Chemical composition, discharge and suspended matter of rivers in North-Western Iceland. The database of the Science Institute, University of Iceland, and the Hydrological Service of the National Energy Authority.

Sigurdur Reynir Gíslason[1], Árni Snorrason[2], Gudmundur Bjarki Ingvarsson[1], Bergur Sigfússon[1], Eydís Salome Eiríksdóttir[1], Sverrir Óskar Elefsen[2], Jórunn Harðardóttir[2], Svava Björk Þorláksdóttir[2] and Peter Torssander[3]

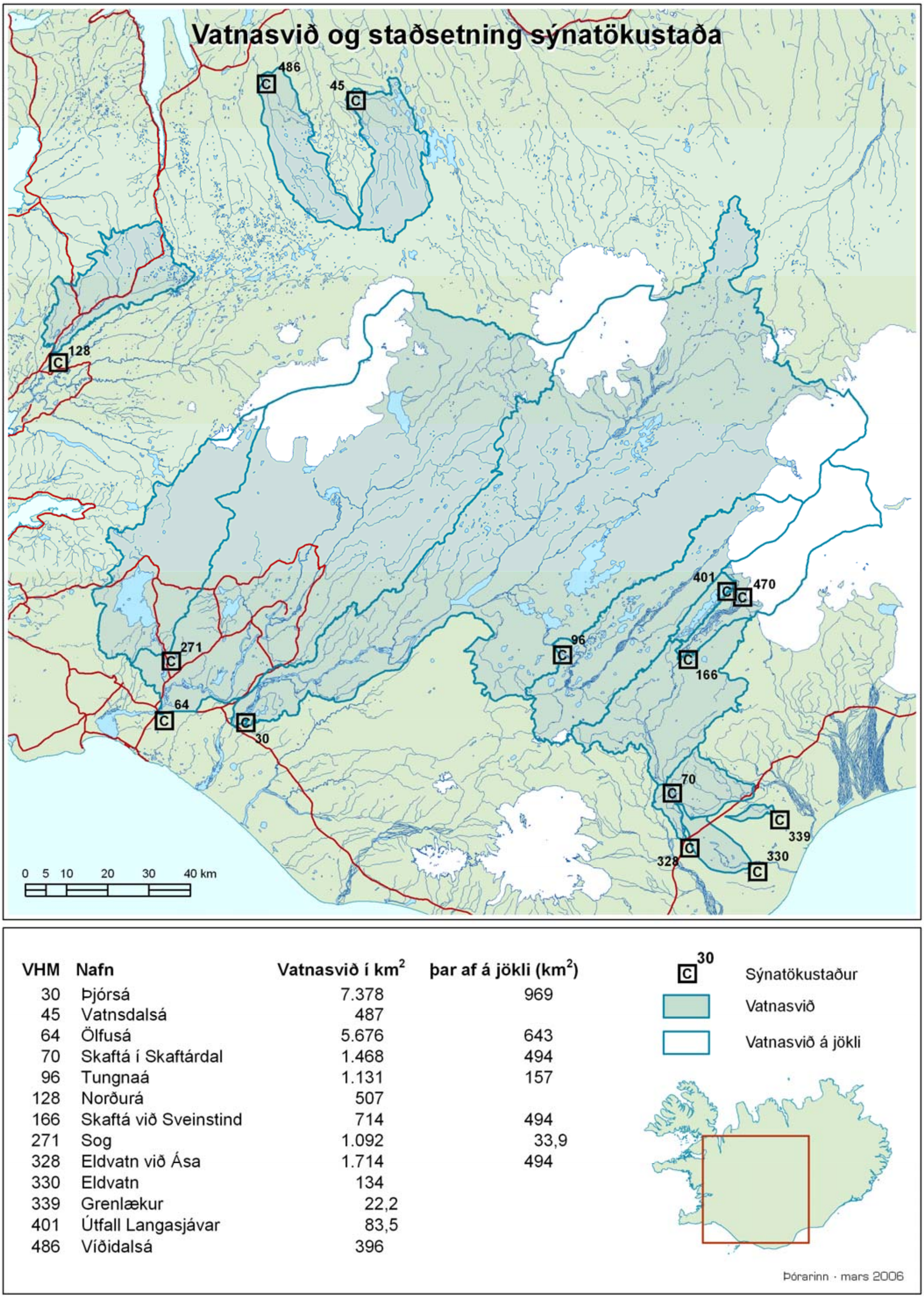
RH-07-2006

[1]Science Institute, University of Iceland, Dunhagi 3, 107 Reykjavík.
[2]Hydrological Service, National Energy Authority, Grensásvegur 9, 108 Reykjavík.
[3]Department of Geology and Geochemistry, Stockholm University, S-106 91 Stockholm, Sweden.

March 2006

TABLE OF CONTENTS

TABLES AND FIGURES



VHM	Nafn	Vatnasvið í km^2	þar af á jökli (km^2)
30	Þjórsá	7.378	969
45	Vatnsdalsá	487	
64	Ölfusá	5.676	643
70	Skaftá í Skaftárdal	1.468	494
96	Tungnaá	1.131	157
128	Norðurá	507	
166	Skaftá við Sveinstind	714	494
271	Sog	1.092	33,9
328	Eldvatn við Ása	1.714	494
330	Eldvatn	134	
339	Grenlækur	22,2	
401	Útfall Langasjávar	83,5	
486	Víðidalsá	396	

Figure 1. Sample locations and catchment areas.

INTRODUCTION

The objectives of this study are:

1. To define the discharge and concentration of dissolved and particulate matter in the Rivers Vatnsdalsá at Forsaeludalur, Vídidalsá at Kolugil and Nordurá at Stekkur in Borgarfjördur and to describe how discharge and concentration are related and how they change during the year from February 25th 2004 until November 18th 2005. The data make it possible to calculate average concentration of river water of over 30 constituents, to calculate average concentration of major dissolved elements in precipitation in the catchments, rate of chemical and mechanical weathering of organic and inorganic matter in the river catchments, and the fixation of atmospheric CO_2 by chemical weathering.
2. To calculate the annual fluxes of over 30 constituents based on data from the three rivers from February 25th 2004 until November 18th.
3. To define second order power functions describing the riverine concentrations as a function of discharge for the monitoring period.
4. To describe by figures the time sequences for selected constituents in the rivers for the period February 25th 2004 until November 18th 2005.

Samples were taken at the following sample locations: (Fig. 1); Vatnsdalsá in Forsaeludalur, Vídidalsá in Kolugil, and Nordurá at Stekkur. One sample was taken at Litla-Skard, Borgarfjördur February 25th 2004 and another one from River Blanda, February 26th 2004. The study was supported by the Ministry for the Environment through AMSUM and the National Energy Authority, Natural Resources Division. This study is a continuation of previous river monitoring studies in South, South-eastern and Eastern Iceland conducted by the Science Institute and the Hydrological Service of the National Energy Authority, Iceland (i.e. Sigurdur R. Gíslason et al. 2003; 2004).

This study is scientifically important because many variables are measured simultaneously and emphasis will be on gaining fundamental understanding of natural and man made processes controlling the chemical composition of the rivers (Gislason et al. 1996; Gislason and Eiríksdóttir 2003; Oelkers et al. 2003; Gislason et al. 2006; Gislason and Torssander 2006).

This report is a progress report, reporting methods and analytical results.

METHODS

The samples were taken from the main channel of the rivers (Fig. 1), all year around from February 25th 2004 until November 18th 2005. Six samples were collected from each river per year. For each sample, discharge, air and water temperature, pH, conductivity, alkalinity and the dissolved organic and inorganic concentration of 36 constituents and the sulphur isotope ratios were measured as well as the suspended particle organic and inorganic concentration. Grain size distribution of all inorganic suspended samples was measured and the C and N concentration in the organic suspended matter.

River discharge

The samples were collected close to the hydrometric monitoring stations run by the Hydrological Service of the National Energy Authority (Fig.1; Árni Snorrason 1990). Before sampling, proper functionality of the hydrometric stations was secured. The discharge reported with each sample in Tables 3, 4, 5 and 6 is the discharge at the time of sampling. Averages of these discharges are given for each river in Table 1. The discharge at the time of sampling can be significantly different from the average daily discharge shown in Figures 2, 7 and 12. Discharge at each station is calculated by applying a rating curve which describes the relationship between discharge and water level. Discharge measurements are done several times each year at each station, depending on the stability of the control cross section of the river bed at the monitoring site. Water level is continuously measured and recorded with 60 minutes intervals. During the winter, the river water level at the measuring site can be disturbed because of ice. Then the discharge is estimated using air temperature, precipitation and discharge of nearby rivers, not disturbed by ice.

Sampling of river particulate suspended matter

Total inorganic suspended particulate matter (SPM) and particulate organic carbon (POC) was sampled from the main channel of the rivers using a suspended matter sampler (Guy and Norman, 1970; Gunnarsson et al., 2001). Two different sediment samplers were used during the collection of the suspended sediment samples. All the samples from Nordurá and Vatnsdalsá were taken with a DH48 hand sampler which is fastened to a rod that is lowered by hand into the river. In Vídidalsá most of the samples were taken with a S49 sampler which is attached to a winch and lowered into and lifted up from the river at a constant rate.

All the suspended sediment samples were classified by their quality into three categories, S1, S2, and S3. S1 samples are taken from several locations (usually 3–5) on the river transect using the S49 sampler. These samples are considered to be the best quality samples. S2 samples are taken from 1–2 locations on the river transect. They are taken with the S49 sampler and are usually equal to S1 samples in quality, especially when taken in high discharge rivers where turbulent flow occurs. S3 samples are always taken with the hand sampler, DH48, and are taken from either riverbank in the greatest current if possible. These samples are of less quality than S1 and S2 samples as they do usually not reach the bottom where the greatest sediment concentration is. S3 samples are thought to represent the finer sediment fraction reasonably, but under represent the coarser sediment load. In occasional instances it is possible to wade the rivers and collect a sample from several locations across the river with the handheld rod sampler (DH48). These samples can be classified as S1 or S2 samples if they are thought to be equal in quality as samples taken with the S49 sampler.

The POC samples were always taken after several samples of inorganic suspended particulate matter had been taken, using the same sampler. Thus it was thoroughly cleaned by the river water. Glass bottles, cleaned with acid (1N HCl) and deionised water, were used for the POC sampling. Before sampling for SPM and POC, glass bottles were mounted in the sampler, and an integrated sample was taken from the river surface to the bottom of the main channel of the river.

Sampling of river water

The river water samples were collected in a plastic bucket and poured into two 5 l plastic containers. The bucket and container were rinsed several times with the river water. The containers were filled completely before being closed. The air and water temperature was measured by a thermistor (± 0.1 °C). The water samples were filtrated immediately after sampling through 0.2 µm Millipore membranes (cellulose acetate) with a peristaltic pump, silicone tubing and a 140 mm Sartorius filter holder into low and high density polyethylene bottles and glass bottles. One l of sample water was pumped through the filtration unit before the samples were collected and all the air in the unit expelled through an air valve.

Samples for pH, alkalinity and conductivity measurements were filtrated into 60 ml and 275 ml amber glass bottles with specially designed taps to prevent air bubbles in the bottles. Then in sequence; one litre sample for S isotopes; 190 ml and two 90 ml bottles for anion and major and trace element analyses; one 100 ml bottle for total dissolved N and P measurements; one 30 ml for dissolved organic carbon measurements and finally four 20 ml bottles for dissolved PO_4, NO_3, NO_2, NH_4. All bottles except those for pH, alkalinity, conductivity, sulphur isotopes and anion measurements were washed in acid (1 N HCl) and deionised water prior to sampling. All bottles were rinsed 3 times with the filtrated river water prior to collection. Sample for major and trace element analyses were acidified by 1 ml of concentrated suprapure HNO_3 (1/90), DOC by 0.1 ml of 1.2 M HCl (0.1/30), and NH_4 and PO_4 by 1 ml of 0.1 M H_2SO_4 (1/20). To prevent any organic growth or decay, samples for the determination of nutrients were refrigerated (-18 ˚C) within hours after collection and kept frozen until analysed. Alkalinity, conductivity and pH were determined 1 to 5 days after sampling. These samples were kept in the refrigerator until analysed. Alkalinity was determined by Gran titration (Stumm and Morgan 1996).

Analytical methods for suspended particulate constituents

Total suspended particulate matter (SPM) concentration, the grain size distribution of the particulates and total dissolved solids (TDS_{meas}) were measured at the Hydrological Service of the National Energy Authority (Svanur Pálsson and Gudmundur Vigfússon, 1996; 2000). Before grain size analysis the organic fraction of the suspended sediment was removed by boiling the sample in hydrogen peroxide (H_2O_2). The grain size was subsequently analyzed using a combination of sediment settling method (for fraction finer than <63µm) and sieving (for material coarser than 63µm). Total suspended inorganic sediment concentration (mg/l) was then calculated based on the results from the grain size analysis.

