of the areas was determined by the extent of the LANDSAT images showing the two industrial centres. The analyses of vegetation indices and land cover changes have been carried out on entire images.

The oldest images available and of interest for this analysis of long-terme effects date from 1973 (Nikel) and 1978 (Monchegorsk). Since then, sensor technology has changed (improved) from «MSS» scanners on the LANDSAT 2 and 5 missions to «TM» carried only by the latter. This called for acquisition of additional imagesin order to overlap the time series covered by the two sensors. Prior to purchasing images, cloud statisticswere studied and «Quick Looks» were inspected to ensure that there were no clouds over vital areas. Even more important when selecting images was the date of capture, as this kind of time study is very sensitive to annual variations in the spring thaw and the subsequent greening of foliage.

The Nikel area had been analysed and interpreted earlier for the period 1973-88, using the MSS images. In 1995, this work was extended to include images from 1992 and 1994, as well as the use of the higher resolution TM-images. Combined with ground truthing carried out at several stages during the time span studied, vegetation or land cover maps were constructed for 1973, 1979, 1985, and 1988 (MSS data), and 1985, 1988, 1992, and 1994 (TM data). Vegetation indices calculated for the various years were used to construct maps showing vegetation changes. Area statistics for the various classes have been linked to estimates and official figures of industrial emissions for the period, and an increase in the areal extent of vegetation degradation is linked to the industrial emissions. However, there are indications that the reduction in emissions since 1980 can be seen as a reduction in the rate of vegetation degradation in the area.

The Monchegorsk area was analysed using MSS images from 1978 and 1986, and TM-scenes from 1986, 1989, and 1994. Land cover maps were made for the same four years with the help of published vegetation maps and literature as well as general experience obtained from the Nikel area. Vegetation indices were calculated and used to construct maps showing vegetation changes for the various time spans between the images studied. As for the Nikel area, figures for annual emissions of SO_2 were combined with areal statistics for the various vegetation classes to determine correlations. Here, too, there are indications that the reduction in SO_2-emissions from industry since the mid-1980ies coincides with slightly improved vegetation quality in the least affected areas and vegetation types.

Conclusions

The Norwegian catchment (Catchment 5, Skjellbekken) is situated only 30 km to the WSW from one of the main sources of contamination in the area, the nickel smelter in Nikel, Russia. Other industries within a radius of 100 km around C5 include the nickel ore roasting plant at Zapoljarniy, Russia, a large open-pit nickel mine in the same area, the open-pit iron mine at Bjørvattn in Norway and the iron ore processing plant in Kirkenes.

The geology within the catchment is a continuation of the Nikel-Pechenga belt of rocks and the catchment has been the site of several attempts of nickel exploration. Natural background levels for a number of airborne pollutants originating from the industry within the area are thus expected to be high. In addition, the glacial history is rather complex in this area. Catchment 5 is thus one of the most varied and difficult catchments with regards to levels, sources and variability of the geogenic element contents of all eight catchments studied.

The bedrock samples from cachment 5 are especially enriched in S, Bi, Te, Cr, Ca, Cd, V, Ni, Cu, Co, As, Mg, Ag, Sc and Fe when compared to all other catchments.

The samples of Quaternary deposits show a surprisingly different picture: for this sample medium element levels observed in catchment 5 represent very well an average for all catchments investigated. Cu is one element for which almost all samples returned above average element contents in Quaternary deposits from this catchment, single samples gave very high As-results.

Topsoil does not reflect the unusual geology and high geogenic background levels observed for the bedrocks. Even for copper, which is enriched in the Quaternary deposits, topsoil only returns average values. There are some single outliers for Ag, Mo, Ca and Mg in topsoil samples from this catchment. It is not possible to use the topsoil to document any anthropogenic input of elements to this catchment. For a geologist, the results obtained from the topsoil samples are rather surprising. For the moment we must conclude that biological processes govern the element contents observed in the topsoils to a much greater extend than geology and/or anthropogenic inputs do.

Moss is one of the sampled media showing that there is an anthropogenic input of elements to catchment 5. As, Cd, Co, Cu, Fe, Hg, Mn, Ni, S and Ti are slightly higher than in the Finnish background catchments. The high variation and median levels observed for Mn and Zn must be attributed to samples either taken too close to trees (throughfall) or to the rich ground vegetation in this catchment. The rather high Hg-level and variation in mosses from catchment 5 cannot be explained at present.

Organic stream sediments from catchment 5 returned average results when compared to the other catchments. High levels of Ca, Mg, Sc and Ti show that they reflect bedrock geochemistry rather well. Slightly higher values for As and Cu can not be attributed to airborne deposition but rather are a reflection of the geogenic background as well considering the high analytical results for these elements in bedrock and Quaternary deposits. Organic stream sediments seem thus to be a rather well suited medium for prospection purposes, but not for environmental studies.

Stream water chemistry was monitored closely in catchment 5. Weekly sampling throughout several months gave a good overview of sources, variation and levels of element contents in stream water. In terms of element levels, Ca and As are the only two elements that are clearly enriched when compared with the stream water results from all other catchments. Both can be explained geologically and have nothing to do with contamination from anthropogenic sources. When compared to world average water, element levels observed in streamwaters from catchment 5 are rather low. In terms of seasonal variation snow melt is the biggest event influencing stream water chemistry. In catchment 5, snowmelt results in a general dilution of element levels due to increased water amounts.

For rain either measured element levels or element levels recalculated to depositon data can be investigated. In terms of deposition data the observed median values fit rather well with background data from other parts of the world. Compared to the Finnish catchments As, Co, Cu, Ni, Pb, Sb, and V show the influence of the nearby smelter (Nikel) in form of slightly elevated levels. It should not be forgotten, however, that the element contents measured in rain are not only influenced by local emission sources but represent a combination of worldwide background levels coming from all kinds of regional and local anthropogenic as well as natural sources, among them dust storms, local wind blown dust, volcanic eruptions. Comparisons of the monthly data show that variation in element levels are very big for rainwater, and that the deposition of heavy metals happens in form of short time events at high levels, depending on the main wind directions, and not at the same rate day after day. In addition it is known that there are big differences in the chemistry of rainfall and throughfall. This makes rainwater a rather diffcult medium to handle.

For snow, filtered meltwater and filter residues were analysed separately. For the filter residues (e.g. particular input), cachtment 5 displays only background levels. The meltwater shows slightly elevated levels for As, Co, Cu, Ni and Sr, as well as some of the highest values for the typical sea spray elements Na, Cl, Ca and Mg.

Catchment 5 is located only 30 km from one of the main pollution sources in Northern Europe. Catchment 5 receives, however, only minor inputs of air pollutants due to topograpy and general wind directions in this area,. These inputs can be measured when using media like snow, rain and moss. Stream water chemistry is strongly governed by geogenic sources. The topsoils have so high and so highly variable natural element contents for the suite of elements emitted by the local industry that it is impossible to distinguish the very minor additional element input via air pollution. The measureable impact of industry on the environment in terms of enhanced element contents in the different media sampled, turns out to be rather restricted to a small area around the known point sources. Already in catchment 5 the anthropogenic inputs are quite difficult to distinguish from natural background levels and variability.

For the reliable interpretation of the results obtained, it is rather important to know element levels and variation in several media. When compared to the results from the pilot project, it is concluded that regional mapping is considerably better suited for fingerprinting the emissions and outlining the contaminated areas than the catchment approach used here. Local variations observed are high for a number of elements, regional contrast, however, observed for most of the elements is much bigger. Thus the construction of stable maps over the whole survey area in 1995/96 should be possible for the majority of the elements studied.

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APPENDIX

Appendix

for snow

*ID	Catch	Med	Loc	Ag_mw	Al_mw	Al_fr	As_mw	As_fr	B_mw	B_fr	Ba_mw	Ba_fr	Be_mw	Bi_mw	Ca_mw	Ca_fr
				µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l
				140M	140M	503P	140M	503P	140M	503P	140M	503P	140M	140M	140P	503P
2002	5	SN	2	<0.01	8,36	17	<0.1	< 0.3	<0.5	< 0.3	0,17	0,08	<0.3	<0.02	0,09	0,01
2004	5	SN	3	<0.01	2,86	5	<0.1	< 0.3	12,5	< 0.3	0,38	0,04	<0.3	<0.02	0,61	< 0.01
2006	5	SN	4	<0.01	1,62	3	<0.1	< 0.3	<0.5	< 0.3	<0.1	0,02	<0.3	<0.02	0,06	< 0.01
2009	5	SN	6	<0.01	1,83	4	0,15	< 0.3	<0.5	< 0.3	0,13	< 0.01	<0.3	<0.02	0,07	< 0.01
2011	5	SN	7	<0.01	2,79	6	<0.1	< 0.3	<0.5	< 0.3	<0.1	0,02	<0.3	<0.02	0,1	< 0.01
2014	5	SN	9	<0.01	3	7	0,14	< 0.3	4,4	< 0.3	0,21	0,04	<0.3	<0.02	0,15	< 0.01
2017	5	SN	11	<0.01	2,89	7	0,11	< 0.3	<0.5	< 0.3	0,11	< 0.01	<0.3	<0.02	0,09	< 0.01
2020	5	SN	13	<0.01	2,47	5	0,16	< 0.3	<0.5	< 0.3	0,1	0,02	<0.3	<0.02	0.05!	< 0.01
2023	5	SN	15	<0.01	1,77	5	0,13	< 0.3	<0.5	< 0.3	0,34	< 0.01	<0.3	<0.02	0,4	< 0.01
2026	5	SN	17	<0.01	4,62	7	0,14	< 0.3	<0.5	< 0.3	0,18	< 0.01	<0.3	<0.02	0,1	< 0.01
2029	5	SN	19	<0.01	3,35	4	0,15	< 0.3	<0.5	< 0.3	0,12	< 0.01	<0.3	<0.02	0.05!	< 0.01
2035	5	SN	24	<0.01	6,92	10	0,13	< 0.3	<0.5	< 0.3	0,16	0,03	<0.3	<0.02	0,1	< 0.01

*ID	Cd_mw	Cd_fr	Co_mw	Co_fr	Cr_mw	Cr_fr	Cu_mw	Cu_fr	Fe_mw	Fe_fr	K_mw	K_fr	La_fr	Li_mw	Li_fr	Mg_mw
	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	mg/l	mg/l	µg/l	µg/l	µg/l	mg/l
	140M	503P	140M	503P	140M	503P	140M	503P	140M	503P	140M	503P	503P	140M	503P	140P
2002	<0.03	< 0.05	0,04	0,1	<0.2	0,31	1,75	2,53	<0.015	0,03	0,07	0,06	< 0.07	<0.1	< 0.07	0,1
2004	<0.03	< 0.05	<0.03	0,05	<0.2	< 0.05	0,82	0,61	<0.015	0,01	0,08	0,06	< 0.07	<0.1	< 0.07	0,16
2006	<0.03	< 0.05	<0.03	0,06	<0.2	< 0.05	0,77	0,75	<0.015	0,01	0,04	0,01	< 0.07	0,15	< 0.07	0,09
2009	<0.03	< 0.05	<0.03	< 0.05	<0.2	< 0.05	0,77	0,58	<0.015	0,01	0,08	< 0.01	< 0.07	<0.1	< 0.07	0,08
2011	<0.03	< 0.05	0,03	0,06	<0.2	0,05	0,89	0,93	<0.015	0,02	0,06	< 0.01	< 0.07	<0.1	< 0.07	0,16
2014	<0.03	< 0.05	0,05	0,09	0,24	0,45	0,97	1,12	<0.015	0,03	0,07	< 0.01	< 0.07	0,17	< 0.07	0,14
2017	<0.03	< 0.05	0,05	0,08	<0.2	0,15	0,95	1	<0.015	0,02	0,05	< 0.01	< 0.07	0,15	< 0.07	0,09
2020	<0.03	< 0.05	0,06	0,12	<0.2	0,09	1,03	1,28	<0.015	0,02	0,04	0,02	< 0.07	<0.1	< 0.07	0,07
2023	<0.03	< 0.05	0,04	0,1	<0.2	0,05	0,93	0,98	<0.015	0,02	0,06	< 0.01	< 0.07	0,12	< 0.07	0,13
2026	<0.03	< 0.05	0,05	0,1	<0.2	0,06	1,07	1,18	<0.015	0,03	0,06	< 0.01	< 0.07	0,19	< 0.07	0,14
2029	<0.03	< 0.05	0,06	0,11	<0.2	0,1	1,38	1,25	<0.015	0,02	0,05	< 0.01	< 0.07	0,15	< 0.07	0,06
2035	<0.03	< 0.05	0,05	0,11	0,21	0,33	1,17	1,33	<0.015	0,03	0,06	< 0.01	< 0.07	0,16	< 0.07	0,1

*ID	Mg_fr	Mn_mw	Mn_fr	Mo_mw	Mo_fr	Na_mw	Na_fr	Ni_mw	Ni_fr	P_mw	P_fr	Pb_mw	Pb_fr	Rb_mw	S_mw
	mg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	mg/l
	503P	140M	503P	140M	503P	140P	503P	140M	503P	140P	503P	140M	503P	140M	140P
2002	< 0.01	0,81	0,17	<0.05	< 0.07	0,6	< 0.01	0,75	3	0,051	0,005	0,32	< 0.3	0,24	0,177
2004	< 0.01	1,79	0,08	<0.05	< 0.07	1,6	< 0.01	0,42	1,2	<0.002	0,0006	0,35	< 0.3	0,08	0,474
2006	< 0.01	0,34	0,06	<0.05	< 0.07	0,8	< 0.01	0,47	1,5	<0.002	< 0.0005	0,23	< 0.3	<0.05	0,166
2009	< 0.01	1,17	0,07	<0.05	< 0.07	0,6	< 0.01	0,6	1,1	0,018	0,0015	0,25	< 0.3	0,26	0,156
2011	< 0.01	0,92	0,11	<0.05	< 0.07	1,4	< 0.01	0,88	1,7	0,018	0,001	0,28	< 0.3	0,06	0,234
2014	< 0.01	0,97	0,14	<0.05	< 0.07	1,4	< 0.01	0,88	2,2	<0.002	0,0009	0,4	< 0.3	0,1	0,327
2017	< 0.01	0,74	0,13	<0.05	< 0.07	0,7	< 0.01	0,77	2,1	<0.002	0,0009	0,34	< 0.3	<0.05	0,213
2020	< 0.01	0,66	0,15	<0.05	< 0.07	0,7	< 0.01	0,72	2,9	<0.002	0,0013	0,32	< 0.3	<0.05	0,184
2023	< 0.01	0,62	0,09	<0.05	< 0.07	1	< 0.01	0,64	2,4	<0.002	< 0.0005	0,24	< 0.3	<0.05	0,234
2026	< 0.01	1,17	0,17	<0.05	< 0.07	1,1	< 0.01	0,87	2,6	0,019	0,0009	0,34	< 0.3	0,06	0,234
2029	< 0.01	0,48	0,12	<0.05	< 0.07	0,7	< 0.01	1,19	2,8	0,013	0,0005	0,39	< 0.3	<0.05	0,209
2035	< 0.01	0,77	0,21	<0.05	< 0.07	0,7	0,01	0,87	2,7	0,023	0,0012	0,56	< 0.3	0,08	0,145

*ID	S_fr	Sb_mw	Sb_fr	Sc_fr	Se_mw	Si_mw	Si_fr	Sr_mw	Sr_fr	Th_mw	Th_fr	Ti_fr	Tl_mw	U_mw	V_mw	V_fr
	mg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
	503P	140M	503P	503P	140M	140P	503P	140M	503P	140M	503P	503P	140M	140M	140M	503P
2002	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	0,55	0,11	<0.01	< 0.5	0,88	<0.01	<0.01	0,15	0,06
2004	< 0.005	0,04	< 0.5	< 0.01	<0.5	<0.1	< 0.01	2,37	0,13	<0.01	< 0.5	0,49	<0.01	<0.01	0,16	< 0.05
2006	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	0,56	0,04	<0.01	< 0.5	0,36	<0.01	<0.01	0,15	< 0.05
2009	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	0,51	0,03	<0.01	< 0.5	0,31	<0.01	<0.01	0,18	< 0.05
2011	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	1,04	0,02	<0.01	< 0.5	0,65	<0.01	<0.01	0,19	< 0.05
2014	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	1,24	0,02	<0.01	< 0.5	0,67	<0.01	<0.01	0,24	0,05
2017	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	0,57	0,02	<0.01	< 0.5	0,73	<0.01	<0.01	0,21	0,05
2020	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	0,58	0,02	<0.01	< 0.5	0,61	<0.01	<0.01	0,22	< 0.05
2023	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	1,2	0,02	<0.01	< 0.5	0,49	<0.01	<0.01	0,19	< 0.05
2026	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	0,91	0,02	<0.01	< 0.5	1,03	<0.01	<0.01	0,25	0,06
2029	< 0.005	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	0,65	0,02	<0.01	< 0.5	0,71	<0.01	<0.01	0,22	< 0.05
2035	0,017	<0.03	< 0.5	< 0.01	<0.5	<0.1	< 0.01	0,61	0,03	<0.01	< 0.5	1,57	<0.01	<0.01	0,18	0,06

*ID	Y_fr	Zn_mw	Zn_fr	EC	pH	Br	Cl	F
	µg/l	µg/l	µg/l	µS/cm	-	mg/l	mg/l	mg/l
	503P	140M	503P	143I	143I	143R	143R	143R
2002	0,01	4,67	0,49	13,7	4,82	< 0.2	1,1	< 0.05
2004	< 0.01	3,05	< 0.02	20	4,84	< 0.2	2,7	< 0.05
2006	< 0.01	2,75	0,17	13,4	4,74	< 0.2	1,3	< 0.05
2009	< 0.01	2,45	0,11	12,5	4,74	< 0.2	1	< 0.05
2011	< 0.01	1,83	0,49	17,7	4,7	< 0.2	2,4	< 0.05
2014	< 0.01	2,84	0,63	16,9	4,82	< 0.2	2	< 0.05
2017	< 0.01	6,16	0,94	14,6	4,76	< 0.2	1,2	< 0.05
2020	< 0.01	2,67	0,3	14,6	4,72	< 0.2	1,2	< 0.05
2023	< 0.01	1,13	0,41	15	4,89	< 0.2	1,6	< 0.05
2026	< 0.01	2,08	0,13	18,7	4,68	< 0.2	2	< 0.05
2029	< 0.01	2,27	0,12	22,9	4,6	< 0.2	1,2	< 0.05
2035	< 0.01	7,32	1,13	13,9	4,74	< 0.2	1,2	< 0.05

Appendix

for Rainwater

Water analysis from GTK. All values in ppb. Analysis below detection limit=det. limit/2

DD	MM	YY	Catch	*ID	ml	bags	*Med	Loc	Ag µg/l 140M	Al µg/l 140M	As µg/l 140M	B µg/l 140M	Ba µg/l 140M	Be µg/l 140M	Bi µg/l 140M	Br µg/l 143r	Ca µg/l 140P	Cd µg/l 140M	Cl µg/l 143r	Co µg/l 140M	Cr µg/l 140M	Cu µg/l 140M	F µg/l 143r	Fe µg/l 140M	K µg/l 140M
1	6	1994	5	2062	1660	5	RW	27	0,005	11,1	2,36	0,25	0,68	0,15	0,01	100	160	0,16	1800	0,19	0,1	9	25	5	260
1	6	1994	5	2060	1460	5	RW	28	0,005	10,5	2,54	0,25	0,65	0,15	0,01	100	130	0,15	1600	0,16	0,1	8,07	25	5	80
1	6	1994	5	2061	1620	5	RW	29	0,005	8,92	2,6	0,25	0,58	0,15	0,01	100	120	0,16	1600	0,13	0,1	6,52	25	5	50
22	6	1994	5	2065	3680	5	RW	27	0,005	8,6	0,25	0,25	0,39	0,15	0,01	100	25	0,015	400	0,04	0,1	0,96	25	5	60
22	6	1994	5	2063	3800	5	RW	28	0,005	5,44	0,26	0,25	0,59	0,15	0,01	100	25	0,015	300	0,015	0,1	0,91	25	5	30
22	6	1994	5	2064	3600	5	RW	29	0,005	6,08	0,25	0,25	0,37	0,15	0,01	100	25	0,015	300	0,04	0,1	1,01	25	5	100
28	7	1994	5	2136	3940	5	RW	27	0,005	3,15	0,25	0,25	0,53	0,15	0,01	100	110	0,015	300	0,04	0,1	0,9	25	5	110
28	7	1994	5	2137	4240	5	RW	28	0,005	4,04	0,28	0,25	0,55	0,15	0,01	100	100	0,03	300	0,04	0,1	1,8	25	5	150
28	7	1994	5	2138	3140	4	RW	29	0,005	3,21	0,23	0,25	0,52	0,15	0,01	100	100	0,04	500	0,04	0,1	5,43	25	5	330
31	8	1994	5	2075	2800	5	RW	27	0,005	5,18	0,19	0,53	0,43	0,15	0,01	100	100	0,015	500	0,04	0,1	0,97	25	5	150
31	8	1994	5	2074	2900	5	RW	28	0,005	5,96	0,22	0,25	0,61	0,15	0,01	100	25	0,015	400	0,015	0,1	0,88	25	5	50
31	8	1994	5	2073	2750	5	RW	29	0,005	2,79	0,15	0,75	0,29	0,15	0,01	100	25	0,015	500	0,015	0,1	0,76	25	5	70
21	9	1994	5	2225	600	5	RW	27	0,005	4,21	0,43	0,25	0,71	0,15	0,01	100	100	0,015	300	0,05	0,1	3,61	25	5	80
21	9	1994	5	2218	610	5	RW	28	0,005	4,51	0,65	0,51	0,6	0,15	0,01	100	25	0,04	300	0,08	0,1	5,13	25	5	40
21	9	1994	5	2217	640	5	RW	29	0,005	4,1	0,51	0,25	0,71	0,15	0,01	100	100	0,03	300	0,06	0,1	3,77	25	5	30

*ID	Li µg/l 140M	Mg µg/l 140P	Mn µg/l 140M	Mo µg/l 140M	Na µg/l 140P	Ni µg/l 140M	NO3 µg/l 143r	P µg/l 140P	Pb µg/l 140M	PO4 µg/l 143C	Rb µg/l 140M	S µg/l 140P	Sb µg/l 140M	Se µg/l 140M	Si µg/l 140P	SO4 µg/l 143r	Sr µg/l 140M	Th µg/l 140M	Tl µg/l 140M	U µg/l 140M	V µg/l 140M	Zn µg/l 140M	pH 143I	EC mS/m 143I
2062	0,05	200	3,49	0,05	1100	4,58	800	210	5	630	0,45	1110	0,05	0,025	50	3200	1,33	0,005	0,01	0,005	1,12	7,41		2,2
2060	0,05	100	1,7	0,025	900	4,12	800	50	4,86	10	0,09	940	0,05	0,025	50	2800	1,18	0,005	0,01	0,005	1,03	5,67		2,3
2061	0,05	100	1,43	0,025	1000	3,33	800	50	6,78	10	0,06	890	0,05	0,025	50	2700	1,03	0,005	0,02	0,005	1,09	5,5		2,8
2065	0,05	25	0,69	0,025	200	0,8	200	50	1,68	10	0,08	310	0,015	0,025	50	900	0,43	0,005	0,005	0,005	0,21	1,82		1,1
2063	0,05	25	0,71	0,025	200	0,85	200	50	2,42	10	0,025	270	0,015	0,025	50	800	0,4	0,005	0,005	0,005	0,2	3,03		1,1
2064	0,05	25	1,29	0,025	200	0,83	200	50	1,24	10	0,09	310	0,015	0,025	50	1000	0,45	0,005	0,005	0,005	0,19	3,36		0,9
2136	0,05	25	4,5	0,025	100	1,1	800	50	0,53	10	0,39	550	0,015	0,025	50	1700	0,3	0,005	0,005	0,005	0,26	4,13		1,6
2137	0,05	25	2,92	0,025	200	1,31	600	50	1,12	10	0,25	530	0,04	0,025	50	1700	0,31	0,005	0,005	0,005	0,21	7,7		1,6
2138	0,05	25	3,25	0,025	300	1,4	700	50	2,31	10	0,47	540	0,03	0,025	50	1500	0,55	0,005	0,005	0,005	0,21	9,48		1,3
2075	0,05	40	2,43	0,025	200	1,12	400		3,4	140	0,31	350	0,015	0,025	50	1000	0,33	0,005	0,005	0,005	0,14	3,54	5,2	0,8
2074	0,05	40	1,38	0,025	200	1,07	300		0,57	10	0,09	310	0,015	0,025	50	800	0,25	0,005	0,005	0,005	0,14	2,6	4,6	0,8
2073	0,05	25	1,14	0,025	200	0,89	400		1,23	10	0,17	330	0,015	0,025	50	900	0,21	0,005	0,005	0,005	0,14	3,28	4,6	0,8
2225	0,05	40	2,9	0,025	200	2,51	500		3,22	10	0,24	360	0,015	0,025	50	1000	0,21	0,005	0,005	0,005	0,16	3,33	4,4	1,1
2218	0,05	25	1,24	0,025	200	3,2	500		4,67	10	0,07	350	0,015	0,025	50	1000	0,35	0,005	0,005	0,005	0,19	3,52	4,5	0,9
2217	0,05	25	1,43	0,025	200	2,4	500		2,75	10	0,07	350	0,015	0,025	50	1000	0,33	0,005	0,005	0,005	0,19	3,16	4,5	0,8

Appendix

for Stream water

Water analysis from GTK. All values in ppb. Analysis below detection limit=det. limit/2