After each expedition, each particulate organic carbon sample (POC) was weighed, and all of it filtered through 0.7 µm glass filter (Whatman GF/F). The filters and filtrate were dried at 50°C overnight, and placed in aluminium folders before analysis. The glass filters and aluminium folders were ‘precombusted’ for four hours at 450°C before sample preparation. Filter holders were washed in 1N HCl before filtration. Analyses of particulate carbon and nitrogen on glass-fibre filters were performed at Umeå Marine Sciences Center, Sweden with a Carlo Erba model 11081 high temperature combustion elemental analyser, using standard procedures and a combustion temperature of 1030°C. Acetanilide was utilized for standardization, and results were corrected for blank filter carbon content.

Analytical methods for dissolved constituents

The dissolved major and trace elements were measured in 4 laboratories: Science Institute, University of Iceland (SI); Analytica-SGAB Luleå, Sweden; Umeå Marine Sciences Center, Sweden and Stockholm University, Sweden. The analytical results, based on replicated analyses of the water samples in the various laboratories, were well within 10%. The average charge balances of major elements were less than 2%. The concentrations of dissolved nutrients (NO_3, NO_2, NH_4 and PO_4) and total dissolved P and N were determined colourimetrically with an Alpkem autoanalyser. Total dissolved P was also measured by ICP from the acidified 90 ml sample (concentrated suprapure HNO_3). DON was calculated by the difference between the sum of dissolved inorganic NO_3, NO_2 and NH_4 and total dissolved N. The colorimetric measurement of total dissolved N and P were performed after 20 ml of the samples had been radiated in silica test tubes for two hours with UV-light. Twenty ml of concentrated hydrogen peroxide were added to the samples before radiation. Total dissolved N was then measured after the radiation as NO_3 concentration, and total dissolved P as PO_4 concentration. DOP was calculated by the difference between the dissolved PO_4 and total dissolved P. The concentration of DOP was most often close to the detection limits of both methods. Thus the uncertainty of the concentration is considerably higher than 10%. The total P and DOP concentrations in this report are based on the total dissolved P measured by the inductively coupled plasma (ICP) as described below. Concentrations of DOC were measured using a Shimadzu TOC-5000 high temperature catalytic oxidation instrument. Samples were acidified and sparged prior to analysis. Calculation of carbon concentrations was made with potassium hydrogen phthalate as standard substance.

The Cl, F and SO_4 measurements were done with a Dionex – High Pressure Liquid Chromatograph. The major elements (Na, Ca, Mg, etc.) were determined by inductively coupled plasma atomic emission spectrometry (ICP-AES) together with minor and trace elements present in relatively high concentrations. Trace elements in low concentrations were determined by inductively coupled plasma sector mass spectrometry (ICP-SMS), sometimes referred to as high resolution ICP-MS. The choice of which ICP technique to use for which element in a specific sample depended on the concentration of the elements. Concentration of K which was below the detection limits of the ICP-AES was measured by atomic adsorption (AA) and mercury by atomic fluorescence spectrometry (AFS).

Dissolved sulphate was converted to $BaSO_4$ for sulphur isotopic analyses (e.g. Torssander, 1986; Torssander and Mörth 1998). The $BaSO_4$ was mixed with an equal amount of V_2O_5 and reacted in an online EA converting the $BaSO_4$ to $SO_{2(g)}$, which was then analysed in a CF-SIRMS (Finnigan Delta+). The sulphur isotope composition was defined as a deviation in ‰ of the ratio $^{34}S/^{32}S$ between a sample and a standard, expressed in the conventional $\delta^{34}S$ notation relative to Cañon Diablo Troilite (CDT). The accuracy of the measurements based on standard measurements was better than ± 0.2 ‰ for all samples.

Flux calculations

Annual river fluxes, F, were calculated according to equation (1) according to the Oslo and Paris Commissions, 1995: Implementation of the Joint Assessment and Monitoring Programme, Appendix 2, Principles of the Comprehensive Study on Riverine Inputs, page 22 to 27:

$$F = \frac{Q_r \sum_{i=1}^{n} (C_i Q_i)}{\sum_{i=1}^{n} Q_i} \qquad (1)$$

Where:

- C_i is the concentration of suspended or dissolved constituents in sample i (mg/kg).
- Q_i is the discharge at the time of sampling (m^3/sek).
- Q_r is the long term average discharge of the river of interest (m^3/sek).
- n is the number of samples collected during the research period.

RESULTS

The results for Rivers Vatnsdalsá, Vídidalsá and Nordurá are reported below and the quality of the results assessed.

Sampling and analytical results

The results from the various measurements are shown in Table 1 and Tables 3 to 6. Calculated fluxes according to equation 1 are shown in Table 2. Detection limits and precision of the various measurements are shown in Table 7.

The average of all measurements for each river for 2004 and 2005 is shown in Table 1. The World average for unpolluted rives is shown for comparison in Table 1 (Meybeck 1979, 1982; Martin and Meybeck, 1979; Martin and Withfield, 1983). Calculated fluxes according to equation 1 are shown in Table 2. These two tables underscore the difference between the three rivers.

Tables 3a and 3b report the results in the sampling sequence. This aids in tracing possible mistake during sampling, by comparing results between individual expeditions. Systematic difference between individual expeditions indicates mistakes during sampling. Results for individual rivers are reported in Tables 4, 5 and 6 were variations within the years are underscored. Detection limits and precision of the various methods are given in Table 7.

Vanadium, V, is included in the flux of heavy metals in Table 2. Vanadium is lighter than iron, Fe, and the concentration of vanadium is relatively high. Including vanadium in the heavy metal flux increases the flux, compared to previous heavy metal flux calculations (S. R. Gíslason et. al. 2003). Chemical analysis of vanadium was initiated in 2004 because it is an important metal in enzymes involved in bacterial fixation of nitrogen in river waters (Gislason and Eiríksdóttir 2004).

The sample temperature at the time of pH and conductivity measurements is given in Tables 3 to 6, since pH and conductivity are temperature dependent. Concentration of dissolved major elements is given in mmol/l, but trace elements in µmol/l or nmol/l. Alkalinity, abbreviated as Alk in Tables 1, and 3 to 6 is given in milliequvalent per kg of water (meq/kg). Total dissolved inorganic carbon, DIC, is given as mmol/kg in Tables 1, and 3-6. DIC is calculated according to equation 2 using the measured alkalinity, total dissolved silica, pH and the sample temperature at which the pH measurement was done. This temperature is used to define the value of the temperature dependent dissociation constants in the equation. Activity as assumed to be equal to molality (mol/kg) in the calculations.

$$DIC = 1000 \frac{\left(Alk - \frac{K_w}{10^{-pH}} - \frac{Si_T}{\left(\frac{10^{-pH}}{K_{Si}} + 1 \right)} + 10^{-pH} \right)}{\left(\left(\frac{10^{-pH}}{K_1} + 1 + \frac{K_2}{10^{-pH}} \right)^{-1} + 2 \left(\frac{\left(10^{-pH}\right)^2}{K_1 K_2} + \frac{10^{-pH}}{K_2} + 1 \right)^{-1} \right)} \qquad (2)$$

K_1 is temperature dependent dissociation constant for carbonic acid (Plummer and Busenberg 1982), K_2 is temperature dependent dissociation constant for bicarbonate (Plummer and Busenberg 1982), K_{Si} is temperature dependent dissociation constant for the monomeric uncharged silica species (Stefán Arnórsson et al. 1982), K_w is temperature dependent dissociation constant for water (Sweeton et al. 1974) and Si_T is the measured total concentration of dissolved silica (Tables 1, 3, 4, 5 and 6). All concentrations are in mol/kg except alkalinity which is in eq/kg. Equation 2 is adequate as long as the pH of the river waters are lower than 9 and total dissolved solids (TDS) are less than about 100 mg/kg. At higher concentration and higher pH computer codes such as PHREEQC (Parkhurst and Appelo 1999) should be used.

Total dissolved solids ($TDS_{calculated}$) are the total sum of the concentrations (mg/l) of the major elements according to equation 3;

$$TDS_{calculated} = Na + K + Ca + Mg + SiO_2 + Cl + SO_4 + CO_3 \qquad (3)$$

Total dissolved inorganic carbon (DIC) given in mmol/l in Tables 1, 3, 4, 5 and 6 is cast in terms of mg CO_3/l in equation 3. This is done to be consistent with measured total dissolved solids, TDS_{meas}. Total dissolved solids are measured by weighing the evaporate residue of the water that passed through the 0.45 µm filter, after the suspended matter measurements as described previously. The pH of the samples increases during evaporation, most of the dissolved inorganic carbon is transferred to carbonate and precipitated as calcite ($CaCO_3$) and finally at very high concentration as trona ($Na_2CO_3NaHHCO_3$). Before trona precipitates at the end of evaporation some CO_2 is lost by degassing (Eugster 1970; Jones et al. 1977; Hardy and Eugster 1970). Because of this loss, TDS_{meas} concentration is most often lower than the calculated total dissolved solid concentration, TDS_{calc}.

The concentration of total suspended matter, TSM, is given in mg/l.

The detection limits and precision of analytical methods are given in Table 7. When the concentration of dissolved constituents is below the detection limits, the concentration is reported as lower than (<) the detection limit given in Table 7. These values are included in average concentration and flux values in Tables 1, 2 and 3 to 6. The detection limit value is used, but the average is reported as lower than (<) the calculated average value including the detection limit value.

All samples measured at the Science Institute are measured at least twice. Average relative errors between measurements are given in Table 7. The relative error varies from one measurement to another, as it varies with the concentration. The relative error is higher close to the detection limits of the methods than at much higher concentrations. The concentrations of the nutrients, PO_4, NO_3, NO_2, NH_4, P_{tot}, and N_{tot} are close to the detection limits of the methods. Thus, the relative error is variable and often higher than 10% and especially for the P_{tot}, and N_{tot} and the P_{tot}, and N_{tot} derived concentrations; DOP and DON, as these concentrations are close to the detection limits of the analytical methods and the preparation of the samples involves transfer between the various sample vials and radiation before analysis.

Charge balance and the relative error of the charge balance

The quality of the chemical analysis of the charged dissolved major elements can be assessed by the charge balance. If measurements are in error, or some major dissolved charged species is missing the + and – charges will not balance. The difference between the + and – charges and the relative charge balance error is given in Tables 3 to 6. The charge balance is calculated according to equation 4:

$$\text{Charge bal.} = \text{Cations} - \text{Anions} = Na + K + 2\,Ca + 2\,Mg - Alk - Cl - 2\,SO_4 - F \quad (4).$$

The relative error of the charge balance is calculated by equation 5:

$$Chargebal\% = 100 \frac{Chargebal.}{cations + anions} \qquad (5)$$

Equation 5 is a bit different from what has been used in previous river monitoring reports. The denominator in eq. 5 used to be ((cations + anions)/2), but now the sum of major cations and anions are used rather than the average of the two. Thus the present chargebal% is lower than the previous one reported by the Science Institute. This was changed be more consistent with speciation computer codes like PREEQC (Parkhurst and Appelo 1999). The average percent charge balance is less than 2% highlighting the good quality of the measurements of the major dissolved elements.

Average composition of the rivers

The average composition of the Nordurá, Vídidalsá and Vatnsdalsá rivers are shown in Table 1. The concentrations and alkalinity of Vatnsdalsá and Vídidalsá are relatively high. Especially in Si, K, Ca, Mg, Fe and dissolved organic carbon (DOC) and dissolved organic nitrogen (DON). Perhaps reflection extensive wetland areas in the two catchments. But these two rivers are low in Al concentration compared to other rivers in Iceland. The Nordurá River has the same average TDS as was measured in the river in 1973-1974 (Gislason et al. 1996). However the Cl concentration in River Nordurá has increased significantly as is the case for some other rivers in West Iceland.

River fluxes in North-Western Iceland

Annual river fluxes calculated according to equation 2 is shown in Table 2. Calculations use data from 2004 and 2005. As discussed earlier, fluxes are given as lower than the calculated one (<) if a sample for that particular element has once or more often been measured below the detection limits of the analytical methods.

Suspended and dissolved matter fluxes are calculated by the same method (eq.1). The fluxes results from air borne dissolved and particulate matter to the catchments, they are caused by chemical and mechanical weathering and denudation, because of decay of organic matter and human disturbances.

Dissolved sulphur is measured by two methods, inductively coupled argon plasma emission spectrograpy (ICP-AES) and a Dionex – High Pressure Liquid Chromatograph.

The ICP-AES measured total dissolved sulphur S_{tot}, but the chromatograph measures the concentration of the dominating sulphur species, sulphate (SO_4^{--}). As can be seen in Tables 3-6, the concentrations are within uncertainty the same (“%) demonstrating that virtually all the dissolved sulphur to be on the form of sulphate (SO_4^{--}). Both S_{tot} and SO_4^{--} fluxes are given in Table 2 and they are about the same.

Nordurá at Stekkur

The results for the Nordurá River are shown in Table 4. There are 6 samples for each year. In 2004 there is one winter sample taken 25th of February, one fall sample; October 21st the rest of the samples were colleted in May, July, August and September. In 2005 there were three winter samples taken in February, October and November, the rest of the samples were collected in May, June and August.

Discharge varied by factor of 7, from 6.5 m^3/s, July 5th 2004 to 45.3 m^3/s 3rd of October 2005. The water temperature during sampling in February 2004 and 2005 was 0 and –0.2°C. The river discharge and chemistry of these samples are more uncertain than the rest because of ice frustules formation and chemical fractionation during partial freezing of water. The average pH was 7.49 and it was highest in the summer samples both years. The average conductivity of the river waters was 68 µS/cm, similar to Ölfusá in South Iceland and Jökulsá á Dal at Hardarhagi in Eastern Iceland. The average Si concentration was 0.189 mmol/l, higher than all rivers in Eastern Iceland, excluding river Jökulsá á Fjöllum. All rivers in south Iceland are higher in average Si concentration except River Sog, which is similar, 0.180 µmol/l. The concentrations of the major cations reflect both the concentrations derived from weathering and the seawater component in precipitation. All rivers in south Iceland are higher in average Na concentration than river Nordurá; 0.266 mmol/l. In East Iceland all rivers but Jökulsá á Fjöllum are lower than river Nordurá in Na average concentration. This is reverse for Ca and Mg, all rivers in South Iceland except rivers Ytri-Rangá and Thjórsá are lower in average Ca and Mg concentrations than River Nordurá; 0.105 and 0.07 mol/l respectively; but in East Iceland all but Fellsá and Fjardará are higher in Ca, but only Jökulsá á Fjöllum and Jökulsá í Fljótsdal are higher in Mg average concentration than Nordurá. Alkalinity indicates the amount of weathering that the river waters have caused. The average alkalinity of Nordurá; 0.370 meq/kg, is lower than all the rivers in South Iceland with the exception of Brúará at Efstidalur. All the rivers in Eastern Iceland except Fellsá and Fjardará are higher in alkalinity then the Nordurá River. The concentration of dissolved sulphur reflects the concentrations derived from weathering, and the seawater and anthropogenic component in precipitation (Gislason and Torssander 2006). The average sulphate concentrations using ICP and ion chromatograph are the same; 0.019 mmol/l (Table 4). Indicating that essentially all the river dissolved sulphur is on the sulphate form (SO_4^{2-}). The average concentration is lower than the average sulphur concentration of all the rivers in South Iceland with the exception of Brúará at Efstidalur; 0.017 mmol/l and river Tungufljót at Faxi; 0.015 mmol/l. In eastern Iceland it is just Fellsá and Fjardará that are lower in dissolved sulphur. The dissolved sulphur isotope ratio of Nordurá; $\delta^{34}S$ (‰) is the second heaviest Icelandic river water ratio measured so far; 12.3 ‰. The heaviest river sulphate isotope ratio is in Vídidalsá; 14.8 ‰ Precipitation on the Langökull glacier range from 13 to 18 ‰ $\delta^{34}S$, the rock component is around 0 ‰ and the anthropogenic component around 5 ‰ (Gislason and Torssander 2006). The average concentration of Cl is high in Nordurá; 0.205 mmol/kg. Average Cl for Nordurá at Stekkur for the years 1973-1972 (average of 17 samples) was 0.189 mmol/l (Gislason et al. 1996), about 8% decline in average Cl concentration. The present Cl concentration of Nordurá is higher than the Cl concentration of all rivers in East Iceland and higher than all but river Ytri-Rangá in South Iceland. The average F concentration in Nordurá is lower than the F concentration in all the rivers in south Iceland and it is lower than all the rivers in East Iceland with the exception of Fellsá and Fjardará. The percent average charge balance is 0.8% which is excellent, reflecting the high quality of the major element analysis. Average calculated TDS for the years 2004 to 2005 was 57 mg/kg. Average calculated TDS for Nordurá at Stekkur for the years 1973-1972 (average of 17 samples) was 58 mg/l (Gislason et al. 1996). Average dissolved organic carbon (DOC) is low like in all Icelandic rivers, 0.037. This is higher than all the rivers in eastern Iceland, and higher than all but Ölfusá and Thjórsá at Sandafell in South Iceland. Particle organic carbon (POC) concentration of Nordurá; 175 µmol/kg, is lower than the POC concentrations of all the rivers in Eastern Iceland, and all but river Ytri-Rangá in South Iceland. The C/N particulate mol ratio of river Nordurá, 9.29 is the lowest average river ratio measured so far in Iceland, close to the 6.6.

Redfield ratio of organic particulates derived from algae. Terrestrial plants and soils have much higher ratio. The average total suspended inorganic particulate concentration (TSM) was 6 mg/kg, lower than the TSM of all the rivers in Eastern Iceland and South Iceland. River Sog in South Iceland is closest, with 7.7 mg/kg. There is a discrepancy in the average total dissolved phosphorous concentration; < 0.050 µmol/l, reported in Table 4 measured by ICP and the average PO4 concentration; <0.260 µmol/l, measured by the Alpkem Auto analyser in Table 4. Because of this discrepancy, the calculated DOP is negative. The average PO4 concentration for Nordurá at Stekkur for the years 1973-1972 (average of 17 samples) was 0.1 µmol/l (Gislason et al. 1996). The average inorganic dissolved nitrogen nutrient concentrations, NO_3, NO_2 and NH_4 for the Nordurá River was 1.15, 0.08 and 0.8 µmol/l respectively (Table 4). The NO_3 concentration is about two times lower than the average concentration for 1973-1974, the NO_2 concentration is about similar, but NH_4 about 3.5 times lower than the one of 1973-1974 (Gislason et al. 1996). The total dissolved nitrogen (N_{total}) analysis for the first 4 samples in 2004 are not included in Table 4. The hydrogen peroxide used for the analysis turned out to be contaminated. The average calculated dissolved organic nitrogen for the rest of the samples; DON ($DON=N_{tot}- NO_3-NO_2-NH_4$) is 3.1 µmol/kg, higher than the DON in all the rivers in East and South Iceland. The average Al concentration of Nordurá River is lower than the one in all the rivers in South and East Iceland with the exception of rivers Fellsá and Fjardará. Conversely, the Fe concentration in River Nordurá is higher than all the rivers in the East and South Iceland except rivers Ölfusá and Ytri-Rangá in South Iceland.

Concentration versus discharge correlations in River Nordurá at Stekkur

After the discharge picture, and table for each river, there are two pages of diagrams depicting the relationship between concentration of selected constituents and discharge similar. This is similar to previous river monitoring reports (e.g. Sigurdur R. Gíslason et al. 2003; 2004). All the data is fitted by a second order power function. The functions and regression coefficients are superimposed on the diagrams on river. The concentration of selected constituents and discharge at the time of sampling is shown on the left hand side. But shown on the right hand side are the rock derived concentrations versus discharge. The concentration of Na, K, Ca, Mg and SO_4 is corrected for the average composition of precipitation in the catchments. Most of the dissolved solids in the precipitation are derived from sea-spray and seawater derived aerosols (Gislason et al. 1996; Gislason and Torssander 2006). For example, the total dissolved sulphate, $_{td}SO_4^{2-,}$ was differentiated according to its origin into non-sea-salt sulphate, $_{nss}SO_4^{2-}$, and sea-salt-derived sulphate, $_{ss}SO_4^{2-}$. The sea-salt-derived sulphate was calculated from the river-dissolved Cl, assuming all the Cl to be derived from seawater, using the SO_4^{2-}/Cl^- molar ratio of 0.05222 (Bruland 1983). This has been proved to be a good assumption (e.g., Gislason et al. 1996) for the rivers of southwest Iceland, because of the overall low average concentration of Cl^- in basaltic rocks, 180ppm (Sigvaldason and Óskarsson, 1976), high runoff and relief, and sparse vegetation and population (less than 3 inhabitants per km^2).

There is some but not a conspicuous correlation between concentration versus discharge in river Nordurá (Figs. 3 and 4). Particulate matter increases with discharge (Fig. 3) and all dissolved constituents decrease in concentration except rock derived sulphate (Fig. 4). Much of the sulphate is derived from precipitation. It is only the concentration of the trace element molybdenum (Mo) that exhibits a striking correlation with discharge. Dissolved constituent concentrations in glacier fed rivers in East Iceland and South Iceland is strongly dependent on discharge, direct rivers a bit less and rivers draining lakes like Rivers Sog in South Iceland and Lagarfljót in East Iceland exhibit very little correlation with discharge (Gíslason et al. 2003 and 2004).

Time series for River Nordurá

There is not much of a seasonal variation in the particulate and dissolved constituents of River Nordurá (Figs. 5 and 6). The flood sample from October 2005 in highest in POC and the February 2005 sample is highest in Cl, SO_4, and the metals Fe, Mn and Co. These three metals in fact exhibit some seasonal variation with maximum concentration in the winter time. The limited data for SO_4 could indicate a continuous increase in SO_4, as the isotope ratio in decreasing indicating increase in man-made sulphur source.

Vídidalsá at Kolugil

The results for River Vídidalsá are shown in Table 5. There are 6 samples for each year. In 2004 there is one winter sample taken 25th of February, one fall sample;

October 21st, the rest of the samples were collected in May, July, August and September. In 2005 there were three winter samples taken in February, October and November, the rest of the samples were collected in May, June and August.

Discharge varied by factor of 5, from 2.6 m^3/s, September 15th 2004 to 12.8 m^3/s 3rd of October 2005. The water temperature during sampling in February 2004 and 2005 was 0 and –0.1°C. The river discharge and chemistry of these samples are more uncertain than the rest because of ice frustules formation and chemical fractionation during partial freezing of water. The average pH was 7.74 and it was highest in the summer samples both years. The average conductivity of the river waters was 92.3 µS/cm, higher than all but Jökulsá á Fjöllum in East Iceland, and all but Ytri – Rangá in south Iceland. The average Si concentration was 0.303 mmol/l, higher than all rivers in Eastern Iceland, and all but the Ytri-Rangá River in south Iceland. The concentrations of the major cations reflect both the concentrations derived from weathering and the seawater component in precipitation. All rivers in South Iceland are higher in average Na concentration than River Vídidalsá; 0.270 mmol/l. In East Iceland all rivers but Jökulsá á Fjöllum are lower than River Vídidalsá in Na average concentration. This is reverse for Ca and Mg. All rivers in South Iceland except rivers Ytri-Rangá are lower in average Ca, Mg and K concentrations than River Vídidalsá; 0.154, 0.139 and 0.016 mmol/l respectively. In East Iceland it is only River Jökulsá í Fljótsdal that is higher in average Ca concentration than Vídidalsá. Alkalinity indicates the amount of weathering that the river waters have caused. The average alkalinity of Vídidalsá river; 0.644 meq/kg, is higher than all the rivers in South Iceland with the exception of River Ytri - Rangá. All the rivers in Eastern Iceland except the rivers Jökulsá á Fjöllum and Jökulsá í Fljótsdal are lower in alkalinity than the Vídidalsá River. The concentration of dissolved sulphur reflects the concentrations derived from weathering, and the seawater and anthropogenic component in precipitation (Gislason and Torssander 2006). The average sulphate concentrations using ICP; 0.013 mmol/l, and ion chromatograph, 0.012 mmol/l are nearly the same (Table 5). Indicating that essentially all the river dissolved sulphur is on the sulphate form (SO_4^{2-}). The average concentration is lower than the average sulphur concentration of all the rivers in South Iceland. In eastern Iceland it is just Fellsá and Fjardará that are lower in dissolved sulphur, 0.007 and 0.011 mmol/l, respectively. The dissolved sulphur isotope ratio of Vídidalsá; $\delta^{34}S$ (‰) is the heaviest Icelandic river water ratio measured so far; 14.8 ‰. The samples from the year 2005 are left to be measured (Table 5). The heaviest river sulphate isotope ratio is in Vídidalsá; 14.8 ‰. Precipitation on the Langökull glacier range from 13 to 18 ‰ $\delta^{34}S$, the sulphate rock component is around 0 ‰ and the anthropogenic component around 5 ‰ (Gislason and Torssander 2006). This high sulphate isotope ratio precludes that oxidation of iron sulphates is the cause of the relatively high concentration of Ca and Mg in this river. The average concentration of Cl is high in Vídidalsá; 0.209 mmol/kg. This is similar to the Cl concentration of Nordurá River in West Iceland, higher than the Cl concentration of all rivers in East Iceland and higher than all but river Ytri-Rangá in South Iceland. The average F concentration of Vídidalsá, 2.37 µmol/l, is lower than the F concentration in all the rivers in South Iceland and it is lower than all the rivers in East Iceland with the exception of rivers Grímsá, Fellsá and Fjardará. The percent average charge balance is 1.6% which is higher than the one for river Nordurá, 0.8%. The highest one is for sample 04N007, 8.1% and the charge balance is negative, indicating that the concentration of negative charges is too high or the concentration of cations are to low (eq. 4). It is most likely that alkalinity of this sample is too high although it is not a striking outlier on a plot of alkalinity vs. conductivity. Average calculated TDS_{calc} for river Vídidalsá for the years 2004 to 2005 was 84 mg/kg. Average dissolved organic carbon (DOC) is low like in all Icelandic rivers, 0.062 mmol/l. However, this is higher than all the rivers in East Iceland, and higher than all but River Ölfusá (0.065 mmol/l) in South Iceland. Average particle organic carbon (POC) concentration of Vídidalsá; 257 µmol/kg, is higher than the POC concentrations of the rivers in East Iceland, except Jökulsá á Dal, Jökulsá í Fljótsdal and Lagarfljót and all but Rivers Sog, Brúará , Ölfusá and Ytri-Rangá in South Iceland. The average C/N particulate mol ratio is low, 10.6 (Table 5). It is close to the 6.6 Redfield mol ratio of organic particulates derived from algae. Terrestrial plants and soils have much higher ratio. This indicates that most of the organic particles in this river stem from algae. The average total suspended inorganic particulate concentration (TSM) was 14 mg/kg, slightly higher than the TSM of rivers Fellsá (10 mg/kg), Grímsá (10 mg/kg), and Fjardará (8 mg/kg), in East Iceland. River Sog, 7.7 mg/kg, is the only river in South Iceland that is lower in TDM than river Vídidalsá. There is a discrepancy in the average total dissolved phosphorous concentration; 0.074 µmol/l, reported in Table 5 measured by ICP and the average PO_4 concentration; <0.205 µmol/l, measured by the Alpkem Auto analyser (Table 5). Because of this discrepancy, the calculated DOP is negative. The average inorganic dissolved nitrogen nutrient concentrations, NO_3, NO_2 and NH_4 for the Vídidalsá River was 0.797, 0.083 and 1.36 µmol/l respectively (Table 5). The total dissolved nitrogen (N_{total}) analysis for the first 4 samples in 2004 are not included in Table 5. The hydrogen peroxide used for the analysis turned out to be contaminated. The average calculated dissolved organic nitrogen for the rest of the samples; DON ($DON=N_{tot}-NO_3-NO_2-NH_4$) is 4.1 µmol/kg, higher than the DON in all the rivers in East, South and west Iceland. The average Al concentration of Vídidalsá River (0.129 µmol/l) is lower than the one in all the rivers in South, East and West Iceland. Conversely, the Fe concentration in River Vídidalsá is higher than all the rivers in the East and South Iceland.