DD	MM	YY	Catch	*ID	*Med	Loc	Ag	Al	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu	Fe	K	Li	Mn	Mo	Ni	Pb	Rb
							µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
							140M	140M	140M	140M	140M	140M	140M	140M	140M	140M	140M	140M	140M	140M	140M	140M	140M	140M	140M
18	3	1994	5	2001	WA	1	0,005	3,16	0,53	1,35	15,2	0,15	0,01	0,015	0,015	0,1	0,42	70	1080	0,51	1,87	0,2	0,62	0,015	0,61
22	3	1994	5	2039	WA	1	0,005	1,9	0,35	0,25	9,86	0,15	0,01	0,015	0,015	0,1	0,25	40	760	0,33	1,05	0,14	0,41	0,015	0,45
30	3	1994	5	2040	WA	1	0,005	4,24	0,57	1,31	14,4	0,15	0,01	0,015	0,015	0,1	1,08	70	1170	0,37	1,94	0,21	0,72	0,08	0,79
6	4	1994	5	2041	WA	1	0,005	3,7	0,52	0,25	13,8	0,15	0,01	0,015	0,015	0,1	0,55	60	1050	0,36	2,36	0,18	0,6	0,015	0,62
15	4	1994	5	2042	WA	1	0,005	7,97	0,58	0,25	13,8	0,15	0,01	0,015	0,015	0,1	2,24	100	1130	0,27	5,66	0,16	1,45	0,19	0,82
20	4	1994	5	2043	WA	1	0,005	6,26	0,67	1,22	15	0,15	0,01	0,015	0,015	0,1	0,91	130	1180	0,45	5,95	0,16	1,24	0,06	0,85
27	4	1994	5	2044	WA	1	0,005	8,38	0,57	0,25	12,6	0,15	0,01	0,015	0,015	0,1	1,03	100	1040	0,28	4,92	0,16	1,2	0,08	0,84
4	5	1994	5	2045	WA	1	0,005	13,5	0,53	0,25	9,76	0,15	0,01	0,015	0,015	0,1	1,14	90	830	0,05	4,94	0,025	1,59	0,07	0,8
11	5	1994	5	2046	WA	1	0,005	24,5	0,43	0,81	7,41	0,15	0,01	0,015	0,015	0,1	1,12	60	560	0,23	3,61	0,11	1,47	0,07	0,7
18	5	1994	5	2047	WA	1	0,005	21,3	0,42	0,54	7,6	0,15	0,01	0,015	0,015	0,1	1,18	50	530	0,28	1,79	0,1	1,31	0,05	0,65
26	5	1994	5	2048	WA	1	0,005	15,6	0,5	0,57	8,19	0,15	0,01	0,015	0,015	0,1	0,98	40	540	0,19	1,52	0,12	1,17	0,03	0,56
1	6	1994	5	2049	WA	1	0,005	13,1	0,51	0,52	8,57	0,15	0,01	0,015	0,015	0,1	1,75	40	570	0,22	1,59	0,14	1,28	0,09	0,56
8	6	1994	5	2050	WA	1	0,005	11,9	0,56	0,63	9,62	0,15	0,01	0,015	0,015	0,1	0,93	40	640	0,32	1,85	0,15	1,12	0,04	0,61
16	6	1994	5	2051	WA	1	0,005	11,6	0,6	0,76	10,4	0,15	0,01	0,015	0,015	0,21	1,22	50	670	0,31	2,6	0,16	1,07	0,07	0,61
22	6	1994	5	2052	WA	1	0,005	13,9	0,55	0,78	9,72	0,15	0,01	0,015	0,015	0,1	1	50	620	0,23	2,75	0,15	1,09	0,07	0,61
29	6	1994	5	2053	WA	1	0,005	12,1	0,64	0,9	10,5	0,15	0,01	0,015	0,015	0,1	1,08	50	660	0,26	2,98	0,15	1,04	0,05	0,6
6	7	1994	5	2054	WA	1	0,005	10,6	0,66	0,75	10,4	0,15	0,01	0,015	0,015	0,1	0,86	40	800	0,16	3,32	0,16	0,92	0,04	0,63
13	7	1994	5	2055	WA	1	0,01	9,85	0,66	0,76	10,5	0,15	0,01	0,015	0,015	0,1	1,09	40	860	0,14	3,34	0,15	0,92	0,04	0,66
19	7	1994	5	2056	WA	1	0,005	14	0,61	0,62	9,51	0,15	0,01	0,015	0,015	0,1	1,08	40	760	0,11	2,54	0,15	1,02	0,04	0,65
27	7	1994	5	2057	WA	1	0,005	10,8	0,66	0,71	10,4	0,15	0,01	0,015	0,03	0,1	1,27	40	770	0,11	2,61	0,13	1,12	0,08	0,6
3	8	1994	5	2058	WA	1	0,02	12,4	0,83	2,24	11,8	0,15	0,01	0,015	0,015	0,1	0,96	30	900	0,42	4,27	0,21	0,91	0,015	0,76
9	8	1994	5	2059	WA	1	0,005	10,3	0,8	2,22	11,4	0,15	0,01	0,015	0,015	0,1	1,23	40	880	0,45	2,84	0,19	1,11	0,13	0,74
17	8	1994	5	2066	WA	1	0,005	8,06	0,72	1,86	11	0,15	0,01	0,015	0,015	0,1	0,86	30	900	0,41	2,88	0,18	0,95	0,015	0,64
24	8	1994	5	2067	WA	1	0,005	7,23	0,68	1,88	11,8	0,15	0,01	0,015	0,015	0,1	0,81	30	930	0,28	2,79	0,18	0,86	0,015	0,63
31	8	1994	5	2068	WA	1	0,005	5,96	0,71	1,69	11,4	0,15	0,01	0,015	0,015	0,1	0,74	20	920	0,38	2,34	0,18	0,81	0,015	0,66
7	9	1994	5	2069	WA	1	0,005	6,22	0,62	1,58	11,7	0,15	0,01	0,015	0,015	0,1	0,77	20	920	0,3	2,4	0,16	0,76	0,015	0,66
14	9	1994	5	2070	WA	1	0,005	5,41	0,6	1,48	11,8	0,15	0,01	0,015	0,015	0,1	0,78	20	970	0,31	2,64	0,17	0,79	0,015	0,72
21	9	1994	5	2071	WA	1	0,01	4,39	0,58	1,43	11,2	0,15	0,01	0,015	0,015	0,1	0,66	20	900	0,37	3,99	0,18	0,82	0,015	0,66
28	9	1994	5	2072	WA	1	0,005	4,88	0,58	1,36	11,4	0,15	0,01	0,015	0,015	0,1	0,85	20	950	0,34	3,25	0,18	0,85	0,06	0,7
5	10	1994	5	2076	WA	1	0,005	4,48	0,59	1,04	11,1	0,15	0,01	0,015	0,015	0,1	0,75	20	950	0,23	2,59	0,18	0,79	0,015	0,68
12	10	1994	5	2077	WA	1	0,03	5,5	0,57	1,21	11,2	0,15	0,01	0,015	0,015	0,1	0,7	20	930	0,25	2,26	0,19	0,88	0,06	0,7
20	10	1994	5	2078	WA	1	0,005	3,8	0,62	1,56	12,2	0,15	0,01	0,015	0,015	0,1	0,63	10	1030	0,21	2	0,18	0,77	0,015	0,7
26	10	1994	5	2079	WA	1	0,005	3,21	0,61	1,42	11,5	0,15	0,01	0,015	0,015	0,1	0,68	10	970	0,37	1,65	0,17	0,77	0,015	0,72
2	11	1994	5	2230	WA	1	0,01	3,19	0,57	1,45	12,6	0,15	0,01	0,015	0,015	0,1	0,77	10	1000	0,3	1,73	0,17	0,91	0,015	0,75

*ID	Sb	Se	Sr	Th	Tl	U	V	Zn	Ca	Mg	Na	P	S	Si	PO4	Br	Cl	F	NO3	SO4	pH	EC
	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l		mS/m
	140M	140M	140M	140M	140M	140M	140M	140M	140P	140P	140P	140P	140P	140P	143C	143r	143r	143r	143r	143r	143I	143I
2001	0,015	0,025	35,8	0,005	0,005	0,06	0,18	2,06	17400	1300	2400	50	2510	3100	10	100	2700	25	200	7900	6,65	11,5
2039	0,015	0,025	23,4	0,005	0,005	0,04	0,11	5,37	17400	1300	2400	50	2610	3100	10	100	2800	25	200	7800	6,73	11,6
2040	0,015	0,025	37,4	0,005	0,005	0,07	0,22	2,28	19400	1500	2900	50	2980	3400	10	100	3300	25	700	9100	6,75	13,3
2041	0,015	0,025	33,4	0,005	0,005	0,06	0,18	6,03	17300	1300	2400	50	2460	3000	10	100	2900	25	400	7600	6,89	11,4
2042	0,015	0,025	32,1	0,005	0,005	0,06	0,2	15,9	18000	1300	2400	50	2480	2700	10	100	3100	25	400	7600	6,85	11,8
2043	0,015	0,025	35,1	0,005	0,005	0,07	0,22	0,88	18300	1300	2400	50	2550	2700	10	100	3100	25	400	7700	6,84	12,1
2044	0,015	0,025	29,1	0,005	0,005	0,05	0,18	0,9	16000	1200	2200	50	2170	2400	10	100	2700	25	300	6600	6,89	10,6
2045	0,015	0,025	19,7	0,005	0,005	0,03	0,19	1,94	11800	900	1700	50	1850	1800	10	100	2300	25	200	5600	6,98	8
2046	0,015	0,025	14,1	0,005	0,005	0,02	0,19	1,13	8250	600	1300	50	1450	1480	10	100	1700	25	100	4900	7	5,5
2047	0,015	0,025	15,9	0,005	0,005	0,03	0,18	1,1	8950	700	1400	50	1630	1550	10	100	1800	25	100	4900	7,6	6
2048	0,015	0,025	17,5	0,005	0,005	0,04	0,2	1,17	10100	800	1500	50	1800	1510	10	100	1900	25	100	5200	7,1	6,7
2049	0,015	0,025	18,7	0,005	0,005	0,04	0,2	2,01	10400	800	1500	50	1850	1430	10	100	1900	25	100	5600	7,2	6,9
2050	0,015	0,025	21,5	0,005	0,005	0,04	0,23	2	11200	800	1600	50	1960	1280	10	100	2200	25	100	5700	7,2	7,4
2051	0,015	0,025	22,5	0,005	0,005	0,04	0,25	1,54	12100	900	1700	50	2040	1210	10	100	2100	25	100	6000	7	8,2
2052	0,015	0,025	21,6	0,005	0,005	0,05	0,25	0,84	12100	900	1700	50	2000	1170	10	100	2100	25	100	6100	7,3	8,1
2053	0,015	0,025	23,9	0,005	0,005	0,04	0,26	1,48	12900	900	1800	50	2050	1240	10	100	2200	25	100	6100	7,4	8,4
2054	0,015	0,025	25,9	0,005	0,005	0,04	0,27	5,26	13600	1000	1900	50	2120	1420	10	100	2300	25	100	6500	7,4	9
2055	0,015	0,025	28	0,005	0,005	0,05	0,23	1,86	14500	1000	2100	50	2110	1570	10	100	2300	25	100	6500	7,5	9,5
2056	0,015	0,025	25	0,005	0,005	0,05	0,23	0,88	14000	1000	1900	50	2050	1380	10	100	2200	25	100	6100	7,5	9
2057	0,015	0,025	27,3	0,005	0,005	0,05	0,25	2,63	14500	1000	1900	50	2020	1570	10	100	2300	25	100	6100	7,5	9,4
2058	0,015	0,025	31,5	0,005	0,005	0,05	0,32	1,37	15400	1090	2000		2120	1700	10	100	2600	25	100	6500	7,1	9,9
2059	0,015	0,025	31,6	0,005	0,005	0,07	0,29	2,35	15600	1130	2000		2040	1700	10	100	2400	25	100	6000	7,2	9,9
2066	0,015	0,025	32,4	0,005	0,005	0,06	0,26	1,24	15900	1140	2100		2140	1900	10	100	2500	25	100	6500	7,2	10,2
2067	0,015	0,025	33	0,005	0,005	0,07	0,24	1,16	16300	1170	2100		2240	2000	10	100	2600	25	100	6800	7,3	10,4
2068	0,015	0,025	32	0,005	0,005	0,07	0,21	0,42	16400	1170	2100		2130	1900	10	100	2700	25	100	6300	7,2	10,4
2069	0,015	0,025	33	0,005	0,005	0,07	0,22	0,96	16500	1200	2200		2180	2000	10	100	2500	25	100	6700	7,2	10,6
2070	0,015	0,025	31,9	0,005	0,005	0,06	0,21	0,82	16400	1210	2100		2180	1900	10	100	2600	25	100	6600	7,3	10,8
2071	0,015	0,025	31,8	0,005	0,005	0,07	0,21	1,01	16400	1200	2100		2260	2000	10	100	2700	25	100	6800	7,3	10,7
2072	0,015	0,025	30,9	0,005	0,005	0,06	0,2	1,94	16600	1180	2100		2230	1900	10	100	2700	25	100	6800	7,3	10,7
2076	0,015	0,025	31,2	0,005	0,005	0,07	0,17	1,9	17100	1250	2200		2410	2100	10	100	2800	25	100	7300	7,2	10,8
2077	0,015	0,025	31,9	0,005	0,005	0,06	0,19	1,56	16500	1210	2100		2320	2100	10	100	2600	25	100	6700	7,3	10,6
2078	0,015	0,025	35,3	0,005	0,005	0,07	0,19	0,99	18100	1310	2300		2550	2300	10	100	2900	25	100	7700	7,1	11,8
2079	0,015	0,025	32,4	0,005	0,005	0,07	0,17	1,07	17200	1240	2200		2420	2000	10	100	2700	25	100	7200	7,3	11,1
2230	0,015	0,025	33,1	0,005	0,005	0,06	0,18	1,09	18100	1320	2300		2630	2200	10	100	16500	25	100	7900	7,3	11,4

Appendix

for Groundwater

ID	Catch	Date	Medium	Loc.	Well nr	Screen m	GWT§ m	Ag µg/l	Al µg/l	As µg/l	B µg/l	Ba µg/l	Be µg/l	Bi µg/l	Cd µg/l	Co µg/l
2501	5	20.09.94	GW	42	1	6.3-7.3	2,94	0,005	37,7	0,81	1,11	6,1	0,15	0,01	0,015	0,15
2502	5	20.09.94	GW	42	2	4.6-5.6	2,92	0,030	134	0,11	0,99	2,33	0,15	0,01	0,015	0,62
2503	5	20.09.94	GW	42	3	2.3-3.3	3,01	0,030	281	0,37	6,7	7,04	0,15	0,01	0,05	2,31
2504	5	21.09.94	GW	43	1	10.9-11.9	3,46	0,005	12,7	0,64	3,89	16,1	0,15	0,01	0,015	1,22
2505	5	21.09.94	GW	43	2	6.7-7.7	3,45	0,005	14,1	0,2	2,17	6,86	0,15	0,01	0,015	0,08
2506	5	21.09.94	GW	43	3	2.6-3.6	3,45	0,005	10,2	0,27	2,65	5,99	0,15	0,01	0,015	0,05
2507	5	21.09.94	GW	44	1	11.9-12.9	3,7	0,005	1,15	3,06	3,48	20,1	0,15	0,01	0,015	0,22
2508	5	21.09.94	GW	44	2	8.2-9.2	3,45	0,005	3,18	2,67	3,16	15,2	0,15	0,01	0,015	0,22
2509	5	21.09.94	GW	44	3	2.8-3.8	1,75	0,020	24,5	0,05	2,19	7,84	0,15	0,01	0,015	0,1

ID	Cr µg/l	Cu µg/l	Fe µg/l	K µg/l	Li µg/l	Mn µg/l	Mo µg/l	Ni µg/l	Pb µg/l	Rb µg/l	Sb µg/l	Se µg/l	Sr µg/l	Th µg/l	Tl µg/l	U µg/l
2501	0,1	1,41	5	2450	0,28	21,1	4	0,78	0,15	0,35	0,23	0,025	29,2	0,005	0,005	0,71
2502	0,1	0,63	30	1080	0,24	11,1	0,79	1,66	0,14	1,27	0,05	0,025	16	0,05	0,005	0,05
2503	0,87	5,69	310	2050	0,36	48,6	1,66	4,3	0,35	1,83	0,14	0,025	28,9	0,19	0,005	0,07
2504	0,1	0,71	5	4280	1,39	53,6	10,4	2,25	0,13	1,41	0,16	0,025	36,8	0,005	0,01	0,18
2505	0,1	0,61	5	2600	0,67	14,1	4,02	0,5	0,015	1,61	0,015	0,025	15	0,005	0,005	0,07
2506	0,1	0,35	10	2000	0,05	30,8	1,59	0,68	0,21	2,66	0,06	0,025	10,5	0,005	0,01	0,04
2507	0,1	0,55	5	1790	0,54	11,9	0,7	0,59	0,015	0,48	0,015	0,025	39,2	0,005	0,01	0,29
2508	0,64	0,23	5	3680	0,51	26,1	0,91	0,37	0,015	0,84	0,015	0,025	42,1	0,005	0,005	0,22
2509	0,1	0,26	5	480	0,25	5,7	0,025	0,5	0,24	1,93	0,015	0,025	12,2	0,01	0,005	0,005

ID	V µg/l	Zn µg/l	Ca µg/l	Mg µg/l	Na µg/l	P µg/l	S µg/l	Si µg/l	PO4_C* µg/l	pH*	EC* mS/m	Br* µg/l	Cl* µg/l	F* µg/l	NO3* µg/l	SO4* µg/l
2501	0,61	2,04	12800	1730	3200		2060	3700	100	7,1	10,4	50	2760	80,9	25	6730
2502	0,52	2,02	2400	580	2800		650	4800	100	6,98	3,5	50	2450	62,3	25	19600
2503	0,87	7,85	6200	1800	4200		1940	5200	100	7,13	7	50	3070	83,1	474	14800
2504	0,31	3,34	16100	1800	3300		5850	3300	100	7,71	13	50	2300	25	25	2030
2505	0,33	1,19	5900	700	2300		1250	3200	100	7,38	5,8	50	2290	25	114	4060
2506	0,24	1,12	3400	460	2300		630	3300	100	7,1	4,1	50	3010	25	406	15800
2507	0,24	3,07	23700	1920	3000		4560	4300	100	7,53	15,7	50	2590	74,2	25	6190
2508	0,37	2,53	24000	2230	3200		4830	4500	100	7,69	15,8	50	2380	65,8	210	2100
2509	0,15	1,67	2100	870	2300		1150	2500	100	6,4	3,5	50	4010	25	179	3730

§ GWT: Groundwater table (m below ground surface), measured 8/19/94

* measured at NGU (other data from GTK)

Appendix

for Moss

Catch	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
Loc	2	2	5	5	12	17	17	22	22	25	25	30	30	31	31		
No	2116	2223	2099	2205	2098	2087	2204	2117	2201	2103	2219	2088	2203	2104	2213		
Spp	Pleu	Hylo	Hylo	Hylo	Hylo	Pleu	Hylo	Hylo	Hylo	Pleu	Hylo	Hylo	Hylo	Hylo	Hylo		
dd	31	21	27	20	27	26	20	31	21	30	21	26	20	30	21		
mm	5	9	5	9	5	5	9	5	9	5	9	5	9	5	9	*Method*	*Det_limit*
Ag	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*503M*	*0.2*
Al	140	140	250	180	110	170	190	120	120	190	100	100	100	110	90	*503P*	*all >*
As	0.45	0.46	0.47	0.34	0.43	0.48	0.36	0.46	0.37	0.61	0.37	0.43	0.36	0.41	0.44	*503M*	*0.3*
B	1.32	2.92	2.15	1.94	1.77	1.35	1.13	1.51	1.17	1.85	2.57	2.29	2.36	1.47	2.89	*503M*	*all >*
Ba	17.5	16.1	35.1	18	18.3	25.4	11.9	21.8	15.1	28.7	20.9	26.4	24.7	19.6	18.7	*503P*	*all >*
Be	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	*503M*	*0.6*
Bi	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*503M*	*0.2*
Ca	2320	2930	4150	3340	3250	2660	2080	2630	2210	3060	2670	3410	3170	3060	2790	*503P*	*all >*
Cd	0.1	0.12	0.15	0.05	0.05	0.15	0.05	0.05	0.1	0.13	0.05	0.05	0.05	0.13	0.1	*503M*	*0.1*
Co	0.87	1	0.98	0.83	0.95	1.22	0.88	0.86	0.91	1.48	0.86	0.79	0.78	0.97	0.94	*503M*	*all >*
Cr	1.22	0.8	1.04	0.55	1.02	1.29	0.51	0.71	0.67	1.44	0.81	0.94	0.44	1.11	0.62	*503M*	*0.4*
Cu	18.7	22.1	21.4	18.6	20	27	16	18.9	20.3	30	20.2	18	18.1	21.9	21.3	*503M*	*all >*
Fe	270	290	230	210	220	360	250	260	250	440	230	180	200	280	250	*503P*	*all >*
Hg	0.13	0.05	0.14	0.12	0.16	0.14	0.09	0.15	0.13	0.16	0.13	0.10	0.11	0.14	0.08	*503H*	*all >*
K	3980	4000	3370	4070	4100	3350	2770	4510	3540	4670	4200	4780	3990	4600	3940	*503P*	*all >*
La	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	*503P*	*0.7*
Li	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	*503P*	*0.7*
Mg	770	1240	870	940	800	640	690	850	950	900	1060	1100	1050	970	1040	*503P*	*all >*
Mn	580	861	480	453	662	419	342	643	495	1020	884	841	721	667	505	*503P*	*all >*
Mo	0.05	0.06	0.08	0.07	0.06	0.06	0.07	0.06	0.06	0.08	0.04	0.05	0.06	0.05	0.06	*503M*	*all >*
Na	20	20	5	5	50	20	5	30	50	70	20	30	5	30	30	*503P*	*10*
Ni	25.9	29.8	26.1	23.2	25.8	35.9	23.5	23.7	27	41.7	26.1	22.3	24.1	28.8	30.8	*503M*	*all >*
P	860	1240	924	1260	940	780	620	1190	1210	1280	1520	1210	1390	893	1450	*503P*	*all >*
Pb	3.05	2.43	3.43	2.29	2.88	4.09	2.07	2.69	2.75	3.69	2.22	2.45	2.15	2.98	2.23	*503M*	*all >*
Rb	15.7	13.2	7.6	9.64	11.7	5.81	7.35	17	12.8	12.4	10.8	11.4	9.24	9.23	8.27	*503M*	*all >*
S	825	977	858	884	859	850	647	884	863	1040	946	959	934	872	960	*503P*	*all >*
Sb	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*503M*	*0.2*
Sc	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.05	0.05	0.05	0.05	*503P*	*0.1*
Se	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	*503M*	*1*
Si	70	220	40	80	40	50	70	60	90	70	280	50	70	60	90	*503P*	*all >*
Sr	3.94	7.13	7.84	7.93	6.15	4.92	3.42	5.63	6.85	6.82	6.07	7.87	7.69	3.43	4.56	*503M*	*all >*
Th	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*503M*	*0.2*
Ti	8.7	6.3	4.3	3.4	4	7.3	5.1	5.5	5	10	4.4	3.1	3.7	4.8	3.6	*503P*	*all >*
Tl	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*503M*	*0.2*
U	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*503M*	*0.2*
V	1.38	1.31	1.36	1.12	1.23	1.53	1.11	1.3	1.33	1.65	1.07	1.15	1.06	1.17	1.19	*503M*	*all >*
Y	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	*503P*	*0.1*
Zn	22.1	90.7	36.4	56.8	32.8	25.4	33.7	32.8	71.9	50.2	70.7	38.3	59.9	25.4	72.7	*503P*	*all >*

Appendix

for Topsoil

*ID	Catch	*DRY	Loc	EASTING	NORTHING	ALTI	Day	Mon	Year	A0	Ag_ar	Al_aa	Al_ar
				m	m	m_asl				cm	mg/kg	mg/kg	mg/kg
											512P/U	201P	512P
2003	5	FD	2	596960	7696640	90	18	3	94	3	1,08	51,6	1120
2005	5	FD	3	592330	7700080	190	19	3	94	3	0,24	19,6	800
2007	5	FD	4	592400	7700100	188	19	3	94	3	0,17	56,6	1790
2008	5	FD	5	593200	7699770	186	19	3	94	<5	0,26	86,8	2780
2010	5	FD	6	592720	7699330	190	19	3	94	3	0,12	38,4	5010
2012	5	FD	7	595040	7699680	130	19	3	94	3	0,53	8,4	860
2013	5	FD	8	595760	7699700	130	19	3	94	3	0,3	38,7	1660
2015	5	FD	9	593840	7697670	177	20	3	94	0,5	0,16	124	3880
2016	5	FD	10	593100	7697200	176	20	3	94	1,5	0,22	46,8	1180
2018	5	FD	11	594500	7698670	150	20	3	94	3	0,17	14,8	720
2019	5	FD	12	595070	7699290	130	20	3	94	<5	0,14	30,9	1230
2021	5	FD	13	595510	7701780	153	20	3	94	3	0,24	65,3	1490
2022	5	FD	14	595229	7700680	140	20	3	94	3	0,32	8,8	460
2024	5	FD	15	595300	7700690	130	20	3	94	3	0,26	67	1620
2025	5	FD	16	594180	7699510	140	20	3	94	3	0,11	194	5660
2027	5	FD	17	596670	7701670	137	21	3	94	3	0,59	305	11300
2028	5	FD	18	596400	7701150	130	21	3	94	<5	0,5	63,5	2380
2030	5	FD	19	598320	7699700	115	21	3	94	3	0,37	278	2800
2031	5	FD	20	597460	7699500	105	21	3	94	3	1,93	344	3990
2032	5	FD	21	596900	7699200	95	21	3	94	0,3	0,03	416	3910
2033	5	FD	22	596630	7698770	100	21	3	94	0,2	0,19	285	3860
2034	5	FD	23	596500	7698180	90	21	3	94	0,2	0,08	152	2160
2036	5	FD	24	596960	7697700	90	21	3	94	0,8	0,03	293	2940
2037	5	FD	25	598400	7698750	120	21	3	94	1,5	0,25	104	5440
2038	5	FD	26	597720	7697920	110	21	3	94	2,3	0,17	257	3690
2080	5	AD	8	595760	7699700	130	26	5	94	2	0,28	35,2	1200
2081	5	AD	7	595040	7699680	130	26	5	94	2,8	0,5	19,5	1600
2082	5	AD	13	595510	7701780	153	26	5	94	2	0,31	50,1	1540
2083	5	AD	14	595229	7700680	140	26	5	94	2,3	0,35	99,1	1760
2084	5	AD	21	596900	7699200	95	26	5	94	1,5	0,12	56	1260
2085	5	AD	17	596670	7701670	137	26	5	94	2,8	0,85	39,5	1540
2086	5	AD	15	595300	7700690	130	26	5	94	2,8	0,82	330	5260
2089	5	AD	12	595070	7699290	130	27	5	94	2	0,38	33,1	1380
2090	5	AD	11	594500	7698670	150	27	5	94	2	0,27	25,9	1400
2091	5	AD	5	593200	7699770	186	27	5	94	<5	0,56	14,4	730
2092	5	AD	9	593840	7697670	177	27	5	94	3	0,29	18,7	1010
2093	5	AD	4	592400	7700100	188	27	5	94	3	0,25	14,1	380
2094	5	AD	3	592330	7700080	190	27	5	94	2,3	0,2	36,1	1270
2095	5	AD	10	593100	7697200	176	27	5	94	2,2	0,24	39,7	1250
2096	5	AD	6	592720	7699330	190	27	5	94	3	0,13	7,3	1070
2097	5	AD	16	594180	7699510	140	27	5	94	2	0,17	78,5	3870
2100	5	AD	25	598400	7698750	120	30	5	94	1,5	0,66	25,8	1080
2101	5	AD	20	597460	7699500	105	30	5	94	2	0,76	140	2620
2102	5	AD	19	598320	7699700	115	30	5	94	<5	0,33	124	2550
2108	5	AD	18	596400	7701150	130	30	5	94	3	0,42	25,3	1810
2109	5	AD	26	597720	7697920	110	31	5	94	2,2	0,16	143	2650
2110	5	AD	23	596500	7698180	90	31	5	94	1,5	0,06	34,5	1060
2111	5	AD	22	596630	7698770	100	31	5	94	1	0,23	55,6	1640
2112	5	AD	24	596960	7697700	90	31	5	94	1	0,05	192	2620
2113	5	AD	2	596960	7696640	90	31	5	94	2,6	0,3	45,5	1020
2119	5	AD	25	598400	7698750	120	27	7	94	2	<1	49,5	1500
2120	5	AD	22	596630	7698770	100	27	7	94	2	<1	215	2820
2121	5	AD	2	596960	7696640	90	27	7	94	2,8	<1	65,9	1080
2122	5	AD	12	595070	7699290	130	28	7	94	2,2	<1	43,5	5920

2123	5	AD	16	594180	7699510	140	28	7	94	2,2	<1	79,8	2560
2124	5	AD	5	593200	7699770	186	28	7	94	2,2	<1	29	960
2125	5	AD	13	595510	7701780	153	28	7	94	3	<1	216	2410
2126	5	AD	14	595229	7700680	140	28	7	94	2	<1	96	1680
2127	5	AD	18	596400	7701150	130	28	7	94	3	<1	23,7	810
2128	5	AD	8	595760	7699700	130	29	7	94	2,2	<1	68,8	1880
2129	5	AD	9	593840	7697670	177	29	7	94	2,8	<1	103	4700
2140	5	AD	11	594500	7698670	150	29	7	94	2,2	<1	29,2	730
2202	5	AD	22	596630	7698770	100	20	9	94	2,3	<1	104	1890
2206	5	AD	9	593840	7697670	177	20	9	94	1,5	<1	211	3770
2207	5	AD	18	596400	7701150	130	20	9	94	2,3	<1	88,1	3800
2208	5	AD	5	593200	7699770	186	20	9	94	2	<1	44,4	3250
2209	5	AD	11	594500	7698670	150	20	9	94	3	<1	83,3	5460
2210	5	AD	13	595510	7701780	153	20	9	94	2,1	<1	226	2810
2211	5	AD	16	594180	7699510	140	20	9	94	1,3	<1	344	7600
2212	5	AD	14	595229	7700680	140	20	9	94	2	<1	81,4	1990
2216	5	AD	20	597460	7699500	105	21	9	94	1,8	<1	337	3360
2220	5	AD	25	598400	7698750	120	21	9	94	1,5	<1	49,2	2010
2221	5	AD	26	597720	7697920	110	21	9	94	1,4	<1	191	2250
2224	5	AD	2	596960	7696640	90	21	9	94	2,3	<1	43,4	830
2227	5	AD	24	596960	7697700	90	22	9	94	<5	<1	445	5790

*ID	As_aa	As_ar	B_aa	B_ar	Ba_aa	Ba_ar	Bi_ar	C	Ca_aa	Ca_ar	Cd_aa	Cd_ar	Co_aa
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	201P/U	512P/U	201P	512P	201P	512P	512U	820L	201P	512P	201P	512P/U	201P
2003	<0.1	0,5	<0.1	4	21,6	51,3	0,12	45,1	1610	2350	0,34	0,34	0,48
2005	<0.1	0,7	<0.1	5	21	49,8	0,13	34,3	1860	2650	0,24	0,24	0,34
2007	<0.1	0,5	<0.1	4	13,5	35,5	0,08	17,8	1020	1530	0,22	0,22	0,38
2008	<0.1	2,5	<0.1	<3	8,71	18,8	0,13	17,5	747	990	0,17	0,17	0,29
2010	<0.1	0,8	0,3	6	21,8	57,4	0,15	28	8940	11300	0,42	0,42	0,6
2012	<0.1	0,8	<0.1	3	14,2	42,6	0,07	42,5	2290	3560	0,46	0,46	0,33
2013	<0.1	1,5	0,1	7	45,4	167	0,11	46,2	11800	17000	1,16	1,16	0,79
2015	<0.1	0,4	<0.1	<3	6,73	21,1	0,08	6,9	323	510	0,06	0,06	0,2
2016	<0.1	0,6	<0.1	6	15,5	39	0,08	27,5	1100	1740	0,16	0,16	0,25
2018	<0.1	0,6	<0.1	6	17,3	46,6	0,1	44,9	5460	7180	0,4	0,4	0,59
2019	<0.1	13,7	<0.1	7	24,2	78	0,16	50,5	3990	6710	0,48	0,48	0,49
2021	<0.1	0,8	<0.1	5	15,2	45,9	0,12	47,4	1820	3120	0,46	0,46	0,63
2022	<0.1	1,2	<0.1	6	15,8	44,6	0,11	52,8	2450	3960	0,5	0,5	0,45
2024	<0.1	1	<0.1	6	18	50,5	0,1	41,4	1770	2820	0,25	0,25	0,79
2025	<0.1	1,8	<0.1	3	17,3	35,7	0,09	15,7	571	1340	0,14	0,14	0,74
2027	<0.1	1,8	<0.1	5	15	51,1	0,09	23,8	966	1950	0,35	0,35	1,22
2028	<0.1	0,7	<0.1	5	14	33,3	0,11	38,9	2030	3180	0,31	0,31	0,79
2030	<0.1	0,8	<0.1	4	18,3	37	0,08	28,1	936	1500	0,26	0,26	0,73
2031	<0.1	0,5	<0.1	5	12,8	41	0,08	23,9	1100	1980	0,24	0,24	0,55
2032	<0.1	0,7	<0.1	5	8,01	20	0,12	6,8	317	1140	0,05	0,05	0,2
2033	<0.1	0,8	<0.1	4	11,2	28	0,09	13,3	357	1310	0,08	0,08	0,2
2034	<0.1	0,8	<0.1	3	11,4	24,6	0,06	22,4	516	1120	0,13	0,13	0,34
2036	<0.1	0,7	<0.1	4	6,07	16,7	0,04	9,8	223	910	0,07	0,07	0,21
2037	<0.1	1,2	<0.1	3	16,7	29,9	0,06	10,3	543	1180	0,05	0,05	0,26
2038	<0.1	0,8	<0.1	4	11,7	29,4	0,04	17,1	679	1580	0,11	0,11	0,36
2080	<0.1	0,7	<0.1	5	22	65,8	0,13	43,2	2030	3460	0,4	0,38	1,03
2081	<0.1	0,5	<0.1	6	27,3	69,1	0,09	40,5	1930	3100	0,18	0,21	0,41
2082	<0.1	0,8	<0.1	5	18,3	57	0,09	43,5	3390	5490	0,4	0,48	1,19
2083	<0.1	0,5	<0.1	3	15,2	39,7	0,1	31,6	1140	1990	0,2	0,23	0,92
2084	<0.1	0,4	<0.1	<3	24,5	63,9	0,08	25,4	1030	1910	0,09	0,14	0,24
2085	<0.1	0,8	<0.1	4	36,4	89,4	0,14	39,2	1580	2410	0,42	0,51	0,69
2086	<0.1	0,5	<0.1	<3	7,6	26,7	0,1	16,8	363	920	0,16	0,19	0,62
2089	<0.1	0,9	<0.1	4	18,7	47,8	0,12	29,4	1380	2250	0,17	0,23	0,65
2090	<0.1	0,7	<0.1	7	20,4	58,5	0,11	37,2	3740	6040	<0.7	0,42	1,17
2091	<0.1	0,6	<0.1	6	22,9	59,7	0,09	33,9	1730	2810	0,15	0,2	0,27
2092	<0.1	0,4	<0.1	6	12,8	28,5	0,11	14,9	808	1280	0,05	0,09	0,26
2093	<0.1	0,5	<0.1	7	23,1	68,1	0,09	47,1	2500	4030	0,34	0,38	0,26
2094	<0.1	0,4	<0.1	5	15,5	38,6	0,09	19,8	990	1820	0,09	0,12	0,27
2095	<0.1	0,6	<0.1	5	15	37,7	0,09	28,1	1260	2060	0,15	0,17	0,44
2096	<0.1	0,7	0,1	9	24,5	81,9	0,04	42,4	10400	15400	0,83	1,42	0,27
2097	<0.1	0,6	<0.1	3	12,1	30,1	0,07	12,1	682	1330	0,14	0,15	0,47
2100	<0.1	0,6	<0.1	6	22,8	54,1	0,08	29,5	1160	2100	0,11	0,16	0,43
2101	<0.1	0,6	<0.1	7	18,8	52	0,09	25,8	1140	2170	0,21	0,26	0,75
2102	<0.1	1	<0.1	6	16,4	44,8	0,1	28,3	1030	1990	0,22	0,27	0,61
2108	<0.1	0,9	<0.1	6	17,1	49,3	0,08	46,9	2030	3810	0,28	0,32	0,53
2109	<0.1	0,5	<0.1	6	8,48	25,3	0,1	14,7	635	1610	0,06	0,09	0,27
2110	<0.1	0,4	<0.1	5	15,3	33,3	0,08	20	713	1270	0,06	0,09	0,2
2111	<0.1	0,5	<0.1	7	20,5	51	0,09	20,5	648	1470	0,05	0,08	0,28
2112	<0.1	0,5	<0.1	5	9,55	25,5	0,06	15,4	454	1170	0,05	0,07	0,23
2113	<0.1	0,5	<0.1	6	19,1	47,4	0,06	24,4	1100	1770	0,13	0,16	0,35
2119	<0.5	<3	<0.1	8	21,6	43,7		23,7	803	1460	0,1	<0.5	0,38
2120	<0.5	<3	<0.1	7	9,62	26,6		11,3	435	1220	0,06	<0.5	0,16
2121	<0.5	<3	<0.1	9	23,5	61,1		29,6	947	1830	0,14	<0.5	0,46
2122	<0.5	<3	0,4	7	50,7	173		22,8	10900	15700	0,19	0,6	0,06

2123	<0.5	<3	<0.1	4	19	47,6		23,6	1870	2840	<0.7	0,6	0,65
2124	<0.5	<3	<0.1	6	13,1	27,7		17,6	1060	1620	0,13	<0.5	0,25
2125	<0.5	<3	<0.1	4	15,9	39,7		35,2	1280	1940	0,21	0,5	1,05
2126	<0.5	<3	<0.1	7	13,3	32,2		33,6	1350	2160	0,21	<0.5	0,56
2127	<0.5	<3	<0.1	5	19,4	43,3		29,3	1460	2360	0,14	<0.5	0,49
2128	<0.5	<3	<0.1	4	22,7	57,4		39,3	2530	3390	0,44	0,6	1,01
2129	<0.5	4	<0.1	5	12,3	30,4		31,6	1590	2060	0,4	0,7	1,1
2140	<0.5	<3	<0.1	4	17,3	39,7		35,3	1190	1820	0,14	<0.5	0,4
2202	<0.5	3	<0.1	<3	14	32,6		22,7	404	1150	0,06	<0.5	0,26
2206	<0.5	<3	<0.1	3	6,59	23,8		7	361	860	0,09	<0.5	0,27
2207	<0.5	<3	<0.1	<3	16,2	34,6		23,2	1070	2420	0,16	<0.5	0,77
2208	<0.5	<3	<0.1	3	13	30,2		19,7	862	1350	0,08	<0.5	0,3
2209	<0.5	5	0,2	6	28,5	98,6		42,1	10500	15300	0,43	0,9	0,44
2210	<0.5	<3	<0.1	4	9,37	23,5		17,4	700	1320	<0.5	<0.5	0,73
2211	<0.5	<3	<0.1	<3	11,9	25,9		8,2	439	1260	0,14	<0.5	0,52
2212	<0.5	<3	<0.1	<3	17,3	40,6		26,6	1160	2120	0,14	<0.5	0,43
2216	<0.5	<3	<0.1	<3	10,2	25,1		13,9	451	1090	0,12	<0.5	0,46
2220	<0.5	<3	<0.1	<3	13,5	24,9		13,4	546	990	0,1	<0.5	0,32
2221	<0.5	<3	<0.1	<3	5,73	12,7		6,5	262	690	0,04	<0.5	0,17
2224	<0.5	<3	<0.1	<3	11,7	23,9		15,9	592	1010	0,09	<0.5	0,26
2227	<0.5	3	<0.1	<3	1,98	13,7		4,3	54,2	900	<0.02	<0.5	0,06

*ID	Co_ar	Cr_aa	Cr_ar	Cu_aa	Cu_ar	Fe_aa	Fe_ar	H	Hg_ar	K_aa	K_ar	La_ar	Li_aa
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	512P	201P	512P	201P	512P	201P	512P	820L	512H	201P	512P	512P	201P
2003	1,7	0,08	2,4	0,6	21	9	1750	6,6	0,19	734	700	0,9	<0.05
2005	1,5	0,09	1,9	0,49	22	3	1300	5,2	0,29	750	800	1,4	<0.05
2007	1,9	0,06	2,9	0,35	11	4	3880	2,8	0,11	438	700	2,2	<0.05
2008	4	0,12	7,1	0,56	39	26	43100	2,9	0,12	445	500	6,1	<0.05
2010	6,2	0,16	12,2	0,46	24	8	8650	4,4	0,13	863	1100	9,6	<0.05
2012	1,8	0,08	2,1	0,37	19	2	2200	6	0,19	511	600	0,8	<0.05
2013	9,1	0,3	3	0,8	35	9	2760	6,7	0,26	903	1100	3,5	<0.05
2015	3	0,17	20,3	0,48	7	16	6510	1,4	0,07	180	800	3,9	<0.05
2016	1,1	0,08	1,9	0,25	11	5	1610	4,1	0,18	549	800	1,8	<0.05
2018	2,4	0,1	2	0,66	32	5	1370	6,7	0,22	963	1000	1,5	<0.05
2019	2,5	0,08	1,6	0,36	24	5	2510	7	0,27	908	1100	1,1	<0.05
2021	2,6	0,24	3,8	0,42	20	24	3000	6,4	0,25	819	1000	0,9	<0.05
2022	2	0,07	1,2	0,38	22	2	760	7,2	0,29	736	900	<0.7	<0.05
2024	2,8	0,1	2,7	0,74	30	7	2460	5,9	0,23	823	900	1,1	<0.05
2025	6,3	0,32	18,5	0,6	13	190	12100	2,7	0,11	328	500	1,9	<0.05
2027	9	0,43	15	2,97	90	2150	75100	4	0,13	403	1000	3,6	<0.05
2028	3,8	0,14	5,2	0,8	27	14	5400	5,5	0,21	659	800	1,2	<0.05
2030	2,5	0,31	4,1	0,95	19	73	4030	4,3	0,21	521	600	2,1	<0.05
2031	2,5	0,32	7,3	1,13	22	77	7250	3,7	0,15	668	900	3,5	<0.05
2032	2,1	0,27	8,7	0,47	8	178	9370	1,2	0,07	118	400	4,2	<0.05
2033	2,1	0,36	10,6	0,48	10	156	10200	2,3	0,11	248	500	5,1	<0.05
2034	1,6	0,13	5,1	0,55	15	19	4150	3,1	0,14	266	400	2,1	<0.05
2036	1,5	0,15	7,5	0,46	10	108	5980	1,6	0,09	114	300	3,5	<0.05
2037	6,8	0,19	8	0,56	8	186	26600	1,8	0,09	260	500	5,1	<0.05
2038	2,4	0,22	8,6	0,67	15	58	7450	2,7	0,1	371	700	3,3	<0.05
2080	4,1	0,09	2,9	0,85	39,3	22,9	3260	6,1		899	1000	0,9	<0.05
2081	2,6	0,04	2,4	0,2	19,1	4,9	5050	5,7		539	600	0,9	<0.05
2082	4,6	0,03	2,2	0,21	21,4	6,7	2010	5,9		514	600	1,7	<0.05
2083	2,8	0,09	2,9	0,41	15,4	55,5	4460	4,7		469	600	3	<0.05
2084	1	0,06	2,7	0,21	12,7	8,8	2060	3,7		258	300	1,9	<0.05
2085	3,6	0,05	4,7	0,38	26,8	8,9	18200	5,4		760	900	1,4	<0.05
2086	3,9	0,14	10,5	0,52	12,3	130	9220	2,8		269	600	2,4	<0.05
2089	3	0,08	3,4	0,74	33,4	6,2	2930	4,4		575	700	1,3	<0.05
2090	4,9	0,08	2,9	0,66	35,1	6,1	2570	5,4		784	1000	2	<0.05
2091	1,5	0,06	2	0,24	17	3,6	2400	4,9		842	1100	1,5	<0.05
2092	1,3	0,08	2,8	0,53	15,8	3,9	2030	2,6		475	700	2,9	<0.05
2093	1,3	0,06	1	0,19	17,4	2,7	590	6,7		909	1100	<0.7	<0.05
2094	1,4	0,05	3	0,18	8,5	5,7	2010	3,2		349	500	2,3	<0.05
2095	1,9	0,05	2,7	0,42	21,1	4,3	2350	4,3		688	800	1,7	<0.05
2096	2,7	0,05	2,4	0,19	32	2,4	1980	5,8		1200	1500	3,1	<0.05
2097	4	0,1	7,8	0,66	15,1	69,4	9400	2,2		345	500	2,1	<0.05
2100	1,8	0,09	3,2	0,45	19,9	4,4	2100	4,4		560	900	2,7	<0.05
2101	2,7	0,08	3,4	0,45	19,4	23,9	2460	4,1		534	900	3,8	<0.05
2102	2,5	0,09	4,3	0,62	25	21,4	3520	4,2		465	800	1,7	<0.05
2108	3,4	0,05	3,7	0,31	24,8	5,9	3590	6,2		772	1100	0,8	<0.05
2109	1,7	0,12	6,9	0,42	13,3	23,1	5740	2,3		253	600	4	<0.05
2110	0,9	0,07	4,4	0,23	10,1	4	2050	3		288	500	2	<0.05
2111	1,6	0,09	6,3	0,36	14	15,4	4040	3,3		300	600	4,8	<0.05
2112	1,5	0,12	6,9	0,2	9,8	43,5	4850	2,3		136	400	2,7	<0.05
2113	1,2	0,05	2,3	0,24	11,5	8,6	1550	3,7		391	700	1,4	<0.05
2119	2,2	0,12	6,8	0,62	19,6	13,6	4630	3,5		446	600	3,3	<0.05
2120	1,4	0,2	8,9	0,09	5,5	224	9210	1,8		152	300	4,1	<0.05
2121	1,8	0,12	2,9	0,54	22,9	28,2	2350	4,2		433	700	1,1	<0.05
2122	5,7	0,18	14,6	0,28	28,3	10,7	11200	3,4		381	600	6,4	<0.05

2123	3,7	0,11	6,8	0,55	22	10,7	6310	3,3		521	600	2,9	<0.05
2124	1,4	0,08	2,3	0,28	11,4	8,3	3640	2,6		393	500	2,3	<0.05
2125	3,2	0,09	2,9	0,85	24,8	51,9	3520	4,8		536	600	2,4	<0.05
2126	2,5	0,44	5,9	0,75	21,1	199	5750	4,5		535	700	1,7	<0.05
2127	2	0,14	3	0,67	26,4	9,8	2320	4,2		499	600	2,1	<0.05
2128	3,5	0,05	2,4	0,28	16,6	25,9	4450	5,4		557	600	2	<0.05
2129	6,5	0,43	62,4	0,91	30,2	44	10600	4,5		631	700	1,4	<0.05
2140	1,7	0,07	2,2	0,38	18,6	6,4	1490	4,8		559	700	2,2	<0.05
2202	1,5	0,16	6,7	0,43	12,3	33,7	5360	3,2		265	400	3,9	<0.05
2206	2	0,36	8,6	0,37	6,6	127	7210	1,3		168	1100	3,3	<0.05
2207	4,7	0,21	7	0,72	18,9	58	8540	3,3		453	600	1,8	<0.05
2208	3,5	0,08	4,2	0,64	18	7,6	7180	3,1		506	700	2,1	<0.05
2209	7,4	0,14	6,8	0,49	40,9	11	6700	5,7		608	800	22,5	<0.05
2210	2,5	0,5	10,1	0,83	12,2	1020	12300	2,7		309	400	3,7	<0.05
2211	6,1	0,49	22,4	0,58	15,2	328	21200	1,4		168	400	2,9	<0.05
2212	2,8	0,15	4,8	0,78	28,8	20	5280	3,9		578	700	2	<0.05
2216	1,8	0,45	6,6	0,72	13,3	193	5000	2,3		361	600	4,6	<0.05
2220	2,6	0,11	6,5	0,67	14,3	12	6810	2,2		272	400	5,2	<0.05
2221	1,2	0,19	6	0,38	5,9	57,1	5950	1,1		98	200	2,8	<0.05
2224	0,8	0,06	2,9	0,19	7,7	7,5	1470	2,4		198	200	<5	<0.05
2227	2,7	0,23	12	0,45	11,3	128	9870	0,8		44	400	3,2	<0.05

*ID	Li_ar	Mg_aa	Mg_ar	Mn_aa	Mn_ar	Mo_aa	Mo_ar	N	Na_aa	Na_ar	Ni_aa	Ni_ar	P_aa
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	512P	201P	512P	201P	512P	201P	512P	820L	201P	512P	201P	512P	201P
2003	<0.7	432	570	161	205	<0.05	<1	1,4	48,3	90	4,1	30	101
2005	<0.7	415	580	153	203	<0.05	<1	1,1	33,2	90	3,99	30	135
2007	0,7	255	880	92	132	<0.05	<1	0,6	24,8	90	3,08	17	76,2
2008	1,4	185	1390	64	151	<0.05	15,8	0,6	21,4	50	3,59	52	63,8
2010	2,4	846	4160	358	745	<0.05	<1	1,1	49,9	90	1,39	26	58,3
2012	<0.7	384	670	42	71	<0.05	<1	1,2	61,4	90	2,28	25	96,4
2013	<0.7	587	850	1070	4310	0,13	1,3	1,7	87,2	120	3,13	41	62,7
2015	2,9	85	2540	21	76	<0.05	<1	0,3	10,4	40	3,26	14	29,5
2016	<0.7	287	500	127	194	<0.05	<1	0,8	29,4	70	2,26	17	94,9
2018	<0.7	580	740	178	252	<0.05	<1	1,3	53,5	70	4,17	40	94,8
2019	<0.7	400	700	92	178	<0.05	1,1	1,4	66,7	90	2,34	28	101
2021	<0.7	642	980	70	114	<0.05	<1	1,2	55,7	90	3,61	29	60,5
2022	<0.7	493	650	89	140	<0.05	<1	1,1	52,2	70	3,59	35	84,3
2024	<0.7	626	920	112	167	<0.05	<1	1	79,5	130	6,84	46	124
2025	2	201	4040	29	108	<0.05	<1	0,7	21,2	60	4,2	22	31,2
2027	4,7	229	6600	78	248	<0.05	1,2	0,8	20,3	50	6,78	33	32,7
2028	<0.7	362	1120	110	168	<0.05	<1	1	57,3	90	6,56	42	51,1
2030	<0.7	291	690	29	54	<0.05	<1	0,9	45,2	90	7,55	32	35,9
2031	1,2	302	1150	99	164	<0.05	<1	0,9	30,9	110	5,31	27	67,7
2032	1,9	52	1190	23	89	<0.05	<1	0,4	14,6	120	1,88	8	22,6
2033	1,2	93	1030	44	111	<0.05	<1	0,6	25,6	130	3,17	14	44,7
2034	<0.7	119	530	35	68	<0.05	<1	0,6	36,9	110	5,35	24	49,4
2036	1	46	710	14	52	<0.05	<1	0,4	13,7	90	3,21	15	21,5
2037	2,2	109	2660	165	384	<0.05	<1	0,4	11,6	70	2,92	10	43,9
2038	1,9	173	1290	79	147	<0.05	<1	0,6	16,8	100	3,93	19	46
2080	<0.7	676	1160	155	280	<0.05	<1	1,2	65,8	100	7,27	57,5	117
2081	<0.7	434	990	86,4	152	<0.05	<1	1,1	53,1	80	2,65	27,2	90,9
2082	<0.7	512	750	23,3	46	<0.05	<1	1,1	56,3	100	3,1	30,9	46,9
2083	<0.7	375	630	51,6	93	<0.05	<1	0,8	49,4	110	4,3	24,1	52,1
2084	<0.7	204	430	47,4	81,7	<0.05	<1	0,8	35,3	100	2,35	18	46,4
2085	<0.7	437	840	73,7	132	<0.05	1,8	0,9	43	70	4,3	33,1	105
2086	1,5	135	1990	20	78	<0.05	<1	0,6	32,2	90	3,72	20,5	28
2089	<0.7	425	990	113	192	<0.05	<1	0,8	54,8	90	7,37	48,6	82,8
2090	<0.7	566	1180	99,8	181	<0.05	<1	1	56,1	120	4,53	38,4	88,9
2091	<0.7	364	620	162	254	<0.05	<1	1,1	31,1	100	2,31	23,4	138
2092	<0.7	203	480	198	340	<0.05	<1	0,6	18,8	80	3,68	20	83,5
2093	<0.7	584	780	148	241	<0.05	<1	1,4	4<5	70	1,98	23,9	184
2094	<0.7	250	540	57,6	101	<0.05	<1	0,8	22,2	110	2,24	14,3	59,8
2095	<0.7	365	590	132	198	<0.05	<1	0,9	37,8	100	4,52	30,6	112
2096	<0.7	922	1350	107	338	<0.05	<1	1,7	49,3	90	1,59	33,5	92,8
2097	1,4	184	2490	33,2	109	<0.05	<1	0,5	18,3	70	4,09	21,1	35,1
2100	<0.7	316	660	217	338	<0.05	<1	0,9	27,7	100	5,21	33,8	109
2101	<0.7	363	720	41,6	86,1	<0.05	<1	1	43,6	130	4,24	29,6	61,9
2102	<0.7	342	810	18,8	47	<0.05	<1	0,8	44,4	120	6,14	39,8	43,6
2108	<0.7	492	1310	76,4	154	<0.05	<1	1	63,9	110	3,56	37,8	84,3
2109	0,7	131	730	64,9	150	<0.05	<1	0,6	14	110	3,25	20,4	31,2
2110	<0.7	168	370	38,5	72,1	<0.05	<1	0,6	28,1	110	2,32	14,5	63,7
2111	<0.7	144	510	165	317	<0.05	<1	0,7	23,5	120	3,48	21,2	60,6
2112	<0.7	86,5	590	24,8	63	<0.05	<1	0,5	22,6	110	2,78	16,1	22,2
2113	<0.7	289	460	79	118	<0.05	<1	0,8	31,4	100	3,16	19,1	65,4
2119	<0.7	212	640	132	226	<0.05	<1	0,8	24,7	90	5,64	27,3	88,2
2120	<0.7	90,5	600	35,9	86,1	<0.05	<1	0,4	20,3	90	1,1	6,5	28,7
2121	<0.7	252	500	136	227	<0.05	<1	1	38,4	100	5	32,1	74,9
2122	1,6	270	3570	249	2640	<0.05	1,1	1	31,2	50	1,09	24,8	31,7