Concentration versus discharge correlations in River Vídidalsá

There is some correlation between concentration of particulate and dissolved constituents versus discharge in river Vídidalsá (Figs. 8 and 9). Particulate matter concentration, organic and inorganic increases with discharge (Fig. 8). Dissolved Na, K, Mg, Si, Cl and SO_4 increases with discharge and Ca and alkalinity are not affected by discharge in river Vídidalsá. This is very rare in Icelandic rivers. When seawater contribution through precipitation is subtracted from the river water composition two samples exhibit “negative concentration” of SO_4 indicating that some Cl could be derived from otter source than seawater. Molibdenum (Mo) exhibits beautiful correlation with discharge, the concentration decreases with increasing river discharge (Fig. 9).

Time series for River Vídidalsá

There is not much of a seasonal variation in the particulate and dissolved constituents of River Vídidalsá (Figs. 10 and 11). The flood sample from October 2005 in highest in POC. The manganese concentration is the only element in Figs. 10 and 11 that shows seasonal variation, with maximum concentration in the winter time.

Vatnsdalsá at Forsaeludalur

The results for River Vatnsdalsá are shown in Table 6. Similar to rivers Nordurá and Vídidalsá, there are 6 samples for each year. In 2004 there is one winter sample taken 25th of February, one fall sample; October 21st the rest of the samples were colleted in May, July, August and September. In 2005 there were three winter samples taken in

February, October and November, the rest of the samples were collected in May, June and August.

There was not much variation in discharge. It varied by factor of 5, from 2.6 m^3/s, September 15th 2004 to 12.8 m^3/s 3rd of October 2005. The water temperature during sampling in February 2004 and 2005 was 0 and –0.2°C. The river discharge and chemistry of these samples are more uncertain than the rest because of ice frustules formation and chemical fractionation during partial freezing of water. The average pH was 7.82 and it was highest in the summer samples both years. The average conductivity of the river waters was 96.8 µS/cm, higher than all but Jökulsá á Fjöllum in East Iceland, and all but Ytri – Rangá in South Iceland. The average Si concentration was 0.341 mmol/l, higher than all rivers in Eastern Iceland, and all but the Ytri-Rangá River in South Iceland. The concentrations of the major cations reflect both the concentrations derived from weathering and the seawater component in precipitation. It is only Rivers Thjórsá and Ytri - Rangá in South Iceland are higher in average Na concentration than River Vídidalsá; 0.377 mmol/l. In East Iceland all rivers but Jökulsá á Fjöllum are lower than River Vatnsdalsá in average Na concentration. All rivers in South Iceland except rivers Ytri-Rangá are lower in average Ca, Mg and K concentrations than River Vatnsdalsá; 0.146, 0.139 and 0.025 mmol/l respectively. In East Iceland it is only Rives Jökulsá á Fjöllum and Jökulsá í Fljótsdal that is higher in average Ca concentration than Vídidalsá. Alkalinity indicates the amount of weathering that the river waters have caused. The average alkalinity of Vatnsdalsá River, 0.733 meq/kg, is higher than all the rivers in South Iceland with the exception of River Ytri - Rangá. All the rivers in Eastern Iceland except the River Jökulsá á Fjöllum are lower in alkalinity than the Vatnsdalsá River. The concentration of dissolved sulphur reflects the concentrations derived from weathering, and the seawater and anthropogenic component in precipitation (Gislason and Torssander 2006). The average sulphate concentrations using ICP; 0.013 mmol/l, and ion chromatograph, 0.013 mmol/l are the same (Table 5). Essentially all the river dissolved sulphur is on the sulphate form (SO_4^{2-}). The average concentration is lower than the average sulphur concentration of all the rivers in South Iceland. In eastern Iceland it is just Fellsá and Fjardará that are lower in dissolved sulphur, 0.007 and 0.011 mmol/l respectively. The dissolved sulphur isotope ratio of Vatnsdalsá; $\delta^{34}S$ (‰) is relatively high; 11.1 ‰. It is just rivers Vídidalsá and Nordurá that have been measured higher in Iceland. The samples from the year 2005 are left to be measured

(Table 5). The heaviest river sulphate isotope ratio is in Vídidalsá; 14.8 ‰. Precipitation on the Langökull glacier range from 13 to 18 ‰ $\delta^{34}S$, the sulphate rock component is around 0 ‰ and the anthropogenic component around 5 ‰ (Gislason and Torssander 2006). This high sulphate isotope ratio precludes that oxidation of iron sulphates is the cause of the relatively high concentration of Ca and Mg in this river. The average concentration of Cl is 0.152 mmol/kg. This is lower than the average Cl concentration of rivers Nordurá and Vídidalsá, higher than the Cl concentration of all rivers in East Iceland and higher than all but rivers Sog, Ölfusá and Ytri-Rangá in South Iceland. The average F concentration of Vatnsdalsá, 4.25 µmol/l, is lower than the F concentration in the rivers close to the volcanic zone in South Iceland (Hvítá, Ölfusá, Thjórsá and Ytri-Rangá) and it is higher than all the rivers in East Iceland with the exception of River Jökulsá á Fjöllum which drains the volcanic zone. The percent average charge balance is 1.6% which is higher than the one for river Nordurá, 0.8% but the same as the one for Vídidalsá (Tables 4 and 5). The highest one is for sample 04N006, 5.8% and the charge balance is positive, indicating that the concentration of negative charges is to low or the concentration of cations are to high (eq. 4). It is most likely that alkalinity of this sample is too low. It is a striking outlier on a plot of alkalinity vs. conductivity, with to low alkalinity. Average calculated TDS_{calc} for river Vatnsdalsá for the years 2004 to 2005 was 91 mg/kg. It is only rivers Jökulsá á Fjöllum (96 mg/kg) and Ytri – Rangá (177 mg/kg) that are higher. Average dissolved organic carbon (DOC) is low like in all Icelandic rivers, 0.051 mmol/l. However, this is higher than all the rivers in East Iceland, and higher than all but Rivers Ölfusá (0.065 mmol/l) and Brúará (0.074 mmol/l) in South Iceland. Average particle organic carbon (POC) concentration of Vatnsdalsá; 364 µmol/kg, is higher than the POC concentrations of the rivers in East Iceland, except Jökulsá í Fljótsdal and Lagarfljót and all but Ölfusá in South Iceland. The average C/N particulate mol ratio is low, 10.1 (Table 5). It is close to the 6.6 Redfield mol ratio of organic particulates derived from algae. Terrestrial plants and soils have much higher ratio. This indicates that most of the organic particles in this river stem from algae. The average total suspended inorganic particulate concentration (TSM) was 7 mg/kg, slightly lower than the TSM of rivers Fellsá (10 mg/kg), Grímsá (10 mg/kg), and Fjardará (8 mg/kg), in East Iceland. And River Sog, 7.7 mg/kg, in South Iceland. There is a discrepancy in the average total dissolved phosphorous concentration; 0.376 µmol/l, reported in Table 5 measured by ICP and the average

PO_4 concentration; <0.386 µmol/l, measured by the Alpkem Auto analyser (Table 5). Because of this discrepancy, the calculated DOP is negative. The average inorganic dissolved nitrogen nutrient concentrations, NO_3, NO_2 and NH_4 for the Vatnsdalsá River was 1.06, 0.075 and 1.31 µmol/l respectively (Table 5). The total dissolved nitrogen (N_{total}) analysis for the first 6 samples in 2004 are not included in Table 5. The hydrogenperoxide used for the analysis turned out to be contaminated. The average calculated dissolved organic nitrogen for the rest of the samples; DON ($DON=N_{total} - NO_3-NO_2-NH_4$) is 4.69 µmol/kg, higher than the DON in all the rivers in East, South and west Iceland. The average Al concentration of Vatnsdalsá River (0.200 µmol/l) is lower than the one in all the rivers in South and East Iceland with the exception of the direct runoff rivers in the East Iceland; Fellsá, Grímsá and Fjardará. Conversely, the Fe concentration in River Vatnsdalsá is higher than all the rivers in the East and South Iceland.

Concentration versus discharge correlations in River Vatnsdalsá

There is some correlation between concentration of particulate and dissolved constituents versus discharge in river Vatnsdalsá (Figs 13 and 14). Particulate matter concentration, organic and inorganic increases with discharge (Fig. 13). Dissolved Na, K, Alkalinity and Mo concentrations decreases with discharge. Conversely, Mg, Ca, Si, Cl and SO_4 increases with discharge in River Vídidalsá. This is very rare in Icelandic rivers. As in Nordurá and Vídidalsá, molybdenum (Mo) exhibits beautiful correlation with discharge, the concentration decreases with increasing river discharge (Fig. 14)

Time series for River Vatnsdalsá

There is not much of a seasonal variation in the particulate and dissolved constituents of River Vídidalsá (Figs. 15 and 16). The flood sample from October 2005 in highest in POC. The manganese concentration is the only element in Figs. 15 and 16 that shows seasonal variation, with maximum concentration in the winter time.

ACKNOWLEDGEMENTS

The study was supported by the Ministry for the Environment through AMSUM and the National Energy Authority, Natural Resources Division. We are grateful to Helgi Jensson, Gunnar Steinn Jónsson and Hákon Adalsteinsson for their support.

REFERENCES

Árni Snorrason 1990. Markmið og skipulag vatnamælinga á Íslandi. Í Vatnið og landið, Guttormur Sigbjarnarson (ritstjóri). Vatnafræðiráðstefna, október 1987. Orkustofnun, Reykjavík, bls. 89-93.

Bruland, K. W. 1983. Trace elements in seawater. In Chemical Oceanography; Riley, J. P., Chester, R., Eds.; Academic Press: London, 1983; Vol. 8, pp 157-220.

Eugster, H. P. 1970. Chemistry and origin of the brines of Lake Magadi, Kenya. Mineral. Soc. Am. Spec. Paper 3, bls. 213-235.

Gislason S. R and Eiríksdóttir E. S. (2003). Molybdenum control of primary production in the terrestrial environment. In: Water-Rock Interactions (Wanty R. B. and Seal II R. R., eds.), 1119-1122. Taylor & Francis Group, London.

Gislason S. R. and Torssander P. (2006). The response of Icelandic river sulfate concentration and isotope composition, to the decline in global atmospheric SO2 emission to the North Atlantic region. Environmental Science and Technology, 40,680-686.

Gislason, S. R., Arnórsson, S., and Ármannsson, H. (1996). Chemical weathering of basalt in SW Iceland: Effects of runoff, age of rocks and vegetative/glacial cover. American Journal of Science, 296, pp. 837-907.

Gislason, S. R., Oelkers E. H. and Snorrason Á. (2006). The role of river suspended material in the global carbon cycle. Geology 34, 49–52.

Gunnarsson, Á., Hardardóttir J., Jónsson P., Snorrason Á., Pálsson S. 2001. Measurements of Discharge and Suspended Matter of Jökulsá á Dal in 2000. 14319 Orkustofnun, Vatnamaelingar OS-2001/078 24: Reykjavik (in Icelandic).