2123	<0.7	339	1480	117	208	<0.05	<1	0,8	27,3	50	4,52	30,1	62,7
2124	<0.7	215	470	138	199	<0.05	<1	0,6	16,7	60	3,37	16,3	91,2
2125	<0.7	365	590	53	83,8	<0.05	<1	0,9	59,1	80	6,53	35,1	53,2
2126	<0.7	388	890	92	150	<0.05	<1	0,9	38	70	6,31	29,2	66,5
2127	<0.7	347	580	247	369	<0.05	<1	0,8	31,5	60	6,47	36,5	101
2128	<0.7	593	1180	34,9	62,1	<0.05	<1	1,1	63,2	70	3,25	22,1	59,5
2129	1,8	505	3560	69,4	133	<0.05	<1	0,9	65,5	70	7,75	56,2	53,4
2140	<0.7	354	550	107	160	<0.05	<1	1	53,3	80	4,69	29,6	115
2202	<0.7	115	560	46,9	95,6	<0.05	<1	0,6	29,3	110	3,56	18,2	58,8
2206	1,2	88,1	1470	6,01	42,7	<0.05	<1	0,3	16,3	70	2,79	11,6	17,4
2207	1,1	277	2040	41,1	128	<0.05	<1	0,6	64,9	110	5,59	28	50,4
2208	1,4	247	1860	141	305	<0.05	<1	0,6	23,7	60	4,26	24,4	102
2209	0,8	495	1850	209	1260	<0.05	1,5	1,3	54,5	70	2,58	36,9	33
2210	1	146	1090	34,5	85,5	<0.05	<1	0,5	32,2	80	3,89	15,5	37,1
2211	3,4	104	3760	9,18	105	<0.05	<1	0,3	16,1	80	2,72	19	12,9
2212	<0.7	241	770	244	364	<0.05	<1	0,8	34,8	70	5,58	33,3	101
2216	<0.7	155	720	26,9	65,3	<0.05	<1	0,5	29,4	100	4,1	18,6	45,1
2220	<0.7	149	970	132	210	<0.05	<1	0,5	14	50	5,51	21,4	66
2221	<0.7	50,4	480	23,8	60,5	<0.05	<1	0,3	10,8	70	2,2	8,2	16,5
2224	<0.7	139	290	38,5	62,4	<0.05	<1	0,5	16,7	80	2,17	10,6	45,4
2227	3,5	15	1700	5,09	66,6	<0.05	<1	0,2	7	80	1,62	11,2	13,1

*ID	P_ar	Pb_aa	Pb_ar	S_aa	S_ar	Sb_aa	Sb_ar	Sc_ar	Se_ar	Si_aa	Si_ar	Sr_aa	Sr_ar
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	512P	201P	512P	201P	512P	201P/U	512P	512P	512U	201P	512P	201P	512P
2003	696	4	10,8	122	1180	<0.5	0,11	0,3	0,45	15	260	10,6	16,1
2005	690	5,1	11	97	1120	<0.5	0,1	0,2	0,45	15	240	9,41	14,4
2007	441	3,1	7,4	60	649	<0.5	0,1	0,3	0,19	11	200	4,33	8,4
2008	614	2,6	6,7	61	678	<0.5	0,31	0,9	1,15	8	320	3,69	5,2
2010	633	2,8	10,7	86	1060	<0.5	0,12	1,6	0,41	15	270	15,1	25,7
2012	564	<5	8,2	87	1150	<0.5	0,12	0,2	0,31	7	300	6,8	12
2013	995	0,3	12,2	112	2190	<0.5	0,16	0,1	0,71	20	230	40,6	77,8
2015	219	2,4	6,2	25	277	<0.5	0,06	1,1	0,11	5	170	1,96	3,3
2016	568	2,7	8,6	70	909	<0.5	0,09	0,2	0,25	11	260	5,83	10,2
2018	652	5,3	13,4	104	1370	<0.5	0,1	0,2	0,62	19	220	9,48	15,8
2019	787	3	11	117	1650	<0.5	0,14	0,3	0,7	21	280	11,8	23,2
2021	604	2,9	9,4	114	1400	<0.5	0,18	0,3	0,44	14	210	8,12	14,9
2022	595	3,7	12,2	108	1400	<0.5	0,17	<0.1	0,41	15	260	8,85	15,8
2024	813	4,8	13,9	108	1190	0,5	0,12	0,3	0,43	14	310	10,6	18
2025	350	3,1	8,3	54	578	<0.5	0,09	1	0,18	10	250	3,54	6
2027	686	2,4	9	77	937	<0.5	0,1	4	0,64	17	210	3,87	8,2
2028	456	4	12,8	101	881	<0.5	0,12	0,6	0,25	16	280	7,13	11,7
2030	441	4,6	11,2	76	700	<0.5	0,08	0,3	0,33	22	240	9,54	14,2
2031	713	3	8,8	100	786	<0.5	0,1	0,2	0,23	22	220	5,61	9,9
2032	320	3,6	9,7	30	300	<0.5	0,1	0,8	0,19	13	180	2,46	5,8
2033	572	2,7	8,6	61	560	<0.5	0,11	0,8	0,26	17	220	2,91	7,3
2034	470	4,3	9,1	59	590	<0.5	0,1	0,3	0,32	8	230	5,76	10
2036	306	3	8	36	381	<0.5	0,09	0,6	0,21	6	210	2,69	6,6
2037	586	1,3	6,1	42	341	<0.5	0,09	2	0,18	7	250	2,64	5,3
2038	485	2,2	6,5	56	563	<0.5	0,09	0,6	0,25	12	190	3,77	7,7
2080	840	5,5	18,2	140	1350	<0.5	0,15	0,3	0,34	8	270	9,39	17,6
2081	589	3	9,8	71,7	1190	<0.5	0,1	0,3	0,37	4	330	7,35	12,8
2082	587	3,7	11,3	70,9	1450	<0.5	0,1	0,3	0,4	14	220	11,8	22,7
2083	568	3,5	12,4	65,3	910	<0.5	0,11	0,3	0,23	11	230	6,73	12,3
2084	498	3,8	11,8	50	811	<0.5	0,07	0,2	0,26	10	220	9,09	17,3
2085	674	3,6	11,4	94,1	1080	<0.5	0,19	0,3	0,63	8	260	7,34	1<5
2086	407	3,8	11,2	49,4	554	<0.5	0,12	0,8	0,33	5	210	2,66	5,5
2089	577	5,4	13,9	68,1	981	<0.5	0,19	0,3	0,56	5	270	6,58	11,6
2090	725	4,6	12,3	82,8	1230	<0.5	0,16	0,4	0,51	15	260	11,3	20,7
2091	816	2,7	8,9	102	1250	<0.5	0,15	0,2	0,41	5	260	8,84	15,8
2092	477	2,7	8,1	51,3	531	<0.5	0,13	0,3	0,24	6	200	2,71	5,1
2093	893	2,4	9,7	114	1530	<0.5	0,1	<0.1	0,49	4	240	6,48	12,4
2094	475	2,4	9,4	42,6	732	<0.5	0,07	0,4	0,19	6	230	6,55	12,2
2095	694	3,5	11	73,2	997	<0.5	0,09	0,3	0,39	13	240	6,62	11,7
2096	843	2,9	14	118	1990	<0.5	0,11	0,2	0,72	15	280	13	27,4
2097	344	3,3	11,3	43,4	519	<0.5	0,05	0,8	0,2	7	190	3,18	6,3
2100	734	3,4	10,4	68,8	951	<0.5	0,06	0,3	0,39	11	280	5,86	11,3
2101	925	4,4	12,8	73,3	1140	<0.5	0,09	<0.1	0,33	13	290	8,92	17,6
2102	560	4,1	13	61,6	968	<0.5	0,06	0,5	0,47	11	240	9,44	18
2108	572	3,1	12,4	96,4	1290	<0.5	0,06	0,5	0,5	11	320	6,71	13,2
2109	500	2,4	8	43	674	<0.5	0,12	0,6	0,25	8	220	3,61	9
2110	456	2,9	7,9	50	596	<0.5	0,09	0,3	0,22	7	230	5,51	9,8
2111	597	3,4	10,8	54,8	687	<0.5	0,11	0,4	0,28	9	250	4,43	9,6
2112	334	2,6	9,1	32,6	425	<0.5	0,06	0,5	0,26	10	220	4,45	9,2
2113	520	10,5	26	63,8	803	<0.5	0,1	0,4	0,28	10	280	7,8	13,5
2119	589	4	13	69,2	692	<0.5		0,5		11	270	5,16	9
2120	474	1,5	9	37,4	465	<0.5		0,6		8	270	3,96	9
2121	627	9,1	30	84,7	996	<0.5		0,2		13	280	6,21	12,1
2122	722	0,6	10	61	1210	<0.5		1,3		22	300	20,1	38,3

2123	536	4,4	17	76,6	808	<0.5		0,4		10	250	6,08	10,2
2124	496	2,3	10	55,4	618	<0.5		0,3		7	210	4,48	7,4
2125	631	5,2	18	86,9	909	<0.5		0,2		13	190	9,18	15,1
2126	548	3,3	16	81,6	941	<0.5		0,6		9	220	5,6	9,1
2127	606	3,8	16	74,2	875	<0.5		0,3		9	220	5,05	8,6
2128	637	4,4	15	102	1130	<0.5		0,6		10	260	14,9	22,7
2129	506	5,7	18	99,6	921	<0.5		1,4		13	240	7,47	11,7
2140	628	4,3	17	89,6	908	<0.5		0,2		11	230	7,36	11,7
2202	547	3,3	12	59,6	551	<0.5		0,4		11	240	3,68	8,2
2206	241	2,8	11	27,1	391	<0.5		0,7		7	160	2,27	5
2207	343	2,3	13	65,3	613	<0.5		1,2		15	250	4,28	8,6
2208	518	3,2	10	59,6	628	<0.5		1,7		13	180	4,42	7,2
2209	956	2,8	17	82,3	1880	<0.5		1,2		25	340	14,1	28,1
2210	420	2,4	12	67,3	652	<0.5		0,7		15	260	4,31	7,8
2211	261	2,4	11	39,5	395	<0.5		1,3		11	220	3,89	7,1
2212	674	2,9	13	79,1	830	<0.5		0,5		16	230	4,26	8,1
2216	524	3,5	16	67,1	633	<0.5		0,5		18	220	3,49	7,1
2220	489	2,7	9	46,7	483	<0.5		0,5		10	240	2,69	5,1
2221	238	1,3	6	23	241	<0.5		0,5		11	230	1,66	3,8
2224	320	2,2	6	35,9	452	<0.5		0,4		8	220	4,49	7,6
2227	314	1,1	7	30,8	165	<0.5		1		16	210	0,42	3,5

*ID	Te_ar	Th_ar	Ti_aa	Ti_ar	V_aa	V_ar	Y_ar	Zn_aa	Zn_ar	pH_dest	pH_CaCl2	El_cond
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			µs/cm
	512U	512P	201P	512P	201P	512P	512P	201P	512P			
2003	0,03	<5	0,14	86	0,07	4,4	0,3	31,3	57,1	3,91	2,90	138,1
2005	0,02	<5	<0.05	172	0,07	6,7	0,3	23,3	43,2	4,22	3,20	123,9
2007	0,01	<5	0,21	201	0,06	10,9	0,4	13,7	24,9	4,21	3,10	87,2
2008	0,05	<5	0,19	247	0,14	47,6	2,4	12,1	90,6	4,21	3,20	84,9
2010	0,04	<5	0,08	218	0,09	28,6	3	15	47,2	5,65	5,00	196,9
2012	0,02	<5	0,08	97	0,03	6	0,3	24,3	57,6	3,89	3,10	125,1
2013	0,04	<5	<0.05	27	0,07	5,3	1,9	35,9	97,7	5,17	4,20	192,3
2015	0,01	<5	0,4	544	0,08	18,5	0,6	6,19	17,8	4,24	3,30	49,7
2016	0,01	<5	0,22	225	0,04	6,8	0,3	12,2	25,7	3,96	2,80	107,2
2018	0,01	<5	<0.05	45	0,06	3,8	0,6	23,2	49,3	4,46	3,60	159,9
2019	0,02	<5	<0.05	42	0,05	8,4	0,8	12,3	33,7	4,04	2,90	148,7
2021	0,01	<5	0,22	108	0,09	9,4	0,4	24,6	54,8	3,81	2,60	160,8
2022	0,01	<5	<0.05	19	0,04	2	0,1	13,8	37,7	3,82	2,50	136,2
2024	0,02	<5	0,14	168	0,07	9,5	0,4	18,1	36,2	3,97	2,80	144,8
2025	0,02	<5	0,52	634	0,27	38,3	0,7	6,75	19,3	4,13	3,10	76,9
2027	0,06	<5	1,44	1100	2,04	214	2,8	14,8	69,1	4,31	3,30	87,7
2028	0,02	<5	0,31	688	0,06	22,8	0,6	15,4	32,8	4,03	3,10	136,5
2030	0,02	<5	0,4	261	0,13	11	0,6	10,9	20,4	3,91	2,80	118,9
2031	0,03	<5	0,54	299	0,16	21,6	1	16,6	31	4,36	3,30	121,5
2032	0,03	<5	1,09	620	0,16	28,4	1,1	4,51	15,6	4,47	3,40	41,2
2033	0,02	<5	1,19	655	0,24	30,7	1,4	9,68	23,9	4,10	3,10	73,3
2034	0,03	<5	0,26	269	0,11	12,9	0,6	9,16	18,7	4,04	2,90	77,1
2036	0,02	<5	0,7	345	0,12	17,4	1	4,7	13,4	4,04	2,90	64,1
2037	0,02	<5	1,04	822	0,39	73,4	1,6	15,2	32,6	4,30	3,10	71,3
2038	0,02	<5	0,45	458	0,11	21	1,2	13,4	29,7	4,16	2,80	77,9
2080	0,04	<5	0,13	154	0,1	15	0,3	36,8	85,1			
2081	0,03	<5	0,07	225	0,04	12,2	0,3	25,3	66,5			
2082	0,02	<5	<0.05	90,9	0,05	4,6	0,9	17,8	44,3			
2083	0,01	<5	0,17	286	0,08	14,8	0,6	14,3	30,5			
2084	<0.01	<5	0,18	145	0,05	6,3	0,4	20,6	49,9			
2085	0,12	<5	0,1	299	0,05	46,2	0,4	17,5	53,5			
2086	0,03	<5	0,45	530	0,09	26,9	1,2	5,48	19,4			
2089	0,03	<5	<0.05	148	0,08	10,8	0,3	19,1	41,9			
2090	0,02	<5	0,05	127	0,07	8	0,9	22,1	51			
2091	0,02	<5	0,1	182	0,04	14,1	0,3	28,1	66,5			
2092	0,02	<5	0,12	280	0,04	7,5	0,4	15,6	29			
2093	0,06	<5	<0.05	17,8	0,03	1,7	0,05	30,7	84,2			
2094	0,02	<5	0,19	411	0,06	12,8	0,5	14,2	29,5			
2095	0,03	<5	0,11	241	0,04	8,5	0,4	15,5	33,2			
2096	0,03	<5	<0.05	65,8	0,07	5,9	1,1	41,3	133			
2097	0,02	<5	0,26	498	0,19	41,4	0,6	8,67	24			
2100	0,01	<5	0,11	188	0,05	7,6	0,5	31,1	66			
2101	0,01	<5	0,24	174	0,09	6,7	0,8	13,8	31,9			
2102	0,02	<5	0,17	293	0,08	12,1	0,5	9,58	24,4			
2108	0,02	<5	0,09	298	0,04	9	0,5	12,2	39,7			
2109	0,04	<5	0,28	412	0,07	17,5	1	9,28	25,1			
2110	0,01	<5	0,12	139	0,04	6,5	0,5	11,3	25,1			
2111	0,01	<5	0,37	323	0,06	14,3	1,1	17,2	37,8			
2112	<0.01	<5	0,43	318	0,07	14,6	0,9	6,45	17,3			
2113	0,01	<5	0,1	144	0,06	5,1	0,4	19	38,8			
2119		<5	<0.05	348	0,11	16,9	0,8	21,5	38,5			
2120		<5	1,44	603	0,21	28,2	1,1	7,68	19,3			
2121		<5	0,22	141	0,1	6,5	0,3	27,5	60,8			
2122		<5	<0.05	150	0,14	55,2	4,2	16,4	77,4			

2123		<5	0,23	320	0,14	33,1	0,9	17	37,1			
2124		<5	0,22	364	0,12	32,9	0,4	18,5	34,8			
2125		<5	0,17	142	0,12	8,2	0,8	14,4	28,5			
2126		<5	1,27	678	0,32	32,5	0,5	16,5	31,1			
2127		<5	<0.05	541	0,09	17,5	0,4	22,4	46,2			
2128		<5	0,13	123	0,11	12,8	1	31,3	57,2			
2129		<5	0,21	175	0,17	38	0,5	14,4	35,1			
2140		<5	0,21	278	0,08	8,6	0,3	22	43,5			
2202		<5	0,71	358	0,13	18,6	1	10,7	26,2			
2206		<5	0,52	700	0,11	17,6	0,9	3,59	14,8			
2207		<5	0,63	1190	0,12	32,7	1,1	8,37	22,3			
2208		<5	0,08	260	0,08	30,8	0,4	18,8	41,5			
2209		<5	<0.05	70,8	0,09	17,2	11,3	25,3	81,7			
2210		<5	1,57	684	0,42	32,5	0,9	9,06	20,7			
2211		<5	0,95	748	0,34	69	1,2	4,62	23,1			
2212		<5	0,42	637	0,12	29,3	0,5	23,8	47,9			
2216		<5	0,8	467	0,26	18,4	1	8,13	19			
2220		<5	<0.05	296	0,12	28	0,8	17,7	33,4			
2221		<5	0,71	444	0,15	23	0,7	6,41	14,9			
2224		<5	0,14	142	0,06	6	0,5	10,8	20,8			
2227		<5	0,84	641	0,09	24,9	1,2	1,12	16			

*ID	F'	Cl'	NO2'	Br'	NO3'	PO4'''	SO4''	LOI
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%
	IC	IC	IC	IC	IC	IC	IC	GRAV
2003	81,8	83	<	<	7,92	390	176,6	85,03
2005	44,6	76,6	<	<	5,58	516	130,2	65,32
2007	42,4	53,8	<	<	3,52	272	101,2	45,06
2008	40,4	47,2	<	<	4,12	558	280	38,88
2010	34,4	178,6	<	<	9,1	486	234	56,70
2012	58,2	106,6	<	<	10,7	354	141,2	84,75
2013	108,8	107,4	<	<	11,12	348	224	91,66
2015	23,0	17,7	<	<	4,26	85	42	18,76
2016	40,8	52,8	<	<	3,2	344	109,2	62,34
2018	74,2	96	<	<	11,44	494	188,8	89,33
2019	61,4	119,8	<	<	6,7	402	165,8	93,58
2021	35,0	92	<	<	3,24	232	202	90,30
2022	41,0	74,4	<	<	5,2	348	167,8	93,16
2024	54,0	79,4	<	<	4,68	468	174,8	76,57
2025	11,3	38,2	<	<	3,38	73,2	81,6	38,57
2027	14,4	44,2	<	<	4,14	22	110	50,87
2028	<	<	<	<	<	<	<	76,11
2030	54,0	60,8	<	<	4,54	106,6	139,8	57,77
2031	50,0	93,4	<	<	5,24	159	172,4	49,36
2032	13,2	24,8	<	<	2,82	18,68	34,8	16,00
2033	35,0	28,8	<	<	2,4	61,4	81	37,34
2034	34,4	36,6	<	<	3,5	125,2	83,2	44,25
2036	32,2	26,2	<	<	1978	42,4	50	21,81
2037	35,2	36,4	<	<	2,74	76	57,6	26,25
2038	41,6	44	<	<	3,54	88,8	85,4	37,33
2080								
2081								
2082								
2083								
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Appendix

for Podzol

Table a. List of determined soil parametres and major information about analytical technique.

Element/ parameter	Form *	Performed for: **	Pretritment	Technique ***	Detection limits value	Detection limits unit	Unit	Laborotary
Ag	Ag *ar*	M	Aqua regia	GFAAS	0.01	mg/kg	mg/kg of dry matter	GTK
	Ag *nn*	O	Nitric acid in microwave oven	ICP-MS	0,2	mg/kg	mg/kg of dry matter	GTK
Al	Al *nn*	O	Nitric acid in microwave oven	ICP-MS	0.2	mg/kg	mg/kg of dry matter	GTK
	Al *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	Al *total*	M	Fusing with litium tetraborate	XRF	100	ppm	Al2O3 % of dry mat.	NGU
	Al *ar*	M	Aqua regia	ICP-AES	10	mg/kg	mg/kg of dry matter	GTK
As	As *ar*	M	Aqua regia	GFAAS	0.2	mg/kg	mg/kg of dry matter	GTK
	As *nn*	O	Nitric acid in microwave oven	ICP-MS	0.05	mg/kg	mg/kg of dry matter	GTK
	As *aa*	B	1 M NH3Ac pH 4.5	GFAAS	0.05	mg/kg	mg/kg of dry matter	GTK
B	B *nn*	O	Nitric acid in microwave oven	ICP-MS	0.5	mg/kg	mg/kg of dry matter	GTK
	B *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.1	mg/kg	mg/kg of dry matter	GTK
	B *ar*	M	Aqua regia	ICP-AES	3.0	mg/kg	mg/kg of dry matter	GTK
Ba	Ba *nn*	O	Nitric acid in microwave oven	ICP-MS	0.05	mg/kg	mg/kg of dry matter	GTK
	Ba *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.01	mg/kg	mg/kg of dry matter	GTK
	Ba *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
Be	Be *nn*	O	Nitric acid in microwave oven	ICP-MS	0,6	mg/kg	mg/kg of dry matter	GTK
Bi	Bi *ar*	M	Aqua regia	GFAAS	0,01	mg/kg	mg/kg of dry matter	GTK
	Bi *nn*	O	Nitric acid in microwave oven	ICP-MS	0,2	mg/kg	mg/kg of dry matter	GTK
Br	Br-	B	Water extraction ****	IC	0.1	mg/l	µg/l	NGU
C	C *total*	B	Pyrolysis in flow of oxygen	Leco Sc-444	0.07	%	% of dry matter	NGU
	C *total org.*	M	Pyrolysis in flow of oxygen	Leco Sc-444	0.1	%	% of dry matter	NGU
	C *total*	O	Pyrolysis in flow of oxygen	IR detector			% of dry matter	GTK
Ca	Ca *total*	M	Fusing with litium tetraborate	XRF	50	ppm	CaO % of dry mat.	NGU
	Ca *ar*	M	Aqua regia	ICP-AES	3.0	mg/kg	mg/kg of dry matter	GTK
	Ca *nn*	O	Nitric acid in microwave oven	ICP-AES	5.0	mg/kg	mg/kg of dry matter	GTK
	Ca aa	B	1 M NH3Ac pH 4.5	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
Cd	Cd *ar*	M	Aqua regia	GFAAS	0.01	mg/kg	mg/kg of dry matter	GTK
	Cd *nn*	O	Nitric acid in microwave oven	ICP-MS	0.02	mg/kg	mg/kg of dry matter	GTK
	Cd *aa*	B	1 M NH3Ac pH 4.5	GFAAS	0.001	mg/kg	mg/kg of dry matter	GTK
Cl	Cl-	B	Water extraction	IC	0.1	mg/l	µg/l	NGU
Co	Co *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	Co *nn*	O	Nitric acid in microwave oven	ICP-MS	0.03	mg/kg	mg/kg of dry matter	GTK
	Co *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.02	mg/kg	mg/kg of dry matter	GTK
Cr	Cr *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	Cr *nn*	O	Nitric acid in microwave oven	ICP-MS	0.4	mg/kg	mg/kg of dry matter	GTK
	Cr *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.02	mg/kg	mg/kg of dry matter	GTK
Cu	Cu *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	Cu *nn*	O	Nitric acid in microwave oven	ICP-AES	1.0	mg/kg	mg/kg of dry matter	GTK
	Cu *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.02	mg/kg	mg/kg of dry matter	GTK
F	F-	B	Water extraction	IC	0.05	mg/l	µg/l	NGU
Fe	Fe *total*	M	Fusing with litium tetraborate	XRF	200	ppm	Fe2O3 % of dry mat.	NGU
	Fe *ar*	M	Aqua regia	ICP-AES	10.0	mg/kg	mg/kg of dry matter	GTK
	Fe *nn*	O	Nitric acid in microwave oven	ICP-AES	10.0	mg/kg	mg/kg of dry matter	GTK
	Fe *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
H	H *total*	O	Pyrolysis in flow of oxygen	TC dtector			% of dry matter	GTK
Hg	Hg *nn*	O	Nitric acid in microwave oven	CVAAS	0.06	mg/kg	mg/kg of dry matter	GTK
	Hg *ar*	M	Aqua regia	CVAAS	0,03	mg/kg	mg/kg of dry matter	GTK
K	K *total*	M	Fusing with litium tetraborate	XRF	50	ppm	K2O % of dry mat.	NGU
	K *ar*	M	Aqua regia	ICP-AES	200.0	mg/kg	mg/kg of dry matter	GTK
	K *nn*	O	Nitric acid in microwave oven	ICP-MS	10.0	mg/kg	mg/kg of dry matter	GTK
	K aa	B	1 M NH3Ac pH 4.5	ICP-AES	20.0	mg/kg	mg/kg of dry matter	GTK
La	La *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	La *nn*	O	Nitric acid in microwave oven	ICP-AES	0,7	mg/kg	mg/kg of dry matter	GTK

Element/ parameter	Form *	Performed for: **	Pretritment	Technique ***	Detection limits value	Detection limits unit	Unit	Laborotary
Li	Li *ar*	M	Aqua regia	ICP-AES	0,7	mg/kg	mg/kg of dry matter	GTK
Li	Li *nn*	O	Nitric acid in microwave oven	ICP-AES	0,7	mg/kg	mg/kg of dry matter	GTK
	Li *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.05	mg/kg	mg/kg of dry matter	GTK
Mg	Mg *total*	M	Fusing with litium tetraborate	XRF	200	ppm	MgO % of dry mat.	NGU
	Mg *ar*	M	Aqua regia	ICP-AES	5.0	mg/kg	mg/kg of dry matter	GTK
	Mg *nn*	O	Nitric acid in microwave oven	ICP-AES	10.0	mg/kg	mg/kg of dry matter	GTK
	Mg *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
Mn	Mn *total*	M	Fusing with litium tetraborate	XRF	40	ppm	MnO % of dry mat.	NGU
	Mn *nn*	O	Nitric acid in microwave oven	ICP-AES	1.0	mg/kg	mg/kg of dry matter	GTK
	Mn *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.05	mg/kg	mg/kg of dry matter	GTK
	Mn ar	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
Mo	Mo *nn*	O	Nitric acid in microwave oven	ICP-MS	0.01	mg/kg	mg/kg of dry matter	GTK
	Mo *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0,05	mg/kg	mg/kg of dry matter	GTK
	Mo *ar*	M	Aqua regia	ICP-AES	1.0	mg/kg	mg/kg of dry matter	GTK
N	N *total*	O	Pyrolysis in flow of oxygen	TC dtector			% of dry matter	GTK
	N-*NO2-*	B	Water extraction	IC	0.05	mg/l	μg/l	NGU
	N-*NO3-*	B	Water extraction	IC	0.05	mg/l	μg/l	NGU
Na	Na *total*	M	Fusing with litium tetraborate	XRF	500	ppm	Na2O % of dry mat.	NGU
	Na *nn*	O	Nitric acid in microwave oven	ICP-AES	20.0	mg/kg	mg/kg of dry matter	GTK
	Na *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	Na *ar*	M	Aqua regia	ICP-AES	15.0	mg/kg	mg/kg of dry matter	GTK
Ni	Ni *nn*	O	Nitric acid in microwave oven	ICP-MS	0.3	mg/kg	mg/kg of dry matter	GTK
	Ni *aa*	B	1 M NH3Ac pH 4.5	ICP-AES	0.05	mg/kg	mg/kg of dry matter	GTK
	Ni *ar*	M	Aqua regia	ICP-AES	1.0	mg/kg	mg/kg of dry matter	GTK
P	P *nn*	O	Nitric acid in microwave oven	ICP-AES	15.0	mg/kg	mg/kg of dry matter	GTK
	P *aa*	B	1 M NH3Ac pH 4.5	ICP- AES	0.5	mg/kg	mg/kg of dry matter	GTK
	P *ar*	M	Aqua regia	ICP-AES	7.0	mg/kg	mg/kg of dry matter	GTK
	P *total*	M	Fusing with litium tetraborate	XRF	60	ppm	P2O5 % of dry mat.	NGU
	P-*PO43-*	B	Water extraction	IC	0.2	mg/l	μg/l	NGU
Pb	Pb *ar*	M	Aqua regia	GFAAS	0.2	mg/kg	mg/kg of dry matter	GTK
	Pb *nn*	O	Nitric acid in microwave oven	ICP-MS	0.04	mg/kg	mg/kg of dry matter	GTK
	Pb *aa*	B	1 M NH3Ac pH 4.5	ICP- AES	0,2	mg/kg	mg/kg of dry matter	GTK
Rb	Rb *nn*	O	Nitric acid in microwave oven	ICP-MS		mg/kg	mg/kg of dry matter	GTK
S	S *nn*	O	Nitric acid in microwave oven	ICP-AES	15.0	mg/kg	mg/kg of dry matter	GTK
	S *aa*	B	1 M NH3Ac pH 4.5	ICP- AES	0.5	mg/kg	mg/kg of dry matter	GTK
	S *ar*	M	Aqua regia	ICP-AES	10.0	mg/kg	mg/kg of dry matter	GTK
	S-SO42-	B	Water extraction	IC	0.1	mg/l	μg/l	NGU
	S *total*	B	Pyrolysis in flow of oxygen	Leco Sc-444	0.01	%	% of dry matter	NGU
Sb	Sb *ar*	M	Aqua regia	GFAAS	0,01	mg/kg	mg/kg of dry matter	GTK
	Sb *nn*	O	Nitric acid in microwave oven	ICP-MS	0.02	mg/kg	mg/kg of dry matter	GTK
	Sb *aa*	B	1 M NH3Ac pH 4.5	ICP- AES	0.5	mg/kg	mg/kg of dry matter	GTK
Sc	Sc *ar*	M	Aqua regia	ICP-AES	0,1	mg/kg	mg/kg of dry matter	GTK
	Sc *nn*	O	Nitric acid in microwave oven	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
Se	Se *ar*	M	Aqua regia	GFAAS	0,01	mg/kg	mg/kg of dry matter	GTK
	Se *nn*	O	Nitric acid in microwave oven	ICP-MS	0.5	mg/kg	mg/kg of dry matter	GTK
Si	Si *total*	M	Fusing with litium tetraborate	XRF	100	ppm	SiO2 % of dry mat.	NGU
	Si *ar*	M	Aqua regia	ICP-AES	10.0	mg/kg	mg/kg of dry matter	GTK
	Si *nn*	O	Nitric acid in microwave oven	ICP-AES	20.0	mg/kg	mg/kg of dry matter	GTK
	Si *aa*	B	1 M NH3Ac pH 4.5	ICP- AES	1.0	mg/kg	mg/kg of dry matter	GTK
Sr	Sr *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	Sr *nn*	O	Nitric acid in microwave oven	ICP-MS	0.2	mg/kg	mg/kg of dry matter	GTK
	Sr *aa*	B	1 M NH3Ac pH 4.5	ICP- AES	0.05	mg/kg	mg/kg of dry matter	GTK
Te	Te *ar*	M	Aqua regia	GFAAS	0,01	mg/kg	mg/kg of dry matter	GTK
Th	Th *ar*	M	Aqua regia	ICP-AES	5	mg/kg	mg/kg of dry matter	GTK

Element/ parameter	Form *	Performed for: **	Pretritment	Technique ***	Detection limits value	unit	Unit	Laborotary
	Th *nn*	O	Nitric acid in microwave oven	ICP-MS	0,2	mg/kg	mg/kg of dry matter	GTK
Ti	Ti *total*	M	Fusing with litium tetraborate	XRF	30	ppm	TiO2 % of dry mat.	NGU
	Ti *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
Ti	Ti *nn*	O	Nitric acid in microwave oven	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	Ti *aa*	B	1 M NH3Ac pH 4.5	ICP- AES	0.05	mg/kg	mg/kg of dry matter	GTK
Tl	Tl *nn*	O	Nitric acid in microwave oven	ICP-MS	0,2	mg/kg	mg/kg of dry matter	GTK
U	U *nn*	O	Nitric acid in microwave oven	ICP-MS	0,2	mg/kg	mg/kg of dry matter	GTK
V	V *nn*	O	Nitric acid in microwave oven	ICP-MS	0.02	mg/kg	mg/kg of dry matter	GTK
	V *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	V *aa*	B	1 M NH3Ac pH 4.5	ICP- AES	0.02	mg/kg	mg/kg of dry matter	GTK
Y	Y *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	Y *nn*	O	Nitric acid in microwave oven	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
Zn	Zn *ar*	M	Aqua regia	ICP-AES	0.5	mg/kg	mg/kg of dry matter	GTK
	Zn *nn*	O	Nitric acid in microwave oven	ICP-AES	1.0	mg/kg	mg/kg of dry matter	GTK
	Zn *aa*	B	1 M NH3Ac pH 4.5	ICP- AES	0.5	mg/kg	mg/kg of dry matter	GTK
Conductivity	Conductivity	M	Water extraction				µS/cm	NGU
Conductivity	Conductivity	O	Water extraction				µS/cm	NGU
pH	pH	M	Water extraction				pH	NGU
pH	pH	O	Water extraction				pH	NGU
LOI	LOI	B	Ashing				% of dry matter	NGU

Explonation:

* - ***Total*** - total content of element; ***ar*** - extractable by aqua regia; ***nn*** - by nitric acid; ***aa*** - by ammonium acetate.

** - performed for: **O** - organic horizon only; **M** - for mineral horizons; **B**- for both.

*** GAAS - atomic absorption spectrophotometry with electrotermal atomization;

FAAS - atomic absorption spectrophotometry with flame atomization;

CVAAS - atomic absorption spectrophotometry, atomization by cold vapor generation;

XRF - wavelength dispersive x-ray fluorescence spectroscopy

ICP-AES -inductively coupled plasma atomic emission spectrometry;

ICP-MS - inductively coupled plasma mass spectrometry;

IC - ion chromotography.

**** 1:20 soil: water (W:V) ratio was used for organic horizons and 1:10 - for mineral horizons.

Table b. Total content of major elements (XRF technique) and lost of ignition (LOI) for mineral horizons of podzols from Skjellbekken catchment, % of dry matter.														
Catch. No	ID	Profile No	Horizon	SiO2	Al2O3	Fe2O3	TiO2	MgO	CaO	Na2O	K2O	MnO	P2O5	LOI
5	2134	P37	Ex	70,37	11,48	4,78	0,75	1,23	2,58	2,61	1,40	0,06	0,05	3,87
5	2134	P37	Ey	72,98	11,61	2,85	0,67	1,09	2,45	2,65	1,51	0,05	0,04	3,04
5	2134	P37	B1x	63,78	13,16	8,36	0,73	2,24	3,52	2,69	1,43	0,09	0,08	4,21
5	2134	P37	B1y	62,23	13,63	8,28	0,69	2,37	3,52	2,81	1,42	0,09	0,08	4,52
5	2134	P37	B2	61,23	14,53	7,09	0,63	2,42	3,78	3,10	1,32	0,10	0,12	5,04
5	2134	P37	BC1	59,77	14,97	8,17	0,73	2,81	4,13	2,99	1,19	0,11	0,13	4,43
5	2134	P37	BC2	62,82	14,54	7,70	0,74	2,81	4,53	3,12	1,15	0,11	0,17	1,97
5	2134	P37	C1	61,49	14,49	8,45	0,87	2,95	4,79	3,07	1,03	0,12	0,18	1,92
5	2134	P37	C2	63,40	14,62	6,70	0,66	2,66	4,50	3,20	1,30	0,10	0,18	2,35
5	2135	P38	E	72,12	10,42	2,70	0,34	1,13	2,56	2,59	1,07	0,04	0,04	6,30
5	2135	P38	B1	66,71	13,95	4,64	0,44	1,87	3,53	3,32	1,36	0,07	0,11	3,64
5	2135	P38	B2	69,15	13,85	4,33	0,40	1,85	3,75	3,49	1,29	0,07	0,10	1,60
5	2135	P38	BC1	68,67	13,95	4,59	0,44	1,97	3,79	3,46	1,43	0,08	0,11	1,25
5	2135	P38	BC2	67,97	13,97	5,05	0,48	2,21	3,97	3,26	1,48	0,08	0,12	1,04
5	2135	P38	C1	65,94	14,58	5,47	0,55	2,44	3,90	3,22	1,79	0,08	0,13	1,22
5	2135	P38	C2	66,61	14,60	5,43	0,53	2,41	3,96	3,33	1,71	0,08	0,14	1,12
5	2141	P39	E	73,56	11,68	3,81	1,01	1,20	2,61	2,92	1,20	0,08	0,03	1,74
5	2141	P39	B	63,27	13,68	7,96	0,73	2,21	3,47	2,95	1,15	0,10	0,07	4,34
5	2141	P39	BC1	63,01	14,83	6,67	0,71	2,41	3,94	3,09	1,22	0,10	0,09	3,63
5	2141	P39	BC2	64,44	14,46	6,74	0,74	2,42	4,05	3,18	1,26	0,10	0,08	2,24
5	2141	P39	BC3	64,82	14,36	6,83	0,76	2,49	4,18	3,19	1,25	0,10	0,12	1,67
5	2141	P39	C	64,62	14,33	6,72	0,74	2,46	4,31	3,23	1,35	0,10	0,17	1,23
5	2142	P40	E	74,96	11,48	2,39	0,81	0,89	2,16	2,54	1,62	0,05	0,04	2,26
5	2142	P40	Bhs	58,41	12,68	9,47	0,83	2,18	3,41	2,39	1,32	0,08	0,09	9,08
5	2142	P40	Bs	57,67	14,92	7,26	0,70	2,40	3,68	2,73	1,34	0,09	0,15	9,14
5	2142	P40	BC1	58,22	15,41	6,96	0,69	2,43	3,68	2,84	1,36	0,09	0,15	8,06
5	2142	P40	BC2	57,49	16,14	7,81	0,85	3,04	4,71	2,82	1,30	0,11	0,15	5,31
5	2142	P40	BC3	60,45	15,23	8,21	0,90	3,19	4,31	2,97	1,42	0,13	0,17	2,80
5	2142	P40	BC4	61,60	15,17	8,12	0,91	3,31	4,24	2,96	1,44	0,14	0,18	2,15
5	2142	P40	C	61,53	14,85	8,79	1,01	3,46	4,22	3,04	1,33	0,14	0,17	2,00
5	2142	P41	E	68,40	9,53	6,52	1,29	0,70	1,50	1,91	1,26	0,05	0,07	7,68
5	2142	P41	Bs1	54,86	12,18	17,08	0,79	1,76	2,72	2,37	1,17	0,08	0,17	6,68
5	2142	P41	Bs2	55,97	12,86	15,40	0,76	1,91	2,93	2,27	1,07	0,08	0,17	6,64
5	2142	P41	Bs3	58,48	12,89	13,44	0,76	2,10	3,19	2,56	1,11	0,09	0,15	5,32
5	2142	P41	Bs4	63,52	12,81	10,14	0,69	1,86	3,10	2,85	1,16	0,09	0,14	3,61
5	2142	P41	BC	66,50	12,78	8,35	0,66	1,67	3,07	3,05	1,07	0,09	0,11	2,60
5	2142	P41	DE	69,56	9,89	4,99	1,28	0,76	1,77	2,28	1,14	0,05	0,06	6,99
5	2142	P41	DBs1	53,55	12,13	18,36	0,82	1,89	2,88	2,29	1,08	0,08	0,19	7,21
5	2142	P41	DBs2	55,23	12,84	15,83	0,77	1,95	2,98	2,34	1,04	0,08	0,17	6,84
5	2142	P41	DBC	66,08	12,73	8,36	0,66	1,70	3,18	3,08	1,01	0,09	0,12	2,50

Table c. Major inorganic anions, pH and electric conductivity (EC) in water extraction for podzols from Skjellbekken catchment.

Catch. No	ID	Profile No	Horizon	F' µg/l	Cl' µg/l	NO2' µg/l	Br' µg/l	NO3' µg/l	PO4''' µg/l	SO4'' µg/l	pH	EC µS/cm
			Water**	0	136	0	0	0	0	0		
5	2134	P37	O	1757	2240	< 50	< 100	166,9	35111	5902,3	4,4	128,8
5	2134	P37	Ox	1604	1677	< 50	< 100	91,5	22065	5756,1	4,3	103,1
5	2135	P38	O	1196	2047	< 50	< 100	355,8	4504	2783,4	4,4	59,5
5	2141	P39	O	1532	3380	< 50	< 100	98,3	29104	5430,5	4,4	128,5
5	2142	P40	O	1950	4564	< 50	< 100	90,3	34966	7758,1	4,4	145,6
5	2142	P41	O	2295	8253	< 50	< 100	75,4	14146	9671,7	4,3	137,7
5	2134	P37	Ex	268,7	317	< 50	< 100	787,9	808,7	1252,7	5,1	22,5
5	2134	P37	Ey	211,1	228	< 50	< 100	701,8	945,8	1120,2	5,0	18,4
5	2134	P37	B1x	< 50	216	< 50	< 100	511,7	< 200	1584,2	5,0	19,4
5	2134	P37	B1y	< 50	358	< 50	< 100	869,5	< 200	1550,2	5,2	19,1
5	2134	P37	B2	< 50	200	< 50	< 100	1487	< 200	813,8	5,5	9,2
5	2134	P37	BC1	< 50	192	< 50	< 100	635,7	< 200	926	5,7	9,6
5	2134	P37	BC2	< 50	125	< 50	< 100	101,8	< 200	581,6	6,1	6,2
5	2134	P37	C1	< 50	< 100	< 50	< 100	93,7	< 200	392,2	6,1	4,9
5	2134	P37	C2	< 50	< 100	< 50	< 100	71,9	< 200	359,3	6,3	4,8
5	2135	P38	E	< 50	690	< 50	< 100	373,7	437,3	931,1	4,9	14,1
5	2135	P38	B1	< 50	509	< 50	< 100	394,1	< 200	1485,5	5,3	7,9
5	2135	P38	B2	< 50	287	< 50	< 100	299	< 200	881	5,6	5,0
5	2135	P38	BC1	< 50	150	< 50	< 100	< 50	< 200	556,6	5,7	3,1
5	2135	P38	BC2	< 50	< 100	< 50	< 100	< 50	< 200	318,7	6,0	2,2
5	2135	P38	C1	< 50	< 100	< 50	< 100	< 50	< 200	203	5,9	2,1
5	2135	P38	C2	< 50	138	< 50	< 100	< 50	< 200	299,9	6,1	2,2
5	2141	P39	E	114,8	278	< 50	< 100	58,4	1025	430	5,3	11,3
5	2141	P39	B	< 50	351	< 50	< 100	156,2	< 200	1157,7	5,3	11,7
5	2141	P39	BC1	< 50	195	< 50	< 100	471,4	< 200	886	5,8	7,5
5	2141	P39	BC2	< 50	118	< 50	< 100	143,3	< 200	1143,2	5,8	6,7
5	2141	P39	BC3	< 50	147	< 50	< 100	101,9	< 200	1291,6	5,8	6,3
5	2141	P39	C	< 50	< 100	< 50	< 100	< 50	< 200	399,6	6,1	3,3
5	2142	P40	E	110,5	234	< 50	< 100	55,9	1085	923,3	4,8	18,7
5	2142	P40	Bhs	201	458	< 50	< 100	351,2	< 200	2268,7	4,9	20,8
5	2142	P40	Bs	144,4	189	< 50	< 100	1296	< 200	981,2	5,3	10,4
5	2142	P40	BC1	< 50	174	< 50	< 100	1432	< 200	616,4	5,4	9,3
5	2142	P40	BC2	81,7	109	< 50	< 100	602,7	< 200	470,6	5,7	6,3
5	2142	P40	BC3	< 50	< 100	< 50	< 100	121,4	< 200	339,8	5,7	4,3
5	2142	P40	BC4	< 50	< 100	< 50	< 100	112	< 200	346,1	5,9	4,0
5	2142	P40	C	< 50	< 100	< 50	< 100	97,4	< 200	260,4	5,5	3,8
5	2142	P41	E	334,5	582	< 50	< 100	50,4	1073	1872,7	4,5	33,0
5	2142	P41	Bs1	148,8	438	< 50	< 100	96,7	< 200	1585,9	5,2	12,2
5	2142	P41	Bs2	54,7	672	< 50	< 100	314	< 200	2601	5,6	10,5
5	2142	P41	Bs3	< 50	1000	< 50	< 100	167	< 200	2420,6	5,7	12,8
5	2142	P41	Bs4	< 50	511	< 50	< 100	86,2	< 200	1905,4	5,8	9,5
5	2142	P41	BC	< 50	119	< 50	< 100	76,4	< 200	1233,3	6,1	6,8
5	2142	P41	DE***	204,2	805	< 50	< 100	163	1254	2112,9	4,5	34,4
5	2142	P41	DBs1	< 50	724	< 50	< 100	255,3	< 200	1670,1	5,3	13,0
5	2142	P41	DBs2	< 50	879	< 50	< 100	515,2	< 200	2180	5,7	12,1
5	2142	P41	DBC	< 50	214	< 50	< 100	< 50	< 200	1349,5	5,9	8,1

* 1:20 soil: water ratio (weight base) for organic horizon and 1:10 for mineral.

** - water used for extraction contained 136 µg/l Cl'.

*** - samples marked D befor horizon index meen that for analysis fraction < 0.5 mm was used.

Table d. Total content of carbon, organic carbon, sufur, hydrogen and nitrogen in podzols from Skjellbekken catchment, % of dry matter.

Catch. No	ID	Profile No	Horizon	S total NGU*	C total NGU	C total org NGU	C total GTK **	H GTK	N GTK
5	2134	P37	O	0,09	48,2		41	6,7	1,1
5	2134	P37	Ox	0,08	45,3		40	6,4	1
5	2135	P38	O	0,05	31,2		26,2	4,1	0,7
5	2141	P39	O	0,10	49,1		43,5	6,5	1,3
5	2142	P40	O	0,09	50,4		48,5	7,2	1,4
5	2142	P41	O	0,09	36,2		31,8	5	1
5	2134	P37	Ex	0,00	1,64	1,60	1,5	0,3	0,05
5	2134	P37	Ey	0,00	1,30	1,26	1	0,2	0,05
5	2134	P37	B1x	0,00	1,13	0,55	0,9	0,3	0,05
5	2134	P37	B1y	0,00	1,03	0,53	0,8	0,3	0,05
5	2134	P37	B2	0,00	1,02	0,27	0,9	0,3	0,05
5	2134	P37	BC1	0,00	0,78	0,27	0,6	0,3	0,05
5	2134	P37	BC2	0,00	0,32	0,11	0,2	0,1	0,05
5	2134	P37	C1	0,00	0,29	0,12	0,2	0,05	0,05
5	2134	P37	C2	0,00	0,31	0,11	0,2	0,1	0,05
5	2135	P38	E	0,00	3,23	3,11	2,6	0,3	0,05
5	2135	P38	B1	0,00	0,92	0,52	0,7	0,3	0,1
5	2135	P38	B2	0,00	0,25	0,13	0,2	0,1	0,05
5	2135	P38	BC1	0,00	0,17	0,07	0,05	0,1	0,05
5	2135	P38	BC2	0,00	0,14	0,07	0,05	0,1	0,05
5	2135	P38	C1	0,00	0,08	0,06	0,05	0,05	0,05
5	2135	P38	C2	0,00	0,08	0,07	0,05	0,1	0,05
5	2141	P39	E	0,00	0,70	0,66	0,6	0,1	0,05
5	2141	P39	B	0,00	0,97	0,73	0,8	0,3	0,05
5	2141	P39	BC1	0,00	0,61	0,45	0,5	0,3	0,05
5	2141	P39	BC2	0,00	0,36	0,31	0,3	0,2	0,05
5	2141	P39	BC3	0,00	0,21	0,13	0,2	0,2	0,05
5	2141	P39	C	0,00	0,12	0,05	0,05	0,1	0,05
5	2142	P40	E	0,00	0,86	0,86	0,8	0,2	0,05
5	2142	P40	Bhs	0,02	2,82	2,14	2,4	0,6	0,1
5	2142	P40	Bs	0,00	2,35	1,64	1,9	0,6	0,1
5	2142	P40	BC1	0,00	1,87	1,36	1,5	0,6	0,1
5	2142	P40	BC2	0,00	1,06	0,79	0,8	0,4	0,05
5	2142	P40	BC3	0,00	0,39	0,25	0,3	0,2	0,05
5	2142	P40	BC4	0,00	0,19	0,14	0,2	0,2	0,05
5	2142	P40	C	0,00	0,15	0,17	0,1	0,2	0,05
5	2142	P41	E	0,01	3,25	3,04	2,5	0,5	0,1
5	2142	P41	Bs1	0,04	1,20	0,84	0,9	0,6	0,1
5	2142	P41	Bs2	0,05	0,91	0,66	0,7	0,5	0,05
5	2142	P41	Bs3	0,04	0,75	0,61	0,6	0,4	0,05
5	2142	P41	Bs4	0,10	0,52	0,38	0,4	0,3	0,05
5	2142	P41	BC	0,09	0,28	0,20	0,1	0,2	0,05
5	2142	P41	DE	0,01	3,37	3,01	2,1	0,4	0,2
5	2142	P41	DBs1	0,06	1,51	0,82	0,9	0,6	0,1
5	2142	P41	DBs2	0,06	1,05	0,56	0,7	0,6	0,1
5	2142	P41	DBC	0,10	0,29	0,14	0,05	0,2	0,05

* - analysed in the analytical laboratory of GTK;
** - analysed in analytical laboratory of NGU.

Table e. Content of microelements extracted by aqua regia in mineral horizons of podzols from Skjelbekken catchment, mg/kg of dry matter.