Guy HP, Norman VW. 1970. Techniques of Water-Resources Investigations of the United States Geological Survey. Field Methods for Measurement of Fluvial Sediment 3 (C2). United States Government Printing Office: Washington, DC; 59.

Hardy, L. A. and Eugster, H. P. 1970. The evolution of closed-basin brines. Mineral. Soc. Am. Spec. Pub. 3, pp. 273-290.

Jones, B. F., Eugster H. P. and Rettig S. L. 1977. Hydrochemistry of the Lake Magadi basin, Kenya. Geochim. Cosmochim. Acta, 41, pp. 53-72.

Martin, J.M., and Meybeck, M. 1979. Elemental mass-balance of material carried by world major rivers: Marine Chemistry, V. 7, pp. 173 206.

Martin, J.M., and Whitfield, M. 1983. The significance of the river input of chemical elements to the ocean, In Wong, S.S., ed., Trace Metals in Seawater, Proceedings of the NATO Advanced Research Institute on Trace Metals in Seawater, March 1981: Erice, Plenum Press, pp. 265-296.

Meybeck, M. 1979. Concentrations des eaux fluviales en éléments majeours et apports en solution aux océans: Rev. Geologie Dynamique et Geographie Physique 21, pp. 215 246.

Meybeck, M. 1982. Carbon, nitrogen, and phosphorus transport by world rivers: American Journal of Science 282, pp. 401-450.

Oelkers, E. H., Gislason S. R, Eiríksdóttir E. S, Elefsen S. O. and Hardardottir J. 2004. The significance of suspended material in the chemical transport in rivers of NE Iceland. In Water-Rock Interactions (Wanty R. B. and Seal II R. R., eds.), 865-868. Taylor & Francis Group, London.

Oslo and Paris Commissions 1995. Implementation of the Joint Assessment and Monitoring Programme, 68 pp.

Parkhurst D.L, Appelo C.A.J. 1999. User's guide to PHREEQC (Version 2) – a computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations. Water resources investigations report 99-4259. Lakewood: US Geological Survey.

Plummer, N.L., and Busenberg, E. 1982. The solubility of calcite, aragonite and vaterite in CO_2-H_2O solutions between 0 and 90°C, and an evaluation of the aqueous model for the system $CaCO_3$-CO_2-H_2O: Geochimica et Cosmochimica Acta 46, pp. 1011 1040.

Sigurður Reynir Gíslason , Árni Snorrason, Eydís Salome Eiríksdóttir, Bergur Sigfússon, Sverrir Óskar Elefsen, Jórunn Harðardóttir, Ásgeir Gunnarsson, og Peter Torssander, (2003). Efnasamsetning, rennsli og aurburður straumvatna á Suðurlandi, VI. Gagnagrunnur Raunvísindastofnunar og Orkustofnnunar. Raunvísindastofnun, RH-03-2003, 85 bls.

Sigurður Reynir Gíslason , Árni Snorrason, Eydís Salome Eiríksdóttir, Bergur Sigfússon, Sverrir Óskar Elefsen, Jórunn Harðardóttir, Ásgeir Gunnarsson, Einar Örn Hreinsson, Peter Torssander, Níels Örn Óskarsson og Eric Oelkers (2004). Efnasamsetning, rennsli og aurburður straumvatna á Austurlandi, V. Gagnagrunnur Raunvísindastofnunar og Orkustofnnunar. Raunvísindastofnun, RH-05-2004, 101 bls.

Sigvaldason, G. E. and Óskarsson, N. 1976. Chlorine in basalts from Iceland. Geochim. Cosmochim. Acta , 40, 777-789.

Stefán Arnórsson, Sven Sigurðsson og Hörður Svavarsson 1982. The chemistry of geothermal waters in Iceland. I. Calculation of aqueous speciation from 0° to 370 °C: Geochimica et Cosmochimica Acta 46, bls. 1513-1532.

Stumm, W. and Morgan, J. 1996. Aquatic Chemistry. Chemical Equilibria and Rates in Natural Waters, 3rd ed. John Wiley & sons, New York, 1022 bls.

Svanur Pálsson og Guðmundur H. Vigfússon 1996. Gagnasafn aurburðarmælinga 1963- 1995, Orkustofnun OS-96032/VOD-05 B, 270 bls.

Svanur Pálsson og Guðmundur H. Vigfússon 2000. Leiðbeiningar um mælingar á svifaur og úrvinnslu gagna. Greinargerð, SvP-GHV-2000-2, Orkustofnun, Reykjavík.

Sweewton R. H., Mesmer R. E. and Baes C. R. Jr. 1974. Acidity measurements at elevated temperatures. VII. Dissociation of water. J. Soln. Chem. 3, nr. 3 pp. 191-214.

Torssander, Peter 1986. Origin of volcanic sulfur in Iceland. A Sulfur Isotope Study. Published PhD thesis. Meddelanden från Stockholms Universitets Geologiska Institution Nr. 268, Stokkhólmi, 164 pp.

Torssander, P. and Mörth, C.-M. 1998. Sulfur dynamics in the roof experiment at Lake Gårdsjön deduced from sulfur and oxygen isotope ratios in sulfate. In Experimental Reversal of Acid Rain Effects: The Gårdsjön Roof Project; Hultberg, H., Skeffington, R., Eds.; John Wiley & Sons: New York, 1998; pp. 185-206.

Table 1. Average composition of Rivers Nordurá, Vídidalsá and Vatnsdalsá in 2004-2005.

River	Discharge m^3/s	Water T °C	Air T °C	pH	Cond. µS/cm	SiO_2 mmol/l	Na mmol/l	K mmol/l	Ca mmol/l	Mg mmol/l	Alk (a) meq./kg	DIC mmol/l	SO_4 mmol/l ICP-AES	SO_4 mmol/l I.chrom	$\partial^{34}S$ ‰ (b)	Cl mmol/l I.chrom	F µmol/l I.chrom	TDS mg/l meas.	TDS mg/l calc.
Nordurá	14.5	4.8	6.0	7.49	68	0.189	0.266	0.008	0.105	0.070	0.370	0.401	0.019	0.019	12.3	0.205	1.57	50	57
Vídidalsá	5.7	4.9	6.0	7.74	92	0.303	0.270	0.016	0.154	0.139	0.644	0.674	0.013	0.012	14.8	0.209	2.37	65	84
Vatnsdalsá	7.9	4.4	5.4	7.82	97	0.341	0.377	0.025	0.146	0.116	0.733	0.763	0.013	0.013	11.1	0.152	4.25	70	91
World average						0.173	0.224	0.033	0.334	0.138		0.853	0.090	0.090		0.162	5.26	100	100

River	DOC mmol/l	POC µg/kg	PON µg/kg	C/N mol	SPM mg/l (c)	P_{total} µmol/l ICP-MS	P_{total} µmol/l col	DIP PO_4-P µmol/l	DOP P_{tot}-DIP	DIP/ DOP	TDN N_{total} µmol/l (d)	NO_3-N µmol/l	NO_2-N µmol/l	NH_4-N µmol/l	DIN	DON N_{tot}-DIN	DIN/ DON	POC/ SPM calc. ratio	DOC/ (DOC+POC) % calc.
Nordurá	0.037	175	<20.7	>9.84	6	*<0.050*	-	*<0.260*	*-0.210*		5.13	<1.05	<0.072	<0.744	<1.87	>3.26	<0.57	0.029	72
Vídidalsá	0.062	257	27.6	10.6	14	*0.074*	-	*0.205*	*-0.131*		6.60	0.797	0.083	<1.36	<2.24	>4.36	<0.51	0.018	74
Vatnsdalsá	0.051	364	41.4	10.1	7	*0.376*	-	*0.386*	*-0.010*		7.14	1.06	0.075	<1.31	<2.45	>4.69	<0.52	0.052	63
World average						0.323	0.323			0.67		7.14	0.065	1.14	8.57	18.60	0.46	1	60

River	Al µmol/l	Fe µmol/l	B µmol/l	Mn µmol/l	Sr µmol/l	As nmol/l	Ba nmol/l	Cd nmol/l	Co nmol/l	Cr nmol/l	Cu nmol/l	Ni nmol/l	Pb nmol/l	Zn nmol/l	Hg nmol/l	Mo nmol/l	Ti nmol/l	V µmol/l
Nordurá	0.151	0.592	0.521	0.066	0.074	<5.80	0.855	<0.019	<0.211	0.533	5.96	<1.66	<0.066	<10.7	<0.010	1.99	3.87	0.014
Vídidalsá	0.129	1.43	0.224	0.083	0.181	<2.01	1.92	<0.030	0.294	1.39	7.19	2.90	<0.093	<9.93	<0.010	<0.836	2.97	0.034
Vatnsdalsá	0.200	1.59	0.307	0.047	0.125	<2.13	1.75	<0.024	0.297	5.13	5.66	2.51	<0.078	<9.55	<0.010	2.68	4.09	0.351
World average	1.850	0.716		1.850	0.716												209	

(a) Alkalinity. (b) Data for δ^{34}S is from 2004. (c) Total inorganic suspended particulate matter.
(d) Data for N_{total} is from late year 2004 and 2005.

Table 2. Annual river fluxes, (tonnes/year), of Rivers Nordurá, Vídidalsá and Vatnsdalsá, calculated from 2004-2005 data.

River	**Average discharge** m^3/s **(a)**	**SiO_2**	**Na**	**K**	**Ca**	**Mg**	**CO_2**	**SO_4** ICP-AES	**SO_4** I.chrom	**Cl**	**F**	**TDS** meas.	**TDS** calc.	**DOC**	**POC**
Nordurá	22.4	7815	4195	228	2882	1158	12070	1279	1205	5033	19.1	32843	39047	380	180
Vídidalsá	7.0	4056	1378	139	1367	759	6572	280	263	1671	9.48	14348	18609	177	72.9
Vatnsdalsá	10.3	6666	2791	317	1896	919	10829	423	414	1750	25.8	22485	29525	202	127
Total	39.7	18537	8363	684	6145	2836	29471	1982	1883	8454	54.4	69676	87182	759	380

River	**PON**	**SPM (b)**	**P**	**PO_4-P**	**NO_3-N**	**NO_2-N**	**NH_4-N**	**N_{total} (c)**	**Al**	**Fe**	**B**	**Mn**	**Sr**
Nordurá	<19.4	5283	<1.17	<5.06	<9.11	<0.639	<6.45	51.6	4.03	25.3	3.65	2.40	4.52
Vídidalsá	7.36	3611	0.522	1.32	2.37	0.234	<3.27	21.5	0.766	19.0	0.542	1.22	3.51
Vatnsdalsá	14.4	2257	3.84	3.81	4.77	0.332	<4.90	31.5	1.73	28.7	1.07	0.905	3.57
Total	<41.2	11151	<5.53	<10.2	<16.3	<1.21	<14.6	105	6.52	72.9	5.26	4.53	11.6

River	**As**	**Ba**	**Cd**	**Co**	**Cr**	**Cu**	**Ni**	**Pb**	**Zn**	**Hg**	**Mo**	**Ti**	**V**	**Heavy metals (d)**
Nordurá	<0.243	0.081	<0.001	<0.014	0.021	0.290	<0.076	<0.009	<0.396	<0.001	0.116	0.216	0.471	<1.94
Vídidalsá	<0.033	0.059	<0.001	0.006	0.014	0.101	0.038	<0.004	<0.140	<0.001	<0.016	0.032	0.354	<0.799
Vatnsdalsá	<0.050	0.080	<0.001	0.008	0.084	0.118	0.049	<0.005	<0.214	<0.001	0.082	0.062	5.64	<6.39
Total	<0.326	0.220	<0.003	<0.028	0.120	0.508	<0.163	<0.018	<0.750	<0.003	<0.214	0.311	6.46	<9.13

(a) Average discharge for Nordurá calculated from data 1971-1987 and 1993-2004, for Vídidalsá from data 2004 and for Vatnsdalsá from data 1949-1984, 1993 and 1997-2004.

(b) Total inorganic suspended particulate matter.

(c) Data for N_{total} is from late year 2004 and 2005.

(d) Heavy metals are As, Ba, Cd, Co, Cr, Cu, Ni, Pb, Zn, Hg, Mo, Ti and V.

Table 3a. Results of samples collected in 2004-2005 in a time sequence.