Catch. No	ID	Profile No	Horizon	Ba	Co	Cr	Cu	Mo	Ni	Pb	Sr	V	Zn
5	2134	P37	Ex	13,7	1,3	9,2	1,6	< 1	1,8	3,7	3	47,4	7,9
5	2134	P37	Ey	9,3	0,8	6	< 0,5	< 1	1,3	1,8	2,9	17,5	5,7
5	2134	P37	B1x	16,6	4,7	26,1	5,9	< 1	8	1,6	5,7	66,3	42,8
5	2134	P37	B1y	21,9	6,6	32,4	9,7	< 1	12,2	1,2	7,1	59,8	60,7
5	2134	P37	B2	36,3	10,7	28,6	17,9	< 1	13,2	2,1	7,6	49	74,7
5	2134	P37	BC1	43,2	9,6	32,9	48,6	1,3	21,5	1,9	10,6	54,8	63,3
5	2134	P37	BC2	42	11,2	22,1	58,1	< 1	21,9	1,2	10,5	50,6	45,2
5	2134	P37	C1	32,7	11,3	17,5	42,7	< 1	19,4	1	8,5	47,4	45,2
5	2134	P37	C2	39,3	10,8	20,3	35,3	< 1	20,8	1,5	9,7	39,3	46,8
5	2135	P38	E	8,6	0,8	5,2	2,3	< 1	3,3	2,5	3,2	13,1	4,8
5	2135	P38	B1	16,7	3,6	15,3	11,7	< 1	8,4	1,4	6	27,1	20,2
5	2135	P38	B2	20,2	4	13,4	12,8	< 1	9,2	1,4	8,4	21,8	22,1
5	2135	P38	BC1	34,5	5	14	15,7	< 1	10,3	1,6	7,6	21,1	26,7
5	2135	P38	BC2	52,3	5,9	18,7	22,5	< 1	13,3	2	9	28,3	29,4
5	2135	P38	C1	73,1	7,2	25,1	29,2	< 1	16,8	2,3	9,4	36,3	37,3
5	2135	P38	C2	62,1	6,5	22,6	25,7	< 1	14,2	2,4	9,3	33,1	32,9
5	2141	P39	E	5,3	0,8	3,6	0,25	< 1	1	2,2	2,3	12,7	3,4
5	2141	P39	B	16,4	7,6	20,4	7,9	< 1	8,6	0,9	5	59,2	36,4
5	2141	P39	BC1	28,7	7,3	22,1	18,7	< 1	14,2	1,5	7,3	40,5	30,9
5	2141	P39	BC2	27,6	6,9	20,4	24,5	< 1	13,6	1,3	7,2	39,3	28
5	2141	P39	BC3	32,2	7,6	19,9	29,9	< 1	14,8	1,3	8,6	44,3	31,4
5	2141	P39	C	50,1	10,5	21	35,1	< 1	16,6	1,8	11	43,3	35,3
5	2142	P40	E	8,2	0,8	6,6	0,25	< 1	1,1	3,1	3,1	19	4
5	2142	P40	Bhs	14,3	4,9	30,3	5,7	< 1	8,1	1,9	4,9	91,9	27,3
5	2142	P40	Bs	27,8	10,7	32,5	13	< 1	15	2	7	47,6	53,6
5	2142	P40	BC1	29,8	13,5	28,3	21,7	< 1	22,2	1,7	7,2	42,7	55,8
5	2142	P40	BC2	37,4	15	31,3	32,1	< 1	34,2	1,3	8,2	47,8	53,4
5	2142	P40	BC3	53,5	19,7	30,8	60,2	< 1	56,9	1,4	10,1	62,3	48,5
5	2142	P40	BC4	62,1	19,5	35,6	58,3	< 1	48,1	1,3	11,9	75,7	51,9
5	2142	P40	C	58,8	20	32,4	64,2	< 1	35,7	1,1	10,1	77,3	54,5
5	2142	P41	E	9,7	1,3	9,8	9,2	6,9	6,4	1,9	2,5	91,7	23,9
5	2142	P41	Bs1	29,9	5,3	34,8	35,4	3,4	9,5	1,4	4,7	58,1	62,3
5	2142	P41	Bs2	62,8	6	31,3	36	3	11,9	1,4	7,8	57	47,9
5	2142	P41	Bs3	53,4	5,5	33,3	33,1	2,2	11,6	1,4	12,1	61,7	29,1
5	2142	P41	Bs4	75,3	6,4	23,4	32,6	2,1	13,8	1	14,1	48,4	30,6
5	2142	P41	BC	58,6	9,4	18,8	33,3	1,4	26,7	0,6	13,4	43,4	37,9
5	2142	P41	DE	9	1,2	7,7	6,4	5,3	4,6	1,7	2,8	66,3	16,2
5	2142	P41	DBs1	30,2	5,3	35,8	33,5	2,7	9,9	1,7	5	61,4	63,2
5	2142	P41	DBs2	58,9	6,3	33,2	37	2,7	11,1	1,6	7,4	59,4	49,9
5	2142	P41	DBC	57,5	9,2	17,7	33,3	< 1	24,8	0,7	13,4	41,4	34,9

Table f. Content of rare elements extracted by aqua regia in mineral horizons of podzols from Skjellbekken catchment, mg/kg of dry matter.

Catch. No	ID	Profile No	Horizon	Ag	As	B	Bi	Cd	Hg	La	Li	Sb	Sc	Se	Te	Th	Y
5	2134	P37	Ex	0,06	2,5	< 3	0,05	0,02	<0.03	5,6	< 0,7	0,03	0,8	0,08	0,02	< 5	1,3
5	2134	P37	Ey	0,06	0,8	< 3	0,03	0,02	<0.03	7,1	< 0,7	0,02	0,7	0,02	< 0,01	< 5	1,3
5	2134	P37	B1x	0,02	1,8	< 3	0,05	0,03	<0.03	6,3	3,9	< 0,01	2	0,22	0,02	< 5	2
5	2134	P37	B1y	0,02	2,2	< 3	0,04	0,03	<0.03	6,1	8	< 0,01	2,7	0,21	0,01	< 5	2,2
5	2134	P37	B2	0,02	1,3	< 3	0,02	0,05	<0.03	7,7	11,8	< 0,01	3,7	0,42	< 0,01	< 5	3,5
5	2134	P37	BC1	0,1	7,7	< 3	0,04	0,05	<0.03	15,5	9,8	< 0,01	5,8	0,8	0,01	< 5	6,2
5	2134	P37	BC2	0,02	8	< 3	0,06	0,07	<0.03	14,8	5,7	0,06	5,1	0,6	0,04	< 5	6,2
5	2134	P37	C1	0,02	6,6	< 3	0,02	0,06	<0.03	10,9	5,2	0,04	4,6	0,52	0,02	< 5	5
5	2134	P37	C2	0,02	3,1	< 3	0,04	0,06	<0.03	11,8	6,3	< 0,01	3,9	0,29	0,02	< 5	5,3
5	2135	P38	E	0,01	0,4	< 3	0,02	0,03	<0.03	2,2	< 0,7	< 0,01	0,5	0,04	< 0,01	< 5	0,7
5	2135	P38	B1	0,02	0,3	3	0,03	< 0.01	<0.03	5,7	5,8	< 0,01	1,9	0,1	< 0,01	< 5	2,2
5	2135	P38	B2	0,01	0,3	< 3	0,03	0,01	<0.03	6,2	5,6	< 0,01	2	0,04	0,01	< 5	2,6
5	2135	P38	BC1	0,01	0,2	< 3	0,04	< 0.01	<0.03	6,8	6,7	< 0,01	1,9	< 0,01	< 0,01	< 5	2,5
5	2135	P38	BC2	0,01	0,3	< 3	0,03	0,02	<0.03	7,6	8	< 0,01	2,5	0,02	< 0,01	< 5	3,3
5	2135	P38	C1	0,01	0,3	< 3	0,03	0,02	<0.03	9,9	10,4	0,04	3,2	0,11	0,04	< 5	4
5	2135	P38	C2	0,02	0,2	< 3	0,06	0,02	<0.03	9,7	8,8	0,03	2,9	0,09	0,02	< 5	4,1
5	2141	P39	E	0,03	0,5	< 3	0,05	< 0.01	<0.03	6,4	< 0,7	0,04	0,7	0,04	< 0,01	< 5	1,1
5	2141	P39	B	0,02	10,1	< 3	0,07	0,04	<0.03	4,5	6,3	0,03	3	0,18	0,03	< 5	2,3
5	2141	P39	BC1	0,09	15,5	< 3	0,03	0,03	0,04	9,5	7,3	0,01	6	0,26	0,02	< 5	6,1
5	2141	P39	BC2	0,04	11,8	< 3	0,04	0,04	0,03	11	6,5	0,02	5,5	0,2	0,02	< 5	6,3
5	2141	P39	BC3	0,04	6,3	< 3	0,04	0,06	0,03	13,5	6,5	0,02	5,3	0,16	0,02	< 5	7,2
5	2141	P39	C	0,01	4	< 3	0,06	0,06	<0.03	17,9	6,5	0,01	4,6	0,14	0,02	5	7,6
5	2142	P40	E	0,09	0,2	< 3	0,06	0,02	<0.03	12,4	< 0,7	< 0,01	0,6	0,02	< 0,01	< 5	1,7
5	2142	P40	Bhs	0,07	0,5	< 3	0,06	0,03	0,06	7,2	3,5	< 0,01	2,7	0,32	0,02	< 5	2,6
5	2142	P40	Bs	0,02	0,6	< 3	0,06	0,03	0,03	9,8	9,7	0,03	4,6	0,36	0,03	< 5	5,4
5	2142	P40	BC1	0,03	0,8	< 3	0,06	0,04	0,03	9,5	10,9	0,02	4,7	0,28	< 0,01	< 5	5,8
5	2142	P40	BC2	0,03	0,9	< 3	0,06	0,05	0,04	13,2	11,9	0,02	5,2	0,27	< 0,01	< 5	6,6
5	2142	P40	BC3	0,02	1,1	< 3	0,06	0,06	<0.03	15,2	9,4	< 0,01	5,9	0,19	< 0,01	6	8
5	2142	P40	BC4	0,02	1,4	< 3	0,04	0,06	<0.03	17,9	9,2	< 0,01	7	0,14	< 0,01	7	9,2
5	2142	P40	C	0,02	1,3	< 3	0,06	0,05	<0.03	17,2	8,8	0,08	6,5	0,2	0,04	6	8,3
5	2142	P41	E	0,11	10,4	< 3	0,08	0,02	<0.03	5,5	< 0,7	0,23	0,6	0,38	0,09	< 5	1,2

			Horizon	Ag	As	B	Bi	Cd	Hg	La	Li	Sb	Sc	Se	Te	Th	Y
5	2142	P41	Bs1	0,09	25,8	< 3	0,09	0,02	<0.03	4,3	7	0,23	2,2	1,57	0,07	< 5	1,5
5	2142	P41	Bs2	0,18	32,8	< 3	0,07	0,04	0,04	6	5,8	0,21	3,2	2,1	0,06	< 5	2
5	2142	P41	Bs3	0,22	22,5	< 3	0,08	0,06	0,07	7,9	4,5	0,22	3,8	1,85	0,04	< 5	2,8
5	2142	P41	Bs4	0,14	32,4	< 3	0,03	0,04	0,04	6,4	5,4	0,15	3,3	1,5	0,03	< 5	2,6
5	2142	P41	BC	0,1	18,1	< 3	0,04	0,07	<0.03	8,8	7,1	0,07	3,8	0,74	0,02	< 5	3,5
5	2142	P41	DE	0,12	4,4	< 3	0,06	0,02	<0.03	5,5	< 0,7	0,14	0,7	0,19	0,06	< 5	1,2
5	2142	P41	DBs1	0,09	21,6	< 3	0,07	0,02	<0.03	4,8	6,4	0,25	2,4	1,34	0,07	< 5	1,7
5	2142	P41	DBs2	0,19	31	< 3	0,04	0,04	0,04	6,3	5,4	0,23	3,3	1,92	0,09	< 5	2,1
5	2142	P41	DBC	0,11	16,6	< 3	0,02	0,06	<0.03	9,3	6,1	0,09	3,8	0,83	0,03	< 5	3,7

Table g. Content of major elements extracted by ammonium acetate (pH 4.5) in mineral horizons of podzols from Skjellbekken catchment, mg/kg of dry matter.

Catch. No	ID	Profile No	Horizon	Al	Ca	Fe	K	Mg	Mn	Na	P	S	Si	Ti
5	2134	P37	Ex	34,9	53,1	55,4	37	14,6	9,46	4,9	4,2	7,2	4	0,69
5	2134	P37	Ey	30,5	66,2	22,8	34	14,5	4,54	5,8	4,2	6	3	0,46
5	2134	P37	B1x	345	95	348	< 20	12,7	16,7	4,4	2	32,8	13	0,91
5	2134	P37	B1y	326	113	289	< 20	13,5	15,9	4,7	2	35,1	15	0,8
5	2134	P37	B2	1060	60,4	224	< 20	3,9	8,52	3,4	2,9	26,3	65	0,67
5	2134	P37	BC1	815	79,3	81,8	< 20	9,1	2,66	4,8	3,7	21,8	87	0,78
5	2134	P37	BC2	408	39,5	60,8	< 20	6,9	0,71	3	2	7,6	49	0,54
5	2134	P37	C1	414	29,8	68,7	< 20	4,1	0,84	2,2	2,1	6	48	0,62
5	2134	P37	C2	490	35,3	62,4	< 20	4,9	0,67	2,7	1,9	5,8	55	1,06
5	2135	P38	E	141	22,6	78,4	22	6,6	0,59	8,4	5,5	6,7	3	0,65
5	2135	P38	B1	736	4,5	72,1	< 20	1,3	2,41	2,7	5,1	35,1	54	0,57
5	2135	P38	B2	328	2,4	20,9	< 20	< 0,5	1,02	1,3	3	25	41	0,37
5	2135	P38	BC1	221	3,8	13,3	< 20	< 0,5	0,67	1,2	1,9	7,5	29	0,48
5	2135	P38	BC2	159	4,2	8,7	< 20	< 0,5	0,43	1,4	1,9	3,9	22	0,43
5	2135	P38	C1	177	6,3	9,6	< 20	< 0,5	0,17	2,1	1,7	2,3	26	0,42
5	2135	P38	C2	161	7,3	9,6	< 20	0,6	0,25	2,4	2,2	2,2	25	0,43
5	2141	P39	E	24,7	31	12,7	24	10,3	2,04	4,6	4,1	3,1	2	0,29
5	2141	P39	B	564	29,7	111	< 20	5,3	5,7	3	1,8	34,3	37	0,5
5	2141	P39	BC1	742	20,2	51,8	< 20	2,7	0,57	3	5,3	37,1	119	1,57
5	2141	P39	BC2	496	20,3	50,8	< 20	2,7	0,5	3,4	6,5	29,1	98	1,97
5	2141	P39	BC3	269	12,2	29,4	< 20	1,9	0,39	3,2	8,9	24,2	51	1,15
5	2141	P39	C	213	10,3	21,1	< 20	1	0,29	3,3	4,3	3	41	0,72
5	2142	P40	E	53,8	23,4	16,9	25	10,4	0,74	5,1	2,6	5,4	3	0,29
5	2142	P40	Bhs	885	22,3	571	< 20	7,3	0,38	5,1	4,1	82,5	23	1,84
5	2142	P40	Bs	1840	32,8	341	< 20	3,1	4,58	3,8	6,4	34	107	1,79
5	2142	P40	BC1	1830	31,4	268	< 20	2,1	7,55	4,1	6,5	32	122	1,58
5	2142	P40	BC2	1230	29,4	107	< 20	1,4	3,61	4,3	5,5	19,4	107	1,6
5	2142	P40	BC3	562	25,2	62,1	< 20	1	1,53	4	4,1	6,2	62	1,22
5	2142	P40	BC4	375	23,4	45,3	< 20	1,3	1,17	4,2	3,2	3,9	51	0,98
5	2142	P40	C	330	17,1	41,7	< 20	1,1	0,99	3	2,3	3,6	45	0,73
5	2142	P41	E	44,8	46	72,6	46	21,9	1,45	9,1	5,9	19,3	3	0,18
5	2142	P41	Bs1	589	24,2	143	< 20	5,5	5,78	5,2	2,6	54,1	38	0,25
5	2142	P41	Bs2	775	21,5	75,3	< 20	5,7	1,85	8,5	2,3	99,4	117	0,25
5	2142	P41	Bs3	528	31	89,2	< 20	9,8	1,41	13,1	2,2	88,7	79	0,41
5	2142	P41	Bs4	342	27,4	51,4	< 20	6,6	1,79	6,1	1,8	40,4	55	0,25
5	2142	P41	BC	134	54,5	34,1	< 20	7,5	1,55	4,6	1,1	15,6	25	0,24
5	2142	P41	E	45,4	44,4	69,7	49	20,4	1,44	8,7	6,1	15,8	3	0,22
5	2142	P41	Bs1	754	27,8	184	< 20	6,5	7,86	5,3	3,8	67	47	0,33
5	2142	P41	Bs2	893	23,7	86,6	< 20	6	2,34	8,9	3	108	130	0,27
5	2142	P41	BC	175	53,6	59,9	< 20	7,3	2,13	3,8	1,6	18,3	34	0,43

Table h. Content of major elements extracted by nitric acid in organic horizon of podzols from Skjellbekken catchment, mg/kg of dry matter.

Catch. No	ID	Profile No	Horizon	Al	K	Ca	Fe	Mg	Mn	Na	P	S	Si	Ti	Zn
5	2134	P37	O	1210	951	2630	1630	500	831	50	918	1270	260	207	92,4
5	2134	P37	Ox	1630	919	2170	3160	600	469	60	769	1070	280	243	54,5
5	2135	P38	O	4570	716	1530	5510	880	67,2	140	557	808	320	464	25,9
5	2141	P39	O	1340	771	3160	2270	690	319	50	891	1560	190	170	64,8
5	2142	P40	O	680	1050	3160	910	590	303	60	882	1750	200	55,8	52,9
5	2142	P41	O	2740	1170	1950	26000	890	133	100	732	1380	280	215	70,7

Table i. Contenet of major elements extracted by aqua regia in mineral horizons of podzols from Skjellbekken catchment, mg/kg of dry matter.

Catch. No	ID	Profile No	Horizon	Al	Ca	Fe	K	Mg	Mn	Na	P	S	Si	Ti
5	2134	P37	Ex	1840	690	17100	300	580	56	140	166	77	240	1330
5	2134	P37	Ey	1430	580	3460	300	380	39	140	76	46	240	663
5	2134	P37	B1x	8490	1710	35600	700	3140	156	230	323	105	170	1700
5	2134	P37	B1y	11300	2160	37000	700	4670	208	290	319	111	160	1610
5	2134	P37	B2	16000	2910	26300	1100	5080	290	270	554	109	200	1210
5	2134	P37	BC1	18400	4170	30200	1000	6500	228	440	573	127	230	1300
5	2134	P37	BC2	11900	4850	22700	1300	5740	220	460	737	50	250	1040
5	2134	P37	C1	10500	4310	20100	1000	5200	199	400	701	41	210	851
5	2134	P37	C2	10500	4280	16800	1300	4790	194	370	708	33	230	929
5	2135	P38	E	1850	570	3590	200	490	27	140	89	68	210	317
5	2135	P38	B1	9590	1870	12100	500	2870	105	210	413	83	180	746
5	2135	P38	B2	7750	2760	9550	800	2840	119	350	388	47	260	593
5	2135	P38	BC1	7070	2440	9600	1500	3290	161	310	336	22	190	657
5	2135	P38	BC2	8290	3040	12800	2300	4430	178	360	443	19	160	900
5	2135	P38	C1	10300	3450	16400	3200	5990	200	370	520	16	170	1190
5	2135	P38	C2	9130	3490	14700	2600	5190	180	350	544	15	160	1060
5	2141	P39	E	1380	610	2720	< 200	510	51	140	57	29	200	584
5	2141	P39	B	11900	1850	29900	400	4030	168	240	224	99	250	1240
5	2141	P39	BC1	15100	2810	17800	700	4570	164	340	319	108	280	1000
5	2141	P39	BC2	11300	2870	16900	700	4540	170	360	262	65	180	1060
5	2141	P39	BC3	11100	3740	18700	1000	5220	192	410	484	51	460	1100
5	2141	P39	C	10700	5050	18600	1500	5530	233	470	695	20	270	1150
5	2142	P40	E	1570	510	3080	200	380	43	140	69	52	240	915
5	2142	P40	Bhs	11400	1520	45700	600	2800	116	210	298	259	200	2140
5	2142	P40	Bs	20600	2970	26800	1100	4830	236	260	608	162	910	1120
5	2142	P40	BC1	21800	3170	24900	1300	5400	240	270	631	138	910	1050
5	2142	P40	BC2	19400	3810	24000	1300	6700	240	330	628	90	550	1110
5	2142	P40	BC3	16700	4800	27000	1700	8900	372	400	732	43	400	1290
5	2142	P40	BC4	18000	5750	30900	2000	10800	458	480	768	30	320	1540
5	2142	P40	C	17800	5030	32000	1900	11500	468	390	764	30	330	1380
5	2142	P41	E	1840	350	39700	300	410	109	90	278	230	310	688
5	2142	P41	Bs1	12700	1050	1E+05	1000	3580	165	180	769	704	450	1290
5	2142	P41	Bs2	16500	1370	92900	1300	4140	166	240	683	745	640	1540
5	2142	P41	Bs3	14500	1830	85100	1100	4690	163	290	638	670	520	1680
5	2142	P41	Bs4	10100	1580	55200	1100	3820	187	310	592	1350	600	1170
5	2142	P41	BC	8600	1530	41400	1000	3720	228	310	453	1140	470	1050
5	2142	P41	DE	1850	460	23900	300	440	74	110	189	158	290	639
5	2142	P41	DBs1	13500	1390	1E+05	1000	3320	154	240	832	652	500	1370
5	2142	P41	DBs2	17800	1490	99900	1300	4020	160	250	776	722	700	1650
5	2142	P41	DBC	7910	1490	41100	900	3140	224	300	467	1150	520	1040

Table j. Content of micro and rare elements extracted by ammonium acetate (pH 4.5) in mineral horizons of podzols from Skjellbekken catchment, mg/kg of dry matter.

Catch. No	ID	Profile No	Horizon	As	B	Ba	Cd	Co	Cr	Cu	Li	Mo	Ni	Pb	Sb	Sr	V
5	2134	P37	Ex	0,01	< 0.1	3,44	0,01	< 0.02	0,08	0,06	< 0.05	< 0.05	0,26	0,2	< 0,5	0,29	0,18
5	2134	P37	Ey	< 0,01	< 0.1	3,31	0,011	0,03	0,06	0,05	< 0.05	< 0.05	0,25	< 0.2	< 0,5	0,43	0,11
5	2134	P37	B1x	0,01	< 0.1	3,99	0,01	0,06	0,45	0,12	< 0.05	< 0.05	0,22	< 0.2	< 0,5	0,77	0,03
5	2134	P37	B1y	0,01	< 0.1	3,98	0,011	0,06	0,52	0,14	< 0.05	< 0.05	0,23	< 0.2	< 0,5	0,75	0,03
5	2134	P37	B2	0,01	< 0.1	3,43	0,011	0,22	0,98	0,27	< 0.05	< 0.05	0,14	< 0.2	< 0,5	0,41	0,03
5	2134	P37	BC1	0,02	< 0.1	6,56	0,005	0,16	0,55	0,47	< 0.05	< 0.05	0,17	< 0.2	< 0,5	0,67	0,06
5	2134	P37	BC2	0,04	< 0.1	5,03	0,003	0,07	0,16	0,68	< 0.05	< 0.05	0,12	< 0.2	< 0,5	0,37	< 0.02
5	2134	P37	C1	0,03	< 0.1	4,12	0,003	0,09	0,18	0,65	< 0.05	< 0.05	0,15	< 0.2	< 0,5	0,25	< 0.02
5	2134	P37	C2	0,02	< 0.1	4,6	0,003	0,08	0,22	0,89	< 0.05	< 0.05	0,18	< 0.2	< 0,5	0,31	0,02
5	2135	P38	E	0,01	< 0.1	1,46	0,008	0,04	0,08	0,04	< 0.05	< 0.05	0,47	0,4	< 0,5	0,36	0,05
5	2135	P38	B1	0,01	< 0.1	0,96	0,002	0,03	0,31	0,15	< 0.05	< 0.05	0,08	< 0.2	< 0,5	0,1	0,06
5	2135	P38	B2	< 0,01	< 0.1	0,89	0,001	< 0.02	0,14	0,11	< 0.05	< 0.05	< 0.05	< 0.2	< 0,5	< 0.05	0,04
5	2135	P38	BC1	0,01	< 0.1	1,45	< 0.001	< 0.02	0,11	0,13	< 0.05	< 0.05	< 0.05	< 0.2	< 0,5	0,07	0,02
5	2135	P38	BC2	0,01	< 0.1	1,83	< 0.001	< 0.02	0,07	0,18	< 0.05	< 0.05	< 0.05	< 0.2	< 0,5	0,08	0,02
5	2135	P38	C1	0,02	< 0.1	4,76	< 0.001	< 0.02	0,06	0,28	< 0.05	< 0.05	< 0.05	< 0.2	< 0,5	0,16	< 0.02
5	2135	P38	C2	0,01	< 0.1	5,84	< 0.001	< 0.02	0,06	0,27	< 0.05	< 0.05	< 0.05	< 0.2	< 0,5	0,15	0,02
5	2141	P39	E	0,01	< 0.1	0,78	0,007	0,03	0,03	0,09	< 0.05	< 0.05	0,14	0,4	< 0,5	0,19	0,07
5	2141	P39	B	0,02	< 0.1	2,76	0,011	0,11	0,33	0,18	< 0.05	< 0.05	0,2	< 0.2	< 0,5	0,24	0,07
5	2141	P39	BC1	0,11	< 0.1	5,11	0,003	0,09	0,42	0,47	< 0.05	< 0.05	0,09	< 0.2	< 0,5	0,2	0,33
5	2141	P39	BC2	0,13	< 0.1	5,54	0,003	0,05	0,23	0,62	< 0.05	< 0.05	0,08	< 0.2	< 0,5	0,22	0,3
5	2141	P39	BC3	0,08	< 0.1	4,72	0,002	0,06	0,1	0,49	< 0.05	< 0.05	< 0.05	< 0.2	< 0,5	0,22	0,16
5	2141	P39	C	0,06	< 0.1	11,6	0,001	0,05	0,05	0,46	< 0.05	< 0.05	< 0.05	< 0.2	< 0,5	0,34	0,03
5	2142	P40	E	0,01	< 0.1	1,12	0,001	0,04	0,04	0,04	< 0.05	< 0.05	0,17	0,3	< 0,5	0,26	0,07
5	2142	P40	Bhs	0,02	< 0.1	2,02	0,008	0,07	0,89	0,16	< 0.05	< 0.05	0,28	< 0.2	< 0,5	0,37	0,28
5	2142	P40	Bs	0,02	< 0.1	1,95	0,006	0,16	1,53	0,3	< 0.05	< 0.05	0,11	< 0.2	< 0,5	0,37	0,09
5	2142	P40	BC1	0,01	< 0.1	2,3	0,006	0,3	1,3	0,51	< 0.05	< 0.05	0,13	< 0.2	< 0,5	0,35	0,07
5	2142	P40	BC2	< 0,01	< 0.1	3,81	0,003	0,21	0,82	0,42	< 0.05	< 0.05	0,1	< 0.2	< 0,5	0,35	0,07
5	2142	P40	BC3	0,01	< 0.1	7,41	0,002	0,13	0,39	0,61	< 0.05	< 0.05	0,13	< 0.2	< 0,5	0,35	0,03
5	2142	P40	BC4	0,01	< 0.1	11,7	0,001	0,09	0,23	0,57	< 0.05	< 0.05	0,09	< 0.2	< 0,5	0,44	0,05
5	2142	P40	C	0,02	< 0.1	7,97	0,001	0,07	0,19	0,58	< 0.05	< 0.05	0,08	< 0.2	< 0,5	0,23	0,02
5	2142	P41	E	0,01	< 0.1	2,28	0,011	0,06	0,06	0,19	< 0.05	< 0.05	0,78	0,5	< 0,5	0,4	0,07
5	2142	P41	Bs1	< 0,01	< 0.1	1,45	0,007	0,07	0,28	0,2	< 0.05	< 0.05	0,26	< 0.2	< 0,5	0,23	< 0.02
5	2142	P41	Bs2	0,01	< 0.1	1,73	0,006	0,05	0,24	0,21	< 0.05	< 0.05	< 0.05	< 0.2	< 0,5	0,18	< 0.02
5	2142	P41	Bs3	< 0,01	< 0.1	2,51	0,006	0,07	0,13	0,25	< 0.05	< 0.05	0,07	< 0.2	< 0,5	0,26	0,02
5	2142	P41	Bs4	< 0,01	< 0.1	2,23	0,003	0,09	0,06	0,21	< 0.05	< 0.05	0,08	< 0.2	< 0,5	0,22	< 0.02
5	2142	P41	BC	< 0,01	< 0.1	2,91	0,002	0,06	< 0.02	0,28	< 0.05	< 0.05	0,15	< 0.2	< 0,5	0,3	< 0.02
5	2142	P41	DE	0,01	< 0.1	2,4	0,015	0,07	0,07	0,2	< 0.05	< 0.05	0,76	0,7	< 0,5	0,39	0,08
5	2142	P41	DBs1	0,02	< 0.1	1,78	0,011	0,12	0,39	0,26	< 0.05	< 0.05	0,31	< 0.2	< 0,5	0,33	< 0.02
5	2142	P41	DBs2	0,02	< 0.1	1,89	0,009	0,08	0,28	0,24	< 0.05	< 0.05	0,05	< 0.2	< 0,5	0,2	< 0.02
5	2142	P41	DBC	0,02	< 0.1	3,19	0,004	< 0.02	0,05	0,36	< 0.05	< 0.05	0,15	< 0.2	< 0,5	0,31	< 0.02

Table k. Content of microelements extracted by nitric acid in organic horizon of podzols from Skjellbekken catchment, mg/kg of dry matter.

Catch. No	ID	Profile No	Horizon	Ba	Co	Cr	Mo	Ni	Pb	Sr	V	Cu	Zn
5	2134	P37	O	113	1,38	2,63	0,3	18,7	11,2	12,1	5,09	14,9	92,4
5	2134	P37	Ox	80,9	1,23	3,54	0,31	21,8	9,72	8,42	7,18	16,2	54,5
5	2135	P38	O	28	2,39	8,19	0,23	42	21,2	11,8	12,8	29,2	25,9
5	2141	P39	O	55,3	1,98	2,65	0,24	38,8	14,4	16,1	7,52	26,3	64,8
5	2142	P40	O	61,5	1,95	2,3	0,19	42	17,8	12,8	3,37	29,1	52,9
5	2142	P41	O	69,6	2,17	8,81	4,67	44	14,9	13,2	26,1	33,6	70,7

Table l. Content of rare elements extracted by nitric acid in organic horizon of podzols from Skjellbekken catchment, mg/kg of dry matter.

Catch. No	ID	Profile No	Horizon	Hg	Ag	As	B	Be	Bi	Cd	Rb	Sb	Se	Th	Tl	U	La	Li	Sc	Y
5	2134	P37	O	0,29	2,05	1,21	2,08	< 0,6	< 0.2	0,22	5,54	< 0.2	< 1	0,72	< 0.2	< 0.2	2,5	< 0.7	0,6	0,6
5	2134	P37	Ox	0,24	1,04	1,5	2,31	< 0,6	< 0.2	0,18	5,32	< 0.2	< 1	0,43	< 0.2	< 0.2	2	0,35	0,7	0,9
5	2135	P38	O	0,13	< 0,2	2,06	1,15	< 0,6	< 0.2	0,17	6,09	< 0.2	< 1	0,5	< 0.2	< 0.2	2,5	1	1,3	1,7
5	2141	P39	O	0,3	0,46	2,15	1,79	< 0,6	< 0.2	0,32	3,26	< 0.2	< 1	0,5	< 0.2	< 0.2	1,7	0,35	0,5	0,5
5	2142	P40	O	0,29	0,37	1,82	2,14	< 0,6	< 0.2	0,33	8,04	0,21	< 1	< 0.2	< 0.2	< 0.2	0,8	0,35	0,2	0,3
5	2142	P41	O	0,25	0,54	10,8	1,8	< 0,6	< 0.2	0,28	6,19	< 0.2	< 1	0,59	< 0.2	0,36	2,3	1,1	0,8	1,5

Table m. Content of major elements extracted by ammonium acetate (pH 4.5) in organic horizon of podzols from Skjellbekken catchment, mg/kg dry matter.

Catch. No	ID	Profile No	Horizon	Al	Ca	Fe	K	Mg	Mn	Na	P	S	Si	Ti
5	2134	P37	O	17,2	1590	5,9	616	269	541	21,9	190	79,8	7	0,12
5	2134	P37	Ox	25,7	1330	7,9	598	305	337	19,8	150	80,6	9	0,12
5	2135	P38	O	269	477	84,2	266	105	20,9	54,1	35,7	54	12	0,36
5	2141	P39	O	34,9	1960	7,8	565	461	218	34	153	78,7	11	0,07
5	2142	P40	O	19,1	1970	3,6	811	413	206	45,9	214	110	14	< 0.05
5	2142	P41	O	68,6	1100	25,9	687	351	61,5	64,4	78,9	116	13	0,14

Table n. Content of micro and rare elements extracted by ammonium acetate (pH 4.5) in organic horizon of podzols from Skjellbekken . catchment, mg/kg of dry matter.

Catch. No	ID	Profile No	Horizon	B	Ba	Co	Cr	Cu	Li	Ni	Pb	Sb	Sr	V	Zn	As	Cd
5	2134	P37	O	< 0.1	40,7	0,31	0,17	0,3	< 0.05	2,45	2,4	< 0.5	6,38	0,05	44	0,03	0,11
5	2134	P37	Ox	< 0.1	33,8	0,3	0,13	0,36	< 0.05	3,6	2,5	< 0.5	4,16	0,05	27,3	0,03	0,1
5	2135	P38	O	< 0.1	9,39	0,45	0,09	1,13	< 0.05	8,92	7,3	< 0.5	4,78	0,15	12,1	0,03	0,1
5	2141	P39	O	< 0.1	20,1	0,49	0,09	0,43	< 0.05	5,11	3,7	< 0.5	9,2	0,09	29,6	0,04	0,19
5	2142	P40	O	< 0.1	22	0,38	0,07	0,38	< 0.05	4,51	4,2	< 0.5	6,96	0,04	20,6	0,02	0,2
5	2142	P41	O	< 0.1	21,4	0,47	0,08	0,76	< 0.05	6,09	4	< 0.5	6,39	0,11	30,8	0,04	0,12

Appendix

for Quaternary deposits

Analysis from GTK. Analysis below detection limit = det. limit/2

*ID	*Med	Catch	No	Ag	Al	As	B	Ba	Ca	Cd	Co	Cr	Cu	Fe	K	La	Li	Mg	Mn	Mo	Na	Ni	P	Pb	S
				ppm	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm
				511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P	511P
94 50422Q	Q	5	422	0,5	0,96	1,5	1,5	28,4	0,42	0,25	5,1	18,4	16,3	1,17	0,05	14,6	5	0,27	123	0,35	0,03	10,3	1200	7	92
94 50423Q	Q	5	423	0,5	1,37	16	1,5	58,5	0,46	0,25	13,3	31,4	62,8	3,07	0,13	24,1	7,5	0,52	227	1,7	0,04	24,5	1060	9	179
94 50424Q	Q	5	424	0,5	0,99	9	1,5	56,4	0,45	0,25	11,3	25,2	36,7	1,83	0,13	23,9	4,5	0,41	181	0,35	0,04	20,8	887	4	34
94 50425Q	Q	5	425	0,5	0,76	1,5	1,5	36,3	0,42	0,25	5,9	21,1	19,3	1,34	0,07	15,9	4,7	0,32	134	0,35	0,03	12	1000	5	32
94 50426Q	Q	5	426	0,5	1,21	9	1,5	93,1	0,51	0,25	13,3	27,5	78	2,64	0,19	19,6	6,5	0,71	319	0,35	0,04	26,2	992	5	23
94 50427Q	Q	5	427	0,5	1,53	110	1,5	100	0,57	0,8	51,1	26,8	173	4,55	0,21	24,1	7,3	0,97	900	1,4	0,04	44,5	1090	4	32
94 50428Q	Q	5	428	0,5	1,18	10	1,5	87,1	0,46	0,25	12,9	24,9	50	2,04	0,18	20,5	6,9	0,53	221	0,35	0,04	21,3	865	5	24
94 50429Q	Q	5	429	0,5	1,14	7	1,5	66,4	0,41	0,25	14,7	26,9	71,9	2,54	0,17	14,9	6,2	0,66	338	0,35	0,03	24,3	1080	5	16
94 50430Q	Q	5	430	0,5	3,05	21	1,5	333	0,37	0,25	56,8	10,4	256	12,5	0,98	14,7	12,4	1,79	2240	1,2	0,02	20,6	1570	1,5	81
94 50431Q	Q	5	431	0,5	1,55	6	4	95	0,53	0,25	14,8	33,9	66,6	2,61	0,26	35,8	9,5	0,74	295	0,35	0,05	40,4	854	6	34
94 50432Q	Q	5	432	0,5	1,73	4	3	98,6	0,46	0,25	16,1	34,8	111	3,52	0,21	20,5	8,6	1,09	539	0,35	0,04	34,6	912	5	23
94 50433Q	Q	5	433	0,5	1,43	3	3	61,4	0,47	0,25	16,4	29,2	114	3,22	0,15	17,9	7,2	0,99	625	0,35	0,04	29,6	1030	4	16
94 50434Q	Q	5	434	0,5	1,43	7	3	62,4	0,47	0,25	19,4	30,1	143	3,42	0,16	20,3	6,9	1,01	795	0,35	0,04	33,3	1010	5	19
94 50435Q	Q	5	435	0,5	1,11	4	1,5	50,1	0,49	0,25	14,5	24,2	84	2,58	0,15	17,1	5,8	0,76	617	0,35	0,04	21,3	1010	5	20
94 50436Q	Q	5	436	0,5	1,38	1,5	1,5	81,4	0,52	0,25	10,7	31,1	53,5	2,3	0,21	29,6	7,8	0,67	248	0,35	0,06	33,6	857	6	26
94 50437Q	Q	5	437	0,5	1,77	14	3	87,2	0,64	0,25	36,8	36,3	142	4,79	0,24	22,8	8,7	1,14	901	1	0,05	43,4	1110	5	60
94 50438Q	Q	5	438	0,5	1,63	19	1,5	80,7	0,46	0,25	26,7	32,8	138	4,11	0,18	20,7	8	1,08	691	1,2	0,03	39	983	7	26
94 50439Q	Q	5	439	0,5	1,55	1,5	1,5	87,3	0,4	0,25	11,4	31,5	37,5	2,21	0,17	21,9	8,1	0,61	245	0,35	0,04	21,4	743	5	37
94 50440Q	Q	5	440	0,5	1,7	5	1,5	92,6	0,57	0,25	22	34,6	94,3	3,4	0,27	23,7	9,3	1,12	285	0,35	0,04	37,5	923	9	799
94 50441Q	Q	5	441	0,5	2,13	8	3	144	0,49	0,25	33,3	34,2	146	5,41	0,3	22,6	10,4	1,28	952	0,8	0,04	54,3	1100	8	39
94 50442Q	Q	5	442	0,5	2,79	5	1,5	151	0,46	0,25	34,3	43	126	6,2	0,29	25,6	13,1	1,65	882	0,9	0,04	52,1	871	6	43
94 50443Q	Q	5	443	0,5	1,68	6	1,5	77,5	0,55	0,25	22,7	28,8	97,9	4,01	0,24	22,6	8,1	1,12	291	1,7	0,04	31,3	1070	7	1860
94 50444Q	Q	5	444	0,5	2,37	6	1,5	182	0,65	0,7	37,1	44,8	239	5,1	0,32	28,8	11,8	1,54	392	0,35	0,04	70	1210	10	389
94 50445Q	Q	5	445	0,5	2,12	4	1,5	142	0,61	0,25	21,8	34,6	123	5,38	0,33	38,7	11,4	1,25	366	0,35	0,04	46,6	1200	6	36
94 50446Q	Q	5	446	0,5	1,65	6	1,5	92,3	0,53	0,25	25,3	31,3	136	3,41	0,27	22,4	8,8	1,09	278	0,35	0,03	38,5	1050	6	884
94 50447Q	Q	5	447	0,5	1,43	4	1,5	69,6	0,7	0,25	19,4	27,9	87,9	3,09	0,23	17,2	7,8	0,95	267	0,35	0,03	30,6	955	5	956
94 50448Q	Q	5	448	0,5	1,08	6	5	59,9	0,59	0,25	10,6	25,6	39,3	1,94	0,16	20,1	7,2	0,5	248	0,35	0,06	19,5	929	6	29
94 50449Q	Q	5	449	0,5	1,52	3	4	120	0,65	0,25	10,8	34,3	52,1	2,49	0,29	28,6	9	0,72	291	0,35	0,07	23,6	817	5	27
94 50450Q	Q	5	450	0,5	1,64	1,5	1,5	126	0,66	0,25	9,9	37	40,8	2,68	0,3	24,6	9,7	0,74	265	0,35	0,07	23,2	878	7	21
94 50451Q	Q	5	451	0,5	3,37	8	3	160	0,61	0,25	24,7	83,2	77,4	3,97	0,62	33,9	24,1	1,39	275	0,8	0,08	62,3	735	12	698
94 50452Q	Q	5	452	0,5	5,15	7	6	202	0,73	0,25	33,4	160	124	6,94	0,87	47,7	33,5	2,11	551	1,3	0,11	115	717	11	618
94 50453Q	Q	5	453	0,5	2,54	42	4	163	0,51	0,25	19,8	40,8	130	4,95	0,43	29,3	14,6	1,03	421	2,5	0,06	44,5	873	8	241
94 50454Q	Q	5	454	0,5	2,25	9	6	201	0,41	0,25	17,9	40,2	107	10,1	0,48	30,9	13,5	1,01	319	6,9	0,05	54,1	1420	13	3590
94 50455Q	Q	5	455	0,5	2,57	12	1,5	214	0,3	0,25	12,9	45,8	126	7,52	0,47	18	12,8	0,98	225	5,5	0,04	42,2	1230	14	1950
94 50456Q	Q	5	456	0,5	1,96	622	1,5	187	1,12	3,2	76,2	29,8	142	7,55	0,33	34,1	11,5	0,85	836	2,5	0,07	31,9	2810	7	59

No	Sb ppm 511P	Sc ppm 511P	Si % 511P	Sr ppm 511P	Th ppm 511P	Ti ppm 511P	V ppm 511P	Y ppm 511P	Zn ppm 511P
422	2,5	2,5	0,05	8,6	5	665	25,5	6,4	22,3
423	2,5	4,2	0,07	10,2	12	1130	50,2	7,9	42,4
424	2,5	3,8	0,05	10,4	11	1020	40,5	7,5	29,6
425	2,5	2,8	0,04	9,2	8	726	30,8	6,8	18,5
426	2,5	5	0,03	13,3	9	1190	56,4	9,5	43,6
427	6	7,6	0,05	18,4	10	1300	89,9	12,4	50
428	2,5	4,6	0,03	10,4	10	1200	42,4	9,1	47,5
429	6	4,6	0,03	9	9	1060	55,8	7,7	39,4
430	7	36,7	0,05	19,7	13	2450	312	33,5	94,6
431	2,5	5,7	0,04	11,9	16	1570	55,2	12,5	57,3
432	2,5	7,7	0,04	12,1	10	1260	77,7	21,1	46,9
433	2,5	5,4	0,09	10,9	9	1080	70,6	11,5	44
434	2,5	6	0,08	10,6	9	1070	76,4	13,3	46,7
435	2,5	4,9	0,07	10,8	8	979	59,2	10,7	36,2
436	2,5	5,3	0,11	11,9	12	1420	49,7	10,9	39,2
437	2,5	6,9	0,16	24,8	9	1670	99,6	10,5	78,8
438	2,5	6,8	0,05	12,3	11	1180	87,5	12,7	67,5
439	2,5	5,1	0,04	10,4	10	1310	48,6	8,8	33,9
440	2,5	6,9	0,04	16,5	12	1490	84,1	12,5	58,8
441	2,5	11,1	0,04	14,3	17	1720	120	15	83,9
442	2,5	11,4	0,03	14	16	2180	136	15,6	84,1
443	2,5	6,7	0,04	18,2	11	1450	93,3	13,5	62
444	2,5	8,7	0,04	25,9	14	2050	127	13,7	74,6
445	2,5	8,6	0,04	21,6	13	1810	117	19,3	65,4
446	2,5	6	0,04	18,3	9	1330	83,4	10,8	52,3
447	2,5	5,2	0,04	20,7	8	1150	75,2	11	59,6
448	2,5	4,8	0,04	12,4	9	1170	39,8	9,7	59,4
449	2,5	6,1	0,03	16,9	11	1770	54,2	10,4	43,1
450	2,5	6,5	0,03	18,5	11	1820	56,4	12	45,8
451	2,5	9,5	0,03	31,4	14	2600	108	12,8	91,2
452	6	13,5	0,03	45,8	23	3440	146	17,3	118
453	2,5	8,5	0,03	17,2	15	2110	75,7	15,6	139
454	5	11,2	0,04	25,1	18	2170	111	12,7	180
455	2,5	7,2	0,03	20,1	16	2090	102	6,6	102
456	5	10	0,03	33,9	12	1740	57,6	33,6	145

Quaternary analysis from NGU

*ID	*Med	Catch	SiO2	Al2O3	Fe2O3	TiO2	MgO	CaO	Na2O	K2O	MnO	P2O5	LOI	Sum
			%	%	%	%	%	%	%	%	%	%	%	%
			XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF
940423	Q	5	58,71	14,92	9,14	0,93	3,11	4,80	2,85	1,34	0,12	0,24	3,37	99,52
940424	Q	5	62,25	15,00	7,36	0,83	2,82	4,80	3,04	1,46	0,11	0,21	1,44	99,31
940426	Q	5	59,15	14,97	8,67	1,04	3,18	4,99	3,16	1,44	0,13	0,23	1,30	98,25
940427	Q	5	58,13	15,33	9,98	1,09	3,25	4,60	3,57	1,24	0,18	0,24	2,07	99,69
940428	Q	5	62,25	15,18	7,22	0,82	2,78	4,65	3,14	1,57	0,11	0,20	1,32	99,24
940429	Q	5	59,96	15,09	9,04	1,17	3,27	5,00	3,14	1,34	0,14	0,24	1,26	99,64
940430	Q	5	53,99	14,48	14,87	0,77	2,85	1,30	4,62	1,43	0,29	0,32	5,04	99,96
940431	Q	5	61,23	15,61	7,28	0,80	2,86	4,42	3,11	1,80	0,10	0,20	1,92	99,34
940432	Q	5	58,12	15,46	9,49	1,01	3,64	4,64	3,06	1,42	0,15	0,21	1,85	99,04
940433	Q	5	58,21	15,27	9,74	1,17	3,69	5,10	3,19	1,21	0,17	0,23	1,56	99,54
940434	Q	5	57,83	15,23	10,12	1,24	3,70	5,14	3,31	1,16	0,19	0,24	1,59	99,75
940435	Q	5	59,47	14,99	9,03	1,15	3,31	5,02	3,27	1,24	0,17	0,23	1,20	99,08
949436	Q	5	61,73	15,49	7,22	0,79	2,90	4,49	3,18	1,71	0,10	0,20	1,68	99,51
940437	Q	5	56,31	14,85	11,22	1,40	3,81	4,94	2,99	1,34	0,20	0,26	2,23	99,56
940438	Q	5	56,87	15,14	10,77	1,26	3,81	4,81	3,04	1,28	0,18	0,23	2,05	99,44
940439	Q	5	61,25	15,47	7,16	0,79	2,82	4,30	3,10	1,62	0,10	0,18	2,51	99,31
940440	Q	5	59,07	15,30	8,56	1,03	3,40	4,60	3,25	1,53	0,11	0,21	1,59	98,65
940441	Q	5	56,23	15,37	10,94	1,30	3,66	4,34	3,07	1,44	0,19	0,24	2,55	99,33
940442	Q	5	54,55	15,42	11,61	1,33	4,07	4,08	2,86	1,43	0,18	0,21	3,28	99,00
940443	Q	5	58,46	15,19	9,78	1,25	3,57	4,70	3,27	1,33	0,12	0,24	1,90	99,81
940444	Q	5	55,27	15,33	11,06	1,49	4,12	4,81	3,10	1,33	0,13	0,28	2,31	99,23
940445	Q	5	57,07	15,29	11,18	1,36	3,65	4,48	3,09	1,41	0,12	0,27	2,58	100,49
940446	Q	5	58,64	15,24	9,34	1,18	3,62	4,71	3,09	1,48	0,11	0,24	1,65	99,30
940447	Q	5	59,14	15,14	8,75	1,08	3,33	4,93	3,32	1,43	0,11	0,22	1,60	99,04
940448	Q	5	62,64	15,04	6,96	0,75	2,76	4,83	3,22	1,50	0,11	0,22	1,34	99,36
940449	Q	5	62,22	15,36	6,83	0,74	2,80	4,47	3,11	1,86	0,10	0,19	1,37	99,04
940450	Q	5	61,83	15,43	7,16	0,79	2,86	4,47	3,03	1,84	0,10	0,20	1,53	99,24
940451	Q	5	57,73	17,26	7,75	0,87	3,49	3,62	2,57	2,24	0,08	0,18	3,87	99,67
940452	Q	5	51,90	18,07	10,19	0,93	4,21	2,81	1,94	2,45	0,10	0,18	6,52	99,30
940453	Q	5	58,33	15,92	9,26	0,79	3,02	4,03	2,76	1,75	0,11	0,20	3,33	99,50
940454	Q	5	52,98	14,44	14,76	0,85	2,94	3,54	2,52	1,66	0,11	0,31	5,36	99,46
940455	Q	5	54,80	15,08	12,47	0,87	3,08	3,61	2,31	1,67	0,10	0,28	5,35	99,62
940456	Q	5	51,51	13,79	15,62	1,45	3,06	4,95	2,66	1,27	0,21	0,61	3,43	98,56

Appendix

for Bedrock

Bedrock analysis from GTK

*ID	*Med	Catch	Loc	Ag mg/kg 512U	Al mg/kg 512P	As mg/kg 512U	B mg/kg 512P	Ba mg/kg 512P	Bi mg/kg 512U	Ca mg/kg 512P	Cd mg/kg 512U	Co mg/kg 512P	Cr mg/kg 512P	Cu mg/kg 512P	Fe mg/kg 512P	Hg µg/g 512H	K mg/kg 512P	La mg/kg 512P	Li mg/kg 512P	Mg mg/kg 512P	Mn mg/kg 512P
Nr.1	BR	5	1	0,02	11600	0,2	1,5	6,1	0,01	14000	0,05	13,9	19,5	50,5	28200	0,01	500	3,6	2,5	6460	332
Nr.2	BR	5	2	0,81	18000	0,2	1,5	82,4	0,18	33200	0,67	34,8	48,2	338	182000	0,03	4400	22,9	8,3	11500	519
Nr.3	BR	5	3	0,16	24900	0,05	1,5	170	0,14	5900	0,15	24,5	176	142	106000	0,02	16900	27,4	15,5	16600	1080
Nr.4	BR	5	4	0,06	8070	1,7	1,5	40,7	0,04	174000	0,08	10,6	34,7	25,3	30800	0,06	300	6	12	39400	1840
Nr.5	BR	5	5	0,07	22100	0,05	1,5	226	0,01	13500	0,06	36,5	47,6	308	95200	0,01	10800	7,8	22,6	15200	466
Nr.6	BR	5	6	0,03	18200	0,05	1,5	5,1	0,005	15200	0,02	13,3	123	87,3	21000	0,01	400	0,9	13,8	17100	382
Nr.7	BR	5	7	0,8	5920	0,05	1,5	78,4	0,29	14100	1,34	51,3	71,5	244	107000	0,03	2100	29,3	2,3	3040	1800
Nr.8	BR	5	8	0,1	26800	4,4	1,5	74,5	0,17	19600	0,09	17,8	39,7	20,3	54500	0,01	8600	34,5	19,3	18000	283
Nr.9	BR	5	9	0,03	25300	1	1,5	43,8	0,03	32000	0,15	16,6	28,1	11,4	48500	0,01	6000	32,1	19,5	16700	421
Nr.10	BR	5	10	0,93	17400	0,3	1,5	129	0,13	2630	4,98	34,6	170	192	115000	0,03	10300	20,5	17,2	12000	153
Nr.11	BR	5	11	0,06	29800	0,1	1,5	305	0,26	3180	0,03	17,9	87,6	52,5	56400	0,01	18800	42,8	33,3	16500	318
Nr.12	BR	5	12	0,01	24000	0,2	1,5	160	0,09	4330	0,02	16	54,3	1,1	38100	0,01	15800	18,7	36,3	15400	459
Nr.13	BR	5	13	0,44	14300	1,1	1,5	54,6	0,38	390	0,15	8,7	42,3	61,5	18100	0,02	3400	11,3	10,6	12900	101
Nr.14	BR	5	14	0,04	37400	0,05	1,5	184	0,01	55400	0,16	20	7,5	27,8	75700	0,01	6000	26,2	36,1	22200	1050
Nr.15	BR	5	15	0,04	1680	1,1	3	2,2	0,02	1230	0,005	1,1	2,8	27,8	23800	0,01	100	4,4	1	540	58,7
Nr.16	BR	5	16	0,19	27700	21,2	1,5	71,1	0,07	270	0,1	10	97,7	48,8	70400	0,04	5000	3,7	28,1	10300	731
Nr.17	BR	5	17	0,005	4820	1,2	1,5	6,7	0,005	303000	0,12	2,6	5,3	1,2	7030	0,05	600	2,2	5,6	15100	781