River	Sample number	Date	Discharge m^3/s	Water T °C	Air T °C	pH	T °C (pH/ cond.)	Cond. µS/cm	SiO$_2$ mmol/l	Na mmol/l	K mmol/l	Ca mmol/l	Mg mmol/l	Alk. (a) meq./kg	DIC mmol/l	SO$_4$ mmol/l ICP-AES	SO$_4$ mmol/l I.chrom	∂^{34}S ‰	Cl mmol/l I.chrom	F µmol/l I.chrom	Charge balance	Error %	TDS mg/l meas.	TDS mg/kg calc.	DOC mmol/l	POC µg/kg	PON µg/kg	C/N mol
Litla-Skard	**04N001**	2/25/2004 11:45		0.0	-4.8	6.45	20.3	64						0.229			0.019	15.4	0.284	0.813			46		0.077	382	35.3	12.7
Nordurá	**04N002**	2/25/2004 13:45	15.0	0.0	-3.2	7.27	20.1	66	0.185	0.258	0.008	0.101	0.068	0.301	0.340	0.017	0.021	12.0	0.251	1.60	0.00	0.8	47	54	0.037	143	21.8	7.68
Vídidalsá	**04N003**	2/25/2004 18:50	5.9	0.0	-5.5	7.60	19.9	84	0.263	0.247	0.016	0.130	0.118	0.516	0.547	0.014	0.016	14.8	0.221	2.26	-0.01	0.6	66	72	0.042	162	17.6	10.7
Blanda	**04N004**	2/26/2004 14:30	50.2	0.0	-6.6	7.60	19.5	78						0.592			0.038	5.45	0.099	5.77			60		0.025	236	35.1	7.82
Vatnsdalsá	**04N005**	2/26/2004 18:15	9.0	0.0	-8.9	7.54	19.3	96	0.323	0.377	0.025	0.148	0.117	0.720	0.770	0.015	0.017	11.2	0.181	4.69	-0.01	0.4	74	92	0.052			
Vatnsdalsá	**04N006**	5/7/2004 8:20	9.1	1.8	2.8	7.48	23.1	107	0.301	0.329	0.022	0.128	0.101	0.537	0.578	0.013	0.015	11.7	0.149	4.56	0.09	5.8	57	75	0.045	335	44.3	8.84
Vídidalsá	**04N007**	5/7/2004 11:30	6.4	2.8	3.2	7.63	22.9	84	0.267	0.241	0.013	0.130	0.120	0.640	0.674	0.013	0.014	15.5	0.216	2.58	-0.13	8.1	50	80	0.068	190	22.9	9.71
Nordurá	**04N008**	5/7/2004 14:30	11.6	5.1	9.6	7.38	23.0	61	0.178	0.239	0.007	0.097	0.064	0.320	0.351	0.017	0.021	13.2	0.204	1.75	0.00	0.0	43	52	0.039	100	15.8	7.41
Nordurá	**04N009**	7/5/2004 8:40	6.5	11.1	12.0	7.61	23.4	67	0.194	0.269	0.010	0.106	0.069	0.392	0.414	0.018	0.021	12.5	0.193	2.05	0.00	0.1	47	58	0.026	142	21.3	7.78
Vídidalsá	**04N010**	7/5/2004 11:30	4.9	12.2	13.3	7.74	23.4	87	0.289	0.256	0.018	0.145	0.124	0.598	0.623	0.011	0.013	13.7	0.190	3.10	0.00	0.2	77	78	0.077	246	38.8	7.41
Vatnsdalsá	**04N011**	7/5/2004 13:10	8.4	11.3	15.8	7.87	23.4	92	0.316	0.357	0.025	0.142	0.111	0.685	0.705	0.012	0.014	11.0	0.148	5.19	0.02	1.3	74	85	0.062	235	37.7	7.28
Nordurá	**04N012**	8/5/2004 8:50	7.1	10.7	11.3	7.68	19.8	68	0.189	0.280	0.010	0.112	0.073	0.431	0.453	0.018	0.020	12.1	0.186	1.87	0.00	0.1	55	60	0.026	177	19.0	10.9
Vídidalsá	**04N013**	8/5/2004 11:55	3.2	11.5	15.3	7.80	19.8	98	0.273	0.271	0.016	0.158	0.132	0.679	0.705	0.006	0.010	14.2	0.190	2.86	-0.03	1.5	78	82	0.050	166	19.6	9.89
Vatnsdalsá	**04N014**	8/5/2004 14:20	6.0	10.9	16.2	8.14	19.8	92	0.304	0.390	0.024	0.147	0.109	0.773	0.787	0.011	0.013	11.2	0.147	5.07	-0.03	1.4	74	90	0.053	235	26.1	10.5
Nordurá	**04N015**	9/15/2004 10:45	11.4	6.8	7.9	7.52	21.6	90	0.189	0.275	0.010	0.115	0.074	0.434	0.465	0.019	0.022	11.5	0.182	1.76	0.00	0.2	52	61	0.035	107	11.0	11.3
Vídidalsá	**04N016**	9/15/2004 14:35	2.6	5.5	12.9	7.63	21.7	94	0.282	0.264	0.013	0.158	0.133	0.664	0.700	0.008	0.011	14.5	0.192	2.68	-0.02	1.2	69	83	0.039	159	15.1	12.2
Vatnsdalsá	**04N017**	9/15/2004 17:10	5.5	5.4	11.0	7.85	21.8	102	0.313	0.393	0.024	0.146	0.107	0.807	0.834	0.009	0.014	10.7	0.150	4.98	-0.06	3.4	73	93	0.042	294	32.1	10.7
Nordurá	**04N018**	10/21/2004 10:15	11.8	0.4	3.0	7.16	24.6	74	0.196	0.267	0.008	0.114	0.075	0.381	0.440	0.020	0.022	12.8	0.204	1.67	0.01	1.6	62	60	0.028	124	14.6	9.92
Vídidalsá	**04N019**	10/21/2004 12:59	4.8	0.1	4.8	7.41	24.1	113	0.308	0.304	0.016	0.184	0.163	0.719	0.782	0.016	0.016	16.0	0.264	2.61	0.00	0.2	78	95	0.058	309	33.5	10.8
Vatnsdalsá	**04N020**	10/21/2004 15:15	6.1	0.0	-3.3	7.54	23.6	110	0.352	0.428	0.026	0.154	0.120	0.797	0.849	0.013	0.016	11.1	0.177	4.99	-0.01	0.4	85	100	0.041	234	28.9	9.44
Nordurá	**05N001**	2/10/2005 10:45	11.6	-0.2	-11.2	7.45	21.5	74	0.202	0.322	0.009	0.116	0.081	0.335	0.363	0.023	0.019		0.318	1.57	0.03	1.8	74	62	0.032	257	33.8	8.88
Vídidalsá	**05N002**	2/10/2005 14:22	6.6	-0.1	-5.6	7.75	21.5	97	0.334	0.321	0.015	0.161	0.158	0.627	0.652	0.018	0.015		0.292	2.00	0.02	1.0	82	90	0.056	216	27.5	9.15
Vatnsdalsá	**05N003**	2/10/2005 17:55	8.2	-0.2	-1.6	7.80	21.2	98	0.377	0.393	0.026	0.149	0.127	0.723	0.749	0.016	0.014		0.179	3.56	0.03	1.7	80	95	0.047	328	44.5	8.60
Nordurá	**05N004**	5/23/2005 11:18	7.9	4.1	6.8	7.72	19.9	65	0.187	0.267	0.008	0.102	0.067	0.351	0.367	0.021	0.016		0.203	1.50	0.02	1.3	53	55	0.024	93.0	16.5	6.57
Vídidalsá	**05N005**	5/23/2005 14:35	4.7	5.1	6.3	7.88	19.9	77	0.307	0.248	0.016	0.133	0.119	0.528	0.544	0.012	0.011		0.172	2.15	0.04	2.9	59	73	0.044	183	23.2	9.21
Vatnsdalsá	**05N006**	5/23/2005 17:13	8.2	4.3	5.4	7.98	19.8	85	0.342	0.363	0.025	0.133	0.108	0.660	0.676	0.013	0.011		0.134	3.54	0.05	2.8	67	84	0.035	252	32.6	9.03
Nordurá	**05N007**	6/29/2005 13:50	13.4	10.0	14.2	7.83	21.0	54	0.167	0.224	0.007	0.082	0.052	0.327	0.338	0.017	0.014		0.147	1.36	-0.01	1.0	43	47	0.033	128	13.7	10.9
Vídidalsá	**05N008**	6/29/2005 17:05	4.2	14.1	14.8	8.11	20.9	83	0.319	0.267	0.019	0.147	0.129	0.613	0.624	0.011	0.009		0.169	2.23	0.03	2.0	34	80	0.054	176	19.3	10.6
Vatnsdalsá	**05N009**	6/29/2005 19:15	7.2	11.7	14.1	8.18	20.9	89	0.360	0.358	0.027	0.132	0.105	0.721	0.731	0.014	0.011		0.130	3.75	-0.02	1.3	62	89	0.052	240	27.5	10.2
Nordurá	**05N010**	8/25/2005 11:15	23.8	5.9	10.7	7.69	20.1	65	0.194	0.265	0.008	0.106	0.070	0.404	0.424	0.019	0.016		0.172	1.51	0.01	0.7	35	57	0.062	128	17.9	8.38
Vídidalsá	**05N011**	8/25/2005 14:15	6.9	5.1	4.6	8.03	20.1	98	0.326	0.278	0.016	0.176	0.163	0.749	0.766	0.012	0.009		0.198	2.33	0.00	0.1	61	92	0.106	195	20.5	11.1
Vatnsdalsá	**05N012**	8/25/2005 16:25	8.0	4.0	4.5	8.08	20.2	99	0.374	0.384	0.026	0.159	0.133	0.813	0.829	0.014	0.011		0.144	3.73	0.00	0.2	61	98	0.082	369	32.3	13.3
Nordurá	**05N013**	10/3/2005 10:21	45.3	2.5	4.8	7.18	20.4	61	0.168	0.233	0.008	0.091	0.061	0.303	0.351	0.018	0.015		0.190	0.943	0.01	1.3	39	50	0.065	590	55.1	12.5
Vídidalsá	**05N014**	10/3/2005 13:30	12.8	2.8	6.5	7.69	20.1	98	0.318	0.275	0.017	0.158	0.154	0.667	0.700	0.014	0.012		0.217	1.69	0.00	0.1	64	87	0.087	878	74.8	13.7
Vatnsdalsá	**05N015**	10/3/2005 15:23	10.9	2.5	6.2	7.73	20.4	97	0.355	0.358	0.024	0.156	0.130	0.771	0.805	0.014	0.011		0.144	3.24	0.01	0.4	63	95	0.063	941	96.4	11.4
Nordurá	**05N016**	11/18/2005 10:07	8.5	0.9	6.3	7.37	21.4	74	0.212	0.299	<0.010	0.121	0.081	0.463	0.510	0.021	0.018		0.212	1.22	-0.01	0.4	48	67	0.031	108	<7.97	>15.9
Vídidalsá	**05N017**	11/18/2005 13:37	5.0	0.1	1.8	7.61	21.6	94	0.345	0.271	0.017	0.169	0.152	0.728	0.770	0.015	0.012		0.188	1.93	-0.02	1.0	66	92	0.057	203	18.4	12.9
Vatnsdalsá	**05N018**	11/18/2005 15:55	8.2	0.8	2.9	7.63	21.7	96	0.370	0.388	0.027	0.153	0.122	0.793	0.836	0.015	0.013		0.142	3.68	0.00	0.2	69	98	0.039	538	53.4	11.8

(a) Alkalinity.

Table 3b. Results of samples collected in 2004-2005 in a time sequence.

River	Sample number	Date	SPM (a) mg/l	P µmol/l	PO_4-P µmol/l	NO_3-N µmol/l	NO_2-N µmol/l	NH_4-N µmol/l	N_{total} µmol/l	Al µmol/l	Fe µmol/l	B µmol/l	Mn µmol/l	Sr µmol/l	As nmol/l	Ba nmol/l	Cd nmol/l	Co nmol/l	Cr nmol/l	Cu nmol/l	Ni nmol/l	Pb nmol/l	Zn nmol/l	Hg nmol/l	Mo nmol/l	Ti nmol/l	V µmol/l
Litla-Skard	**04N001**	2/25/2004 11:45	3		0.136	0.907	0.150	0.720																			
Nordurá	**04N002**	2/25/2004 13:45	3	0.126	0.200	3.31	0.074	0.850		0.188	0.727	0.367	0.140	0.073	<13.3	0.659	<0.018	0.355	0.617	6.85	3.05	<0.048	11.7	<0.010	1.26	6.41	0.011
Vídidalsá	**04N003**	2/25/2004 18:50	83	0.108	0.491	2.32	0.118	0.887		0.143	1.03	0.220	0.069	0.155	<0.667	2.17	0.060	0.214	1.63	6.42	3.73	<0.048	11.5	<0.010	0.809	2.59	0.028
Blanda	**04N004**	2/26/2004 14:30	22		0.340	3.33	0.146	1.72																			
Vatnsdalsá	**04N005**	2/26/2004 18:15	13	0.455	0.470	2.79	0.074			0.168	1.06	0.324	0.079	0.134	<0.667	2.23	0.040	0.403	4.98	5.92	3.46	<0.048	7.13	<0.010	2.54	4.53	0.283
Vatnsdalsá	**04N006**	5/7/2004 8:20	7	0.462	0.555	0.464	0.147	0.906		0.215	1.59	0.271	0.098	0.111	<0.667	1.98	0.049	0.350	4.71	8.21	4.58	0.080	54.0	<0.010	2.61	3.99	0.320
Vídidalsá	**04N007**	5/7/2004 11:30	10	0.092	0.243	0.474	0.105	1.71		0.148	1.75	0.197	0.159	0.155	<0.667	1.99	0.031	0.392	1.23	8.17	5.79	0.076	31.7	<0.010	0.789	4.03	0.030
Nordurá	**04N008**	5/7/2004 14:30	6	0.035	<0.065	1.20	0.102	1.75		0.113	0.494	0.433	0.068	0.065	<12.0	0.493	<0.018	0.077	0.392	4.67	2.52	<0.048	21.1	<0.010	1.68	2.34	0.011
Nordurá	**04N009**	7/5/2004 8:40	5	0.043	<0.065	0.232	0.111	1.10		0.115	0.517	0.625	0.009	0.072	<10.7	0.582	<0.018	<0.058	0.523	6.83	1.65	<0.048	27.7	<0.010	2.50	2.32	0.020
Vídidalsá	**04N010**	7/5/2004 11:30	2	0.106	0.146	0.155	0.111	3.19		0.146	0.859	0.249	0.029	0.178	<0.667	1.89	0.026	0.159	1.23	11.6	2.74	0.066	19.6	<0.010	0.947	2.01	0.048
Vatnsdalsá	**04N011**	7/5/2004 13:10	2	0.387	0.351	0.213	0.065	1.03		0.274	1.70	0.307	0.012	0.126	<0.667	1.71	0.021	0.162	5.02	6.12	2.44	0.069	9.63	0.012	2.87	2.84	0.406
Nordurá	**04N012**	8/5/2004 8:50	6	<0.032	<0.065	0.310	0.089	0.822		0.071	0.274	0.680	0.008	0.078	<9.34	0.626	<0.018	<0.058	0.417	5.30	1.33	<0.048	13.2	<0.010	2.52	0.309	0.020
Vídidalsá	**04N013**	8/5/2004 11:55	1	0.045	0.114	0.377	0.089	0.869	5.57	0.144	0.698	0.236	0.019	0.189	1.00	1.76	0.023	0.257	2.19	6.23	2.40	0.060	11.9	<0.010	1.07	1.86	0.046
Vatnsdalsá	**04N014**	8/5/2004 14:20	2	0.247	0.232	0.435	0.089	0.272	7.04	0.356	2.18	0.320	0.017	0.124	3.22	1.40	0.020	0.364	6.77	5.92	2.25	0.118	10.0	<0.010	3.14	8.04	0.452
Nordurá	**04N015**	9/15/2004 10:45	12	<0.032	1.01	0.861	0.214	*80.5*	4.85	0.069	0.526	0.584	0.026	0.080	<9.34	1.65	<0.018	<0.058	0.554	6.34	1.68	0.110	10.5	<0.010	1.95	1.77	0.017
Vídidalsá	**04N016**	9/15/2004 14:35	3	0.043	0.265	1.42	0.183	*6.15*	6.08	0.102	1.07	0.171	0.018	0.184	1.13	1.98	0.037	0.229	2.42	6.40	3.27	0.124	5.32	<0.010	1.18	2.84	0.031
Vatnsdalsá	**04N017**	9/15/2004 17:10	9	0.234	0.189	1.56	0.120	*9.30*	6.93	0.108	1.38	0.312	0.011	0.122	2.34	1.42	<0.018	0.262	5.96	4.14	2.30	0.077	<3.06	<0.010	3.17	2.76	0.444
Nordurá	**04N018**	10/21/2004 10:15	2	0.039	0.933	1.46	0.069	0.999	5.13	0.088	0.440	0.509	0.081	0.077	<9.34	0.445	<0.018	0.150	0.281	6.04	1.52	<0.048	7.36	<0.010	1.94	4.11	0.012
Vídidalsá	**04N019**	10/21/2004 12:59	4	0.068	0.178	0.310	0.089	0.906	7.21	0.149	1.49	0.224	0.109	0.216	1.33	1.94	0.027	0.372	1.50	7.73	2.67	0.136	7.08	0.011	0.821	7.39	0.027
Vatnsdalsá	**04N020**	10/21/2004 15:15	3	0.358	1.19	1.05	0.131	0.785	13.0	0.158	1.27	0.338	0.027	0.128	1.60	1.49	0.036	0.239	5.98	6.04	2.62	0.095	7.43	<0.010	3.07	5.93	0.373
Nordurá	**05N001**	2/10/2005 10:45	13	0.078	0.189	2.65	0.036	0.701	5.61	0.192	1.34	0.562	0.268	0.088	<0.801	1.43	0.026	0.852	0.500	5.57	1.66	0.176	20.2	<0.010	1.84	5.22	0.011
Vídidalsá	**05N002**	2/10/2005 14:22	24	0.119	0.146	1.68	0.064	0.697	9.74	0.150	3.26	0.283	0.143	0.189	<9.34	2.36	0.028	0.420	1.70	9.22	2.91	0.214	14.5	<0.010	0.642	2.94	0.029
Vatnsdalsá	**05N003**	2/10/2005 17:55	14	0.494	0.437	2.75	0.051	0.434	7.46	0.171	1.79	0.314	0.090	0.128	<6.67	2.21	0.020	0.363	5.00	6.25	2.28	0.154	8.03	<0.010	2.27	4.28	0.304
Nordurá	**05N004**	5/23/2005 11:18	6	<0.032	0.131	<0.143	0.031	0.596	3.50	0.116	0.532	0.567	0.070	0.071	<0.667	0.910	<0.018	0.211	0.614	5.29	1.09	0.065	<3.06	<0.010	2.49	1.60	0.013
Vídidalsá	**05N005**	5/23/2005 14:35	7	0.073	0.112	0.178	0.087	0.668	4.84	0.120	1.44	0.194	0.058	0.146	<4.00	1.58	0.061	0.178	1.09	6.92	2.32	0.138	5.32	<0.010	0.862	2.55	0.037
Vatnsdalsá	**05N006**	5/23/2005 17:13	8	0.488	0.122	0.195	0.046	0.409	4.86	0.231	1.59	0.283	0.065	0.108	<2.67	1.37	<0.018	0.285	4.92	4.77	1.87	0.057	<3.06	<0.010	2.43	4.55	0.357
Nordurá	**05N007**	6/29/2005 13:50	4	0.043	0.179	0.162	0.021	0.398	3.89	0.191	0.281	0.462	0.007	0.061	<0.667	0.634	<0.018	0.091	0.542	4.89	<0.852	0.052	<3.06	<0.010	1.99	2.53	0.018
Vídidalsá	**05N008**	6/29/2005 17:05	8	0.067	0.417	0.145	0.021	0.308	5.87	0.174	1.37	0.239	0.022	0.164	<2.67	1.63	<0.018	0.176	0.981	6.11	1.59	0.080	<3.06	<0.010	0.902	1.77	0.054
Vatnsdalsá	**05N009**	6/29/2005 19:15	1	0.446	0.160	0.178	0.036	0.316	6.46	0.304	1.83	0.324	0.015	0.114	3.03	1.58	<0.018	0.285	5.56	5.82	1.70	0.073	<3.06	<0.010	2.68	2.53	0.426
Nordurá	**05N010**	8/25/2005 11:15	5	0.035	0.084	0.195	<0.020	0.298	3.66	0.165	0.605	0.438	0.024	0.080	1.11	0.757	<0.018	0.162	0.644	6.47	0.922	<0.048	4.01	<0.010	1.54	2.63	0.015
Vídidalsá	**05N011**	8/25/2005 14:15	5	0.050	0.084	0.195	0.031	0.406	6.40	0.096	1.88	0.218	0.051	0.207	<1.33	1.50	<0.018	0.340	0.817	5.90	2.30	0.082	<3.06	<0.010	0.745	2.78	0.033
Vatnsdalsá	**05N012**	8/25/2005 16:25	5	0.267	0.236	0.170	0.049	0.305	4.91	0.161	2.35	0.283	0.028	0.136	2.03	1.41	<0.018	0.324	4.75	4.58	2.23	0.062	<3.06	<0.010	2.71	2.99	0.310
Nordurá	**05N013**	10/3/2005 10:21	12	0.061	0.103	0.245	0.056	0.470	6.19	0.426	0.781	0.396	0.037	0.067	1.00	0.808	<0.018	0.303	0.744	8.23	2.57	0.049	3.75	<0.010	1.12	15.9	0.010
Vídidalsá	**05N014**	10/3/2005 13:30	18	0.067	0.112	0.345	0.054	0.330	7.76	0.122	1.60	0.235	0.181	0.188	<0.667	2.13	<0.018	0.489	0.733	6.37	2.83	0.050	<3.06	<0.010	<0.521	3.32	0.020
Vatnsdalsá	**05N015**	10/3/2005 15:23	6	0.278	0.274	0.120	0.054	0.434	5.61	0.147	1.57	0.287	0.078	0.145	1.19	2.01	<0.018	0.370	3.42	5.32	2.64	<0.048	<3.06	<0.010	2.15	3.97	0.241
Nordurá	**05N016**	11/18/2005 10:07	4	0.039	0.093	1.99	0.046	<0.200	8.23	0.073	0.582	0.633	0.060	0.079	1.32	1.26	<0.018	0.158	0.571	5.00	1.09	<0.048	<3.06	<0.010	3.02	1.27	0.011
Vídidalsá	**05N017**	11/18/2005 13:37	6	0.052	0.150	1.97	0.046	<0.200	5.95	0.060	0.741	0.220	0.137	0.195	<0.667	2.12	<0.018	0.305	1.18	5.13	2.20	<0.048	<3.06	<0.010	0.741	1.51	0.021
Vatnsdalsá	**05N018**	11/18/2005 15:55	11	0.394	0.417	2.73	0.044	<0.200	7.95	0.102	0.774	0.326	0.039	0.123	0.806	2.13	<0.018	0.158	4.50	4.78	1.74	<0.048	<3.06	<0.010	2.58	2.72	0.294

(a) Total inorganic suspended particulate matter.

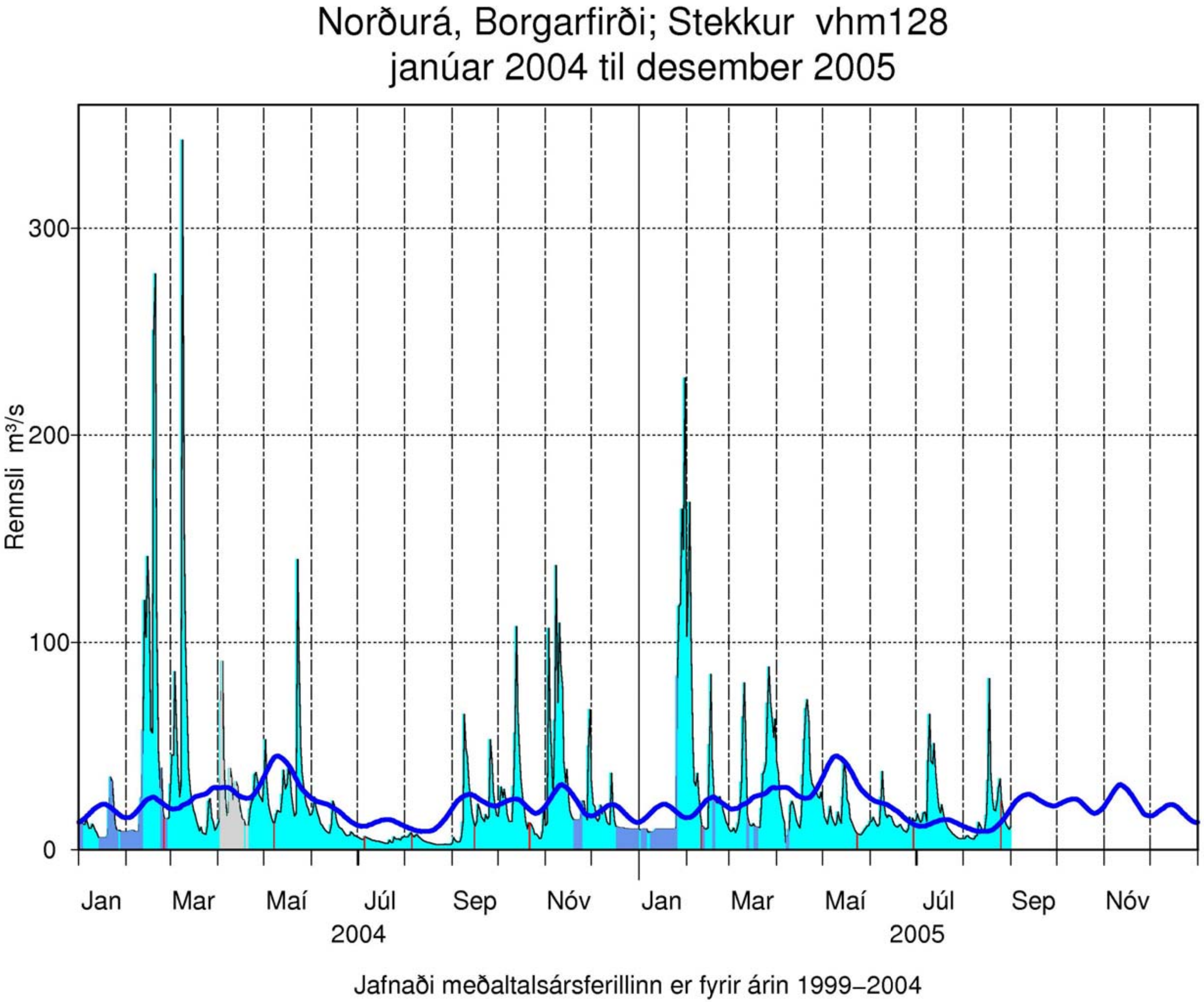


Figure 2. Discharge of River Nordurá at Stekkur for 2004 and 2005. Red lines show when samples were taken.

Table 4. Chemical composition, discharge and suspended matter in River Nordurá in 2004-2005.

Sample number	Date	Discharge m^3/s	Water T °C	Air T °C	pH	T °C (pH/cond.)	Cond. µS/cm	SiO_2 mmol/l	Na mmol/l	K mmol/l	Ca mmol/l	Mg mmol/l	Alk (a) meq./kg	DIC mmol/l	SO_4 mmol/l ICP-AES	SO_4 mmol/l I.chrom	$\partial^{34}S$ ‰	Cl mmol/l I.chrom	F µmol/l I.chrom	Charge balance	Error %	TDS mg/l meas.	TDS mg/kg calc.	DOC mmol/l	POC µg/kg	PON µg/kg	C/N mol
04N002	2/25/2004 13:45	15.0	0.0	-3.2	7.27	20.1	66	0.185	0.258	0.008	0.101	0.068	0.301	0.340	0.017	0.021	12.0	0.251	1.60	0.00	0.8	47	54	0.037	143	21.8	7.68
04N008	5/7/2004 14:30	11.6	5.1	9.6	7.38	23.0	61	0.178	0.239	0.007	0.097	0.064	0.320	0.351	0.017	0.021	13.2	0.204	1.75	0.00	0.0	43	52	0.039	100	15.8	7.41
04N009	7/5/2004 8:40	6.5	11.1	12.0	7.61	23.4	67	0.194	0.269	0.010	0.106	0.069	0.392	0.414	0.018	0.021	12.5	0.193	2.05	0.00	0.1	47	58	0.026	142	21.3	7.78
04N012	8/5/2004 8:50	7.1	10.7	11.3	7.68	19.8	68	0.189	0.280	0.010	0.112	0.073	0.431	0.453	0.018	0.020	12.1	0.186	1.87	0.00	0.1	55	60	0.026	177	19.0	10.9
04N015	9/15/2004 10:45	11.4	6.8	7.9	7.52	21.6	90	0.189	0.275	0.010	0.115	0.074	0.434	0.465	0.019	0.022	11.5	0.182	1.76	0.00	0.2	52	61	0.035	107	11.0	11.3
04N018	10/21/2004 10:15	11.8	0.4	3.0	7.16	24.6	74	0.196	0.267	0.008	0.114	0.075	0.381	0.440	0.020	0.022	12.8	0.204	1.67	0.01	1.6	62	60	0.028	124	14.6	9.92
05N001	2/10/2005 10:45	11.6	-0.2	-11.2	7.45	21.5	74	0.202	0.322	0.009	0.116	0.081	0.335	0.363	0.023	0.019		0.318	1.57	0.03	1.8	74	62	0.032	257	33.8	8.88
05N004	5/23/2005 11:18	7.9	4.1	6.8	7.72	19.9	65	0.187	0.267	0.008	0.102	0.067	0.351	0.367	0.021	0.016		0.203	1.50	0.02	1.3	53	55	0.024	93.0	16.5	6.57
05N007	6/29/2005 13:50	13.4	10.0	14.2	7.83	21.0	54	0.167	0.224	0.007	0.082	0.052	0.327	0.338	0.017	0.014		0.147	1.36	-0.01	1.0	43	47	0.033	128	13.7	10.9
05N010	8/25/2005 11:15	23.8	5.9	10.7	7.69	20.1	65	0.194	0.265	0.008	0.106	0.070	0.404	0.424	0.019	0.016		0.172	1.51	0.01	0.7	35	57	0.062	128	17.9	8.38
05N013	10/3/2005 10:21	45.3	2.5	4.8	7.18	20.4	61	0.168	0.233	0.008	0.091	0.061	0.303	0.351	0.018	0.015		0.190	0.943	0.01	1.3	39	50	0.065	590	55.1	12.5
05N016	11/18/2005 10:07	8.5	0.9	6.3	7.37	21.4	74	0.212	0.299	<0.010	0.121	0.081	0.463	0.510	0.021	0.018		0.212	1.22	-0.01	0.4	48	67	0.031	108	<7.97	>15.9
Average 2004-2005		14.5	4.8	6.0	7.49	21.4	68	0.189	0.266	0.008	0.105	0.070	0.370	0.401	0.019	0.019	12.3	0.205	1.57	0.01	0.8	50	57	0.037	175	<20.7	>9.84

Sample Number	Date	SPM (b) mg/l	P µmol/l	PO_4-P µmol/l	NO_3-N µmol/l	NO_2-N µmol/l	NH_4-N µmol/l	N_{total} µmol/l	Al µmol/l	Fe µmol/l	B µmol/l	Mn µmol/l	Sr µmol/l	As nmol/l	Ba nmol/l	Cd nmol/l	Co nmol/l	Cr nmol/l	Cu nmol/l	Ni nmol/l	Pb nmol/l	Zn nmol/l	Hg nmol/l	Mo nmol/l	Ti nmol/l	V µmol/l
04N002	2/25/2004 13:45	3	0.126	0.200	3.31	0.074	0.850		0.188	0.727	0.367	0.140	0.073	<13.3	0.659	<0.018	0.355	0.617	6.85	3.05	<0.048	11.7	<0.010	1.26	6.41	0.011
04N008	5/7/2004 14:30	6	0.035	<0.065	1.20	0.102	1.75		0.113	0.494	0.433	0.068	0.065	<12.0	0.493	<0.018	0.077	0.392	4.67	2.52	<0.048	21.1	<0.010	1.68	2.34	0.011
04N009	7/5/2004 8:40	5	0.043	<0.065	0.232	0.111	1.10		0.115	0.517	0.625	0.009	0.072	<10.7	0.582	<0.018	<0.058	0.523	6.83	1.65	<0.048	27.7	<0.010	2.50	2.32	0.020
04N012	8/5/2004 8:50	6	<0.032	<0.065	0.310	0.089	0.822		0.071	0.274	0.680	0.008	0.078	<9.34	0.626	<0.018	<0.058	0.417	5.30	1.33	<0.048	13.2	<0.010	2.52	0.309	0.020
04N015	9/15/2004 10:45	12	<0.032	1.01	0.861	0.214	*80.5*	4.85	0.069	0.526	0.584	0.026	0.080	<9.34	1.65	<0.018	<0.058	0.554	6.34	1.68	0.110	10.5	<0.010	1.95	1.77	0.017
04N018	10/21/2004 10:15	2	0.039	0.933	1.46	0.069	0.999	5.13	0.088	0.440	0.509	0.081	0.077	<9.34	0.445	<0.018	0.150	0.281	6.04	1.52	<0.048	7.36	<0.010	1.94	4.11	0.012
05N001	2/10/2005 10:45	13	0.078	0.189	2.65	0.036	0.701	5.61	0.192	1.34	0.562	0.268	0.088	<0.801	1.43	0.026	0.852	0.500	5.57	1.66	0.176	20.2	<0.010	1.84	5.22	0.011
05N004	5/23/2005 11:18	6	<0.032	0.131	<0.143	0.031	0.596	3.50	0.116	0.532	0.567	0.070	0.071	<0.667	0.910	<0.018	0.211	0.614	5.29	1.09	0.065	<3.06	<0.010	2.49	1.60	0.013
05N007	6/29/2005 13:50	4	0.043	0.179	0.162	0.021	0.398	3.89	0.191	0.281	0.462	0.007	0.061	<0.667	0.634	<0.018	0.091	0.542	4.89	<0.852	0.052	<3.06	<0.010	1.99	2.53	0.018
05N010	8/25/2005 11:15	5	0.035	0.084	0.195	<0.020	0.298	3.66	0.165	0.605	0.438	0.024	0.080	1.11	0.757	<0.018	0.162	0.644	6.47	0.922	<0.048	4.01	<0.010	1.54	2.63	0.015
05N013	10/3/2005 10:21	12	0.061	0.103	0.245	0.056	0.470	6.19	0.426	0.781	0.396	0.037	0.067	1.00	0.808	<0.018	0.303	0.744	8.23	2.57	0.049	3.75	<0.010	1.12	15.9	0.010
05N016	11/18/2005 10:07	4	0.039	0.093	1.99	0.046	<0.200	8.23	0.073	0.582	0.633	0.060	0.079	1.32	1.26	<0.018	0.158	0.571	5.00	1.09	<0.048	<3.06	<0.010	3.02	1.27	0.011
Average 2004-2005		6	<0.050	<0.260	<1.05	<0.072	<0.744	5.13	0.151	0.592	0.521	0.066	0.074	<5.80	0.855	<0.019	<0.211	0.533	5.96	<1.66	<0.066	<10.7	<0.010	1.99	3.87	0.014

(a) Alkalinity.
(b) Total inorganic suspended particulate matter.

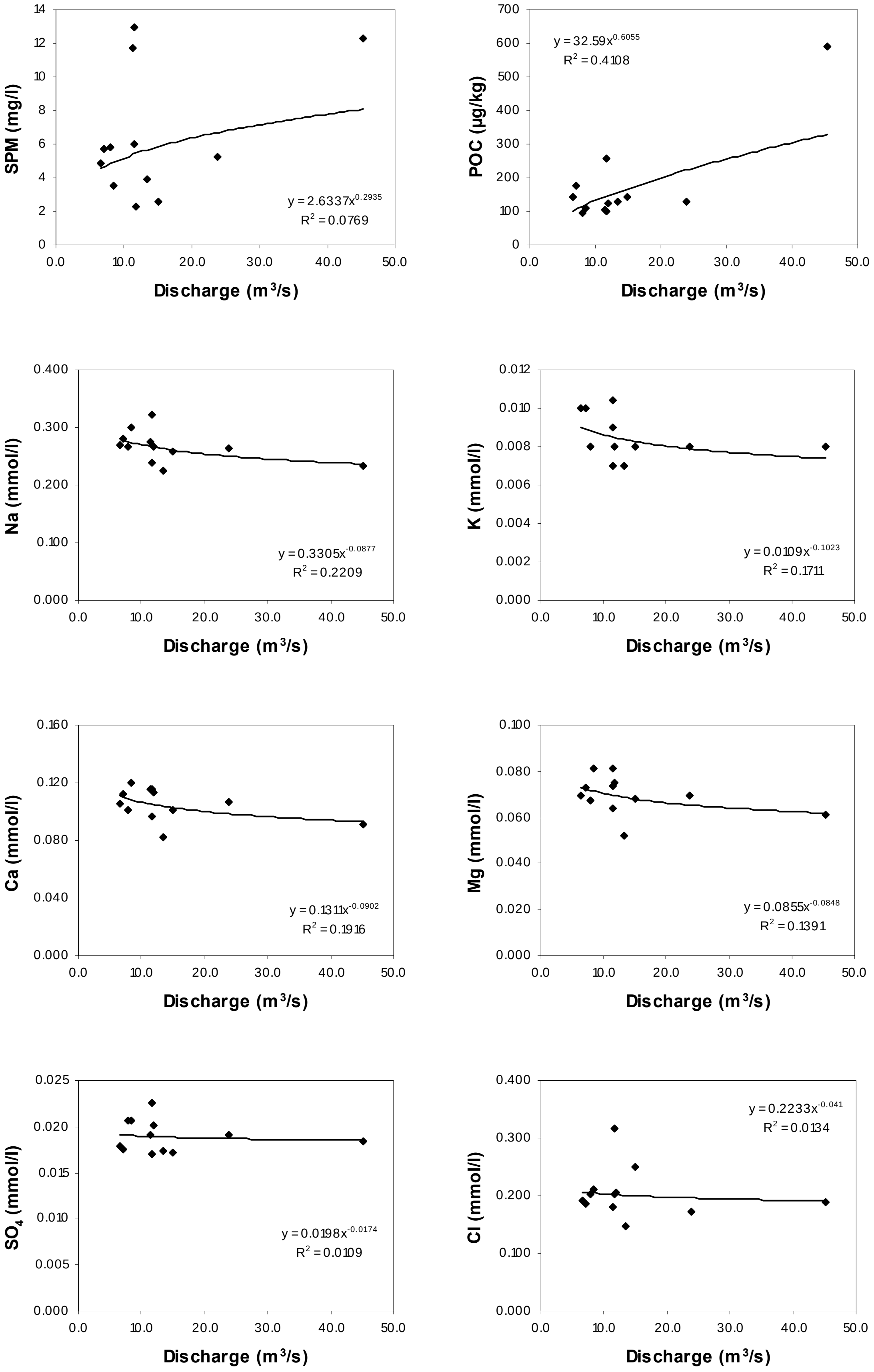