*ID	Mo mg/kg 512P	Na mg/kg 512P	Ni mg/kg 512P	P mg/kg 512P	Pb mg/kg 512U	S mg/kg 512P	Sb mg/kg 512U	Sc mg/kg 512P	Se mg/kg 512U	Si mg/kg 512P	Sr mg/kg 512P	Te mg/kg 512U	Th mg/kg 512P	Ti mg/kg 512P	V mg/kg 512P	Y mg/kg 512P	Zn mg/kg 512P
Nr.1	0,5	1160	21,7	643	0,4	588	0,02	7,6	0,15	230	6,5	0,005	2,5	2370	96	10	35,4
Nr.2	5	300	109	8680	2,8	28600	0,05	2,9	10,1	220	19,1	0,54	16	857	180	40,4	59,8
Nr.3	2,9	390	86	414	2	17400	0,02	20	6,95	230	7,3	0,22	16	4540	263	18,4	157
Nr.4	4,7	20	34,7	675	3,6	3470	0,02	3,1	0,24	210	166	0,05	2,5	76,6	46,6	10,2	26,6
Nr.5	0,5	760	36,3	731	0,9	251	0,005	8,7	0,3	240	25,3	0,005	9	4530	208	9,6	95,2
Nr.6	0,5	1100	45	173	0,4	30	0,005	7,7	0,03	280	16,6	0,005	2,5	541	61,5	3	27,6
Nr.7	5,3	260	144	943	5,8	25700	0,18	2,5	5,16	200	34,3	0,31	18	1610	112	12,1	64,1
Nr.8	0,5	170	23	794	3,6	1810	0,06	7,9	0,17	300	40,4	0,005	15	2370	82,1	22,1	69,5
Nr.9	0,5	80	21,3	790	3,7	887	0,03	4,5	0,05	340	58,5	0,005	13	1760	51,1	19,8	74,8
Nr.10	13,3	420	222	211	7,3	22100	0,05	21	4,4	160	7	0,5	18	3440	224	11,9	713
Nr.11	0,5	230	25,5	781	3,9	335	0,01	10,4	0,12	310	23,9	0,03	17	3020	134	13,9	104
Nr.12	0,5	230	24,3	615	4,7	33	0,03	5,3	0,005	290	53,7	0,005	11	2710	52,3	7,5	88,7
Nr.13	8,2	220	27,6	299	5,8	2890	0,14	3	2,3	350	11,6	0,08	15	238	43,1	5,5	45,3
Nr.14	0,5	150	8,4	1760	1,3	90	0,005	16,1	0,03	590	39,8	0,005	8	2760	149	29	192
Nr.15	0,5	20	2,5	298	0,3	542	0,005	0,2	0,04	310	1,6	0,06	2,5	153	5,2	4,4	13
Nr.16	5,6	480	40,3	86	4,6	17700	0,13	5,7	1,02	350	14,1	0,21	11	50,8	61,5	5,4	65
Nr.17	0,5	50	4,3	137	2,3	68	0,005	2,9	0,005	440	122	0,005	2,5	68,8	12,1	6,2	20,8

Bedrock analysis from NGU

*ID	*Med	Catch	Loc	SiO2	Al2O3	Fe2O3	TiO2	MgO	CaO	Na2O	K2O	MnO	P2O5	LOI	Sum
				%	%	%	%	%	%	%	%	%	%	%	%
				XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF
Nr.1	BR	5	1	49,09	13,01	16,78	2,05	5,46	9,45	2,03	0,27	0,22	0,18	0,50	99,04
Nr.2	BR	5	2	45,71	4,71	25,70	0,24	2,68	5,86	0,05	0,56	0,12	1,86	11,20	98,63
Nr.3	BR	5	3	55,21	14,10	12,75	1,64	2,35	2,88	3,50	2,12	0,42	0,10	3,44	98,52
Nr.4	BR	5	4	38,56	1,56	3,79	0,13	6,19	22,63	0,05	0,04	0,22	0,26	23,78	97,13
Nr.5	BR	5	5	54,78	12,80	15,33	1,96	3,17	6,28	2,09	1,43	0,16	0,18	0,61	98,79
Nr.6	BR	5	6	49,01	14,14	10,97	0,50	9,61	9,91	2,08	0,56	0,22	0,08	1,82	98,90
Nr.7	BR	5	7	53,44	9,51	15,79	0,58	1,94	4,49	3,44	0,38	1,66	0,22	6,85	98,30
Nr.8	BR	5	8	62,04	13,79	7,30	0,93	2,83	2,83	3,19	2,34	0,05	0,19	3,04	98,53
Nr.9	BR	5	9	60,95	13,92	6,89	0,95	2,83	4,00	1,85	3,04	0,07	0,19	3,80	98,50
Nr.10	BR	5	10	55,18	14,99	13,01	1,13	1,72	2,09	4,96	1,71	0,03	0,06	4,18	99,07
Nr.11	BR	5	11	64,92	14,03	8,12	0,84	2,55	2,01	3,03	2,53	0,12	0,18	0,74	99,06
Nr.12	BR	5	12	67,43	13,81	5,48	0,57	2,23	2,48	3,22	2,50	0,08	0,13	0,95	98,88
Nr.13	BR	5	13	63,32	17,45	2,30	0,91	2,44	0,81	3,22	3,04	0,01	0,07	5,40	98,97
Nr.14	BR	5	14	50,86	12,74	10,57	2,32	3,11	8,43	2,42	0,74	0,18	0,38	6,82	98,58
Nr.15	BR	5	15	93,46	0,31	4,95	0,05	0,30	0,18	0,05	0,01	0,02	0,05	0,57	99,78
Nr.16	BR	5	16	64,65	12,42	8,24	1,55	1,71	0,13	0,77	2,30	0,09	0,02	7,35	99,24
Nr.17	BR	5	17	15,92	1,02	1,51	0,08	4,54	42,38	0,05	0,07	0,11	0,10	34,43	100,14

Appendix

for Mosses

Sample	Al ppm	Fe ppm	Ti ppm	Mg ppm	Ca ppm	Na ppm	K ppm	Mn ppm
HSA-N1/I	1702,81	2566,1	149,604	1044,04	9322,85	<200.0000	342,571	128,901
HSA-N3/I	5055,87	8167,68	430,774	2585,58	10481,3	285,078	941,696	437,985
HSA-N9/I	5460,18	8713,93	534,542	2709,02	10495,6	279,844	740	492,725
HSA-N27/I	8440,58	13411,5	795,041	4047,4	11344,3	392,65	1475,37	927,622
HSA-N81/I	10209,7	17614,2	844,658	4750	12897,8	500	1270,01	1674,84
SFA-N1/I	2930,48	4735,66	303,336	2120,88	23872,4	235,746	479,45	240,752
SFA-N3/I	8564,02	14245,7	841,601	4560,89	20373,5	386,637	1384,12	740,502
SFA-N9/I	9248,31	15015	983,885	4702,73	17216,4	382,851	1263,32	779,17
SFA-N27/I	11120,6	18568,8	1214,41	5749,17	18864,6	567,595	1422,27	999,674
SFA-N81/I	10723,6	19002,7	899,986	5053,81	17076,1	462,555	1280,93	2072,1
HSA-N1/II	672,312	795,662	44,9182	833,287	11976,2	270,191	271,176	19,7809
HSA-N3/II	819,035	900,564	75,0351	1070,81	16863,4	384,051	293,021	15,0899
HSA-N9/II	1123,77	1405,92	41,1971	1193,2	20536,9	320,343	439,531	39,5619
HSA-N27/II	1253,9	1471,62	39,8485	1190,41	20872	323,167	533,69	41,1564
SFA-N1/II	471,034	429,209	36,0844	864,789	14733,6	423,924	154,42	30,642
SFA-N3/II	474,456	404,732	33,7856	1431,84	28668,5	535,412	282,099	40,9715
SFA-N9/II	370,605	377,346	33,3959	2069,97	39637,9	319,892	117,886	22,8082
SFA-N27/II	411,195	433,289	34,0712	2010,04	40038,9	301,141	176,641	20,7746
HSA-R1/I	3256,99	2730,47	61,5916	1528,85	8832,18	<200.0000	148,77	145,977
HSA-R3/I	6912,14	5710,79	114,59	1766,1	9210,23	212,696	281,722	254,495
HSA-R9/I	9046,61	7339,39	153,74	1893,78	9683,36	280,018	417,31	242,524
HSA-R27/I	11688,5	11442,8	182,021	2311,68	12074,5	338,981	803,736	343,879
HSA-R81/I	3110	4530	71,6	1870	10800	<200.0000	666	171
HSA-R1/II	786,447	977,168	72,7429	1209,92	3715,99	309,951	168,355	17,239
HSA-R3/II	668,144	786,607	64,9963	1918,04	7980,33	233,367	150,277	16,384
HSA-R9/II	371	449	35,8	1450	8270	<200.0000	218	16,1
HSA-R27/II	430	531	40,1	1410	8410	<200.0000	180	15,2
HSA-R81/II	545	684	48,6	1570	9810	<200.0000	216	28,6
SFA-R1/II	378,476	365,111	32,5225	2062,73	7569,07	806,845	196,979	19,8734
SFA-R3/II	445,323	399,779	37,3013	3812,38	15442,6	322,377	142,744	25,2114
SFA-R9/II	207	221	18,1	3380	17200	<200.0000	128	24,8
SFA-R27/II	206	228	17,2	3790	21100	<200.0000	<100.0000	29,6
SFA-R81/II	246	252	17,2	3510	20600	<200.0000	176	41,4
HSA-UEKS	376,722	437,658	28,9202	180,495	<200.0000	<200.0000	120,049	7,0464
SFA-UEKS	156,465	176,727	16,8362	101,578	240,516	<200.0000	<100.0000	6,3722

Metal contents in acid-washed mosses from experiment 1(I) and 2(II) in Norway(N) and Russia(R).
HSA and SFA = *Hylocomium splendens* and *Sphagnum fuscum* respectively.
Numbers refer to exposure time in days(UEKS = unexposed samples).

Sample	Cu ppm	Zn ppm	Ni ppm	Co ppm	V ppm	Cr ppm	Ba ppm	Sr ppm
HSA-N1/I	5,5943	18,8224	8,6854	1,3074	6,7214	4,915	27,0285	17,5631
HSA-N3/I	15,2224	30,6571	18,8676	4,3795	21,0883	13,5808	51,8582	21,433
HSA-N9/I	16,2	31,4756	18,7582	4,6369	23,398	13,8395	52,4481	20,7231
HSA-N27/I	25,4694	45,9096	26,2307	7,7916	34,8283	20,7916	77,5996	23,3794
HSA-N81/I	35,3633	64,6868	35,1041	11,1883	41,7604	29,2967	93,792	24,8913
SFA-N1/I	9,5029	23,5514	13,1296	2,9184	12,3736	7,8251	47,3535	41,7439
SFA-N3/I	24,3994	43,6248	24,6594	7,4808	36,3717	22,473	78,4577	38,7442
SFA-N9/I	24,6052	44,6152	23,5749	7,0781	38,9344	22,6347	74,9182	32,264
SFA-N27/I	22,3828	46,9657	22,9931	9,8131	47,3158	26,3209	74,2747	35,5385
SFA-N81/I	35,7002	70,2812	31,8	12,5491	45,1718	26,7477	104,864	30,9806
HSA-N1/II	3,9993	8,7903	2,5345	< 1.0000	2,1018	3,2824	15,211	22,8351
HSA-N3/II	3,7047	28,7025	< 2.0000	< 1.0000	2,6075	2,3396	20,4784	32,4634
HSA-N9/II	4,3781	24,7748	4,1067	< 1.0000	4,0037	3,2824	37,0868	37,8608
HSA-N27/II	7,0718	14,1344	8,7447	< 1.0000	4,8208	4,0855	42,1392	40,1147
SFA-N1/II	3,7047	22,9892	2,5345	< 1.0000	1,3233	< 1.0000	16,4472	27,7778
SFA-N3/II	6,7772	49,9842	3,258	< 1.0000	1,4929	1,4317	32,2494	54,3495
SFA-N9/II	3,5364	96,9374	2,9372	< 1.0000	1,7871	< 1.0000	53,104	87,7027
SFA-N27/II	3,5785	9,3537	5,2395	< 1.0000	2,4395	< 1.0000	61,7576	92,4476
HSA-R1/I	7280,76	63,5464	1085,38	42,9331	5,0275	6,9488	64,7138	35,6663
HSA-R3/I	8886,33	82,9772	1376,21	66,5127	12,9791	24,5827	76,2161	37,9201
HSA-R9/I	10251	93,3897	1574,89	70,5352	15,2762	27,2365	79,8173	40,2728
HSA-R27/I	11096,1	129,334	2270,55	93,7477	24,1227	46,6513	97,1244	52,1155
HSA-R81/I	6290	98,7	2460	53,8	< 1.0000	16,2	63,3	36,2
HSA-R1/II	15,8693	9,599	70,392	1,4695	1,9862	3,5617	9,9973	12,1392
HSA-R3/II	21,5947	11,8869	213	3,5216	1,9764	3,2824	19,4571	25,0494
HSA-R9/II	33,6	12	371	5,78	< 1.0000	1,28	25,9	24,5
HSA-R27/II	73,6	18,6	614	7,82	< 1.0000	1,24	27,9	25
HSA-R81/II	414	41,5	1460	23,8	< 1.0000	1,93	46,2	30,6
SFA-R1/II	17,5953	18,8761	117,626	1,4335	< 1.0000	< 1.0000	14,2435	23,4282
SFA-R3/II	32,6683	27,665	268,992	3,6594	1,183	< 1.0000	31,7119	47,9043
SFA-R9/II	48,5	26,2	431	6,04	< 1.0000	< 1.0000	39,5	50,4
SFA-R27/II	111	20,7	691	9,29	< 1.0000	< 1.0000	52,3	61,3
SFA-R81/II	322	28,8	833	16,4	< 1.0000	1,32	56	61,4
HSA-UEKS	1,3157	3,3454	3,5468	< 1.0000	< 1.0000	1,5198	1,2334	< 2.0000
SFA-UEKS	< 1.0000	3,2626	< 2.0000	< 1.0000	< 1.0000	< 1.0000	1,2334	< 2.0000

Metal contents in acid-washed mosses from experiment 1(I) and 2(II) in Norway(N) and Russia(R).
HSA and SFA = *Hylocomium splendens* and *Sphagnum fuscum* respectively.
Numbers refer to exposure time in days(UEKS = unexposed samples).

Sample	Al ppm	Fe ppm	Ti ppm	Mg ppm	Ca ppm	Na ppm	K ppm	Mn ppm
CE-N1/I	< 0.0200	< 0.0100	< 0.005	2,3328	16,445	2294,197	59,7648	< 0,001
CE-N3/I	0,4492	8,5984	< 0.005	672,8359	7615,1918	11721,612	1258,9165	8,1743
CE-N9/I	< 0.0200	3,6823	0,1427	894,5441	7846,5394	11702,333	2005,0125	8,3864
CH-N1/I	< 0.0200	< 0.0100	< 0.005	519,9307	4621,606	25842,48	362,0258	2,1567
CH-N3/I	< 0.0200	< 0.0100	192,5669	1272,8673	13556,711	18948,585	506,451	8,6077
CH-N9/I	< 0.0200	< 0.0100	269,5937	1731,1766	12305,026	8973,6183	294,6274	16,3104
CE-N1/II	< 0.0200	1,8982	< 0.005	112,8507	1251,8269	820,6777	223,6209	0,3827
CE-N3/II	< 0.0200	2,0264	< 0.005	287,533	3054,1502	1637,3759	578,3322	0,9756
CE-N9/II	1,0161	4,5512	0,2613	1032,787	5717,3527	3724,8144	1619,4544	3,0165
CE-N27/II	2,8352	8,605	0,6025	2618,4132	5860,4743	5060,6189	2663,9931	6,2219
CH-N1/II	0,935	2,1624	0,1473	510,8752	7271,8728	21909,136	439,3717	2,2691
CH-N3/II	2,331	5,1402	0,4184	1373,0155	12335,691	21399,815	682,4135	7,0635
CH-N9/II	3,1123	8,9761	0,7685	2630,4326	13026,797	19268,265	679,9032	14,1846
CH-N27/II	10,6817	23,1329	1,2658	2586,9717	13009,25	1258,367	78,2147	22,9088
CE-R1/I	0,6632	4,7908	< 0.005	337,2238	872,3694	17625,024	359,7667	12,5757
CE-R3/I	< 0.0200	6,8537	< 0.005	1708,3054	4235,936	17849,817	1397,4764	55,1243
CE-R9/I	< 0.0200	9,3966	< 0.005	4301,0989	6953,1136	18537,44	3092,9632	110,5302
CE-R27/I	< 0.0200	14,519	0,295	11512,512	11644,322	18223,636	5750,8965	178,6273
CE-R81/I	5,9186	21,5924	0,8676	15789,474	53614,806	7595,9129	2274,9181	158,4731
CH-R1/I	< 0.0200	0,9571	< 0.005	2165,0298	6701,0013	19330,83	418,6347	62,2453
CH-R3/I	< 0.0200	0,8473	< 0.005	3926,7861	10320,123	17096,052	420,9898	144,9182
CH-R9/I	< 0.0200	1,6195	0,0963	6611,1304	11308,993	10083,459	355,284	247,073
CH-R27/I	< 0.0200	1,8775	1,8544	8753,5143	11767,976	2189,0044	104,0574	255,9445
CH-R81/I	< 3.8513	2,8692	0,2754	4756,4029	20412,093	38,8985	19,2567	94,1652
CE-R1/II	< 0.0200	1,5483	< 0.005	187,8396	398,8374	4461,5348	178,4199	0,6999
CE-R3/II	< 0.0200	1,6948	< 0.005	566,8601	1188,0073	4506,5266	495,3331	1,4808
CE-R9/II	< 0.0200	5,2444	0,1986	3827,2438	10411,646	6275,9086	2072,6887	9,5054
CE-R27/II	< 0.0200	8,1076	0,3798	7693,0493	21498,12	8416,0802	3258,4595	21,4981
CE-R81/II	< 1.9281	9,1198	0,5293	10218,837	31138,533	3075,2916	1638,8701	35,3803
CH-R1/II	< 0.0200	0,8965	< 0.005	1599,0316	4901,9496	21870,5	580,7414	5,2213
CH-R3/II	< 0.0200	1,8358	0,2476	4092,9059	10258,745	21733,243	931,3982	12,9166
CH-R9/II	< 4.2692	4,8029	0,3992	6062,331	22413,548	8260,9933	416,2516	29,8847
CH-R27/II	< 4.2692	8,0689	0,4803	7236,374	28390,494	702,2912	78,1272	54,4329
CH-R81/II	7,1723	17,077	0,4696	5976,9461	32019,354	67,881	21,5597	133,2005

Metal contents in ion-exchange resins from experiment 1(I) and 2(II) in Norway(N) and Russia (R).
CE and CH = cation-exchange resin and chelating ion-exchange resin respectively.
Numbers refer to exposure time in days.

Sample	Cu ppm	Zn ppm	Ni ppm	Co ppm	V ppm	Cr ppm	Ba ppm	Sr ppm
CE-N1/I	< 0.005	< 0.002	< 0.0200	< 0.0100	< 0.0050	< 0.0100	< 0.0020	0,0193
CE-N3/I	< 0.005	0,6844	2,2171	< 0.0100	< 0.0050	0.2005	7,5381	16,1751
CE-N9/I	< 0.005	0,7037	1,8816	< 0.0100	< 0.0050	< 0.0100	6,2849	16,3291
CH-N1/I	< 0.005	< 0.002	< 0.0200	< 0.0100	< 0.0050	< 0.0100	5,3341	15,752
CH-N3/I	< 0.005	< 0.002	< 0.0200	< 0.0100	0,258	< 0.0100	14,9432	36,5877
CH-N9/I	< 0.005	< 0.002	< 0.0200	< 0.0100	0,2908	< 0.0100	21,1824	48,1417
CE-N1/II	< 0.005	0,0704	0,8985	< 0.0100	< 0.0050	< 0.0100	0,6459	2,1325
CE-N3/II	< 0.005	0,0916	1,0402	< 0.0100	< 0.0050	< 0.0100	1,6177	5,2801
CE-N9/II	0,0656	0,2256	1,2561	< 0.0100	0,1157	< 0.0100	6,9768	20,7886
CE-N27/II	0,3451	0,4126	1,744	< 0.0100	0,4107	< 0.0100	19,3888	54,5455
CH-N1/II	< 0.005	0,4163	< 0.0200	< 0.0100	< 0.0050	< 0.0100	6,7753	15,9819
CH-N3/II	0,2113	0,9371	< 0.0200	< 0.0100	0,2305	< 0.0100	18,0995	42,5366
CH-N9/II	0,1217	1,5561	< 0.0200	< 0.0100	0,5187	< 0.0100	34,963	80,1295
CH-N27/II	1,522	1,6864	0,9798	< 0.0100	0,5315	< 0.0100	37,5459	78,9875
CE-R1/I	14,8834	2,1457	52,2152	2,568	< 0.0050	< 0.0100	1,6985	2,6875
CE-R3/I	55,4694	8,1029	231,6426	11,2821	0,1215	< 0.0100	8,6832	13,5261
CE-R9/I	113,4741	17,5747	501,2281	24,5441	0,4184	< 0.0100	20,0077	32,1727
CE-R27/I	196,2445	33,2678	974,0042	43,6861	1,0796	< 0.0100	46,4585	78,5271
CE-R81/I	206,2849	37,4012	1091,1895	41,8354	< 0.1928	< 0.1928	108,5406	168,3054
CH-R1/I	< 0.005	6,8072	25,8771	< 0.0100	0,1502	< 0.0100	17,0537	35,9715
CH-R3/I	< 0.005	13,0252	77,1385	0,3755	0,2734	< 0.0100	32,5939	52,9116
CH-R9/I	0,1309	25,3187	153,1061	0,4429	0,389	< 0.0100	53,5644	81,9045
CH-R27/I	0,1964	40,2561	197,254	0,8743	0,545	< 0.0100	66,1872	98,9293
CH-R81/I	1,2844	36,5877	336,9921	1,5675	< 0.1926	< 0.1926	35,6249	50,8377
CE-R1/II	0,5861	0,3201	7,4434	0,1735	< 0.0050	< 0.0100	0,3914	0,9669
CE-R3/II	1,3391	0,5996	19,2336	0,3625	< 0.0050	< 0.0100	1,2051	2,8892
CE-R9/II	7,5677	3,3163	115,685	2,1787	< 0.0964	< 0.0964	12,0505	25,7399
CE-R27/II	17,2563	7,0471	240,0463	4,8588	< 0.0964	< 0.0964	26,4147	53,6007
CE-R81/II	26,9932	11,3757	360,5514	8,9559	< 0.0964	< 0.0964	44,8279	80,6903
CH-R1/II	2,267	3,1123	79,6215	1,6479	< 0.0050	< 0.0100	8,4787	14,3361
CH-R3/II	4,9651	6,0324	172,0656	3,2788	0,4483	< 0.0100	20,9385	35,5607
CH-R9/II	11,5056	11,2495	367,1553	6,9802	< 0.2135	< 0.2135	34,5809	55,9271
CH-R27/II	23,0539	19,1049	636,1178	12,9572	< 0.2135	< 0.2135	43,7598	67,881
CH-R81/II	70,656	47,6021	1475,0249	37,9963	< 0.2135	< 0.2135	50,804	68,308

Metal contents in ion-exchange resins from experiment 1(I) and 2(II) in Norway(N) and Russia (R).
CE and CH = cation-exchange resin and chelating ion-exchange resin respectively.

Sample	Al ppm	Fe ppm	Ti ppm	Mg ppm	Ca ppm	Na ppm	K ppm	Mn ppm
D-N1/I	< 0.0200	< 0.0100	< 0.0050	0,517	6,7	1	< 0,5000	0,0068
-	-	-	-	-	-	-	-	-
D-N9/I	< 0.0200	0,502	0,0259	0,17	0,855	0,52	< 0,5000	0,0224
D-N1/II	< 0.0200	0,0287	< 0.0050	0,9619	13,1306	2,127	1,3437	0,004
D-N3/II	0,0362	0,0917	< 0.0050	0,8766	11,783	2,4191	1,2406	0,0092
-	-	-	-	-	-	-	-	-
D-N27/II	0,1979	0,6288	0,0166	1,2087	15,7965	2,2241	1,3461	0,0433
D-R1/I	< 0.0200	0,0229	< 0.0050	1,8294	5,5027	1,6436	0,8518	0,0729
D-R3/I	0,0656	0,0688	< 0.0050	2,3521	6,8517	1,6138	1,1614	0,0798
D-R9/I	0,0542	0,0516	< 0.0050	2,7405	8,0107	1,8962	1,0318	0,0586
D-R27/I	0,0742	0,1166	< 0.0050	3,323	9,7257	2,3272	1,1446	0,0335
D-R81/I	0,104	0,219	< 0.0050	3,3	9,87	2,22	0,843	0,0157
D-R1/II	< 0.0200	0,0248	< 0.0050	3,7205	10,7614	2,6104	1,2501	0,0116
D-R3/II	< 0.0200	0,0306	< 0.0050	4,0508	11,8645	3,2477	2,186	0,0112
D-R9/II	< 0.0200	0,0945	< 0.0050	4,04	11	2,92	1	0,0265
D-R27/II	< 0.0200	0,0987	< 0.0050	4,25	11,9	2,78	0,95	0,0154

Sample	Cu ppm	Zn ppm	Ni ppm	Co ppm	V ppm	Cr ppm	Ba ppm	Sr ppm
D-N1/I	< 0.0050	0,002	< 0.0200	< 0.0100	< 0.0050	< 0.0100	0,005	0,0122
-	-	-	-	-	-	-	-	-
D-N9/I	< 0.0050	0,0212	< 0.0200	< 0.0100	< 0.0050	< 0.0100	0,0043	0,002
D-N1/II	< 0.0050	0,0037	< 0.0200	< 0.0100	< 0.0050	< 0.0100	0,0094	0,0249
D-N3/II	< 0.0050	0,0039	< 0.0200	< 0.0100	< 0.0050	< 0.0100	0,0091	0,0228
-	-	-	-	-	-	-	-	-
D-N27/II	0,0136	0,0079	< 0.0200	< 0.0100	< 0.0050	< 0.0100	0,0156	0,0318
D-R1/I	0,2758	0,0233	0,2745	0,0167	< 0.0050	< 0.0100	0,0127	0,02
D-R3/I	0,3471	0,0112	0,327	0,0218	< 0.0050	< 0.0100	0,0152	0,0246
D-R9/I	0,2534	0,011	0,302	0,0193	< 0.0050	< 0.0100	0,0163	0,028
D-R27/I	0,1818	0,0137	0,2872	0,0136	< 0.0050	< 0.0100	0,0188	0,0338
D-R81/I	0,0867	0,0837	0,158	< 0.0100	< 0.0050	< 0.0100	0,016	0,0311
D-R1/II	0,0261	0,102	0,1547	< 0.0100	< 0.0050	< 0.0100	0,0145	0,0327
D-R3/II	0,0329	0,1037	0,1651	< 0.0100	< 0.0050	< 0.0100	0,0163	0,036
D-R9/II	0,0574	0,113	0,212	< 0.0100	< 0.0050	< 0.0100	0,0181	0,0345
D-R27/II	0,058	0,0997	0,181	< 0.0100	< 0.0050	< 0.0100	0,0181	0,0362

Metal contents in de-ionized water(D) from experiment 1(I) and 2(II) in Norway(N) and Russia(R).
Numbers refer to exposure time in days.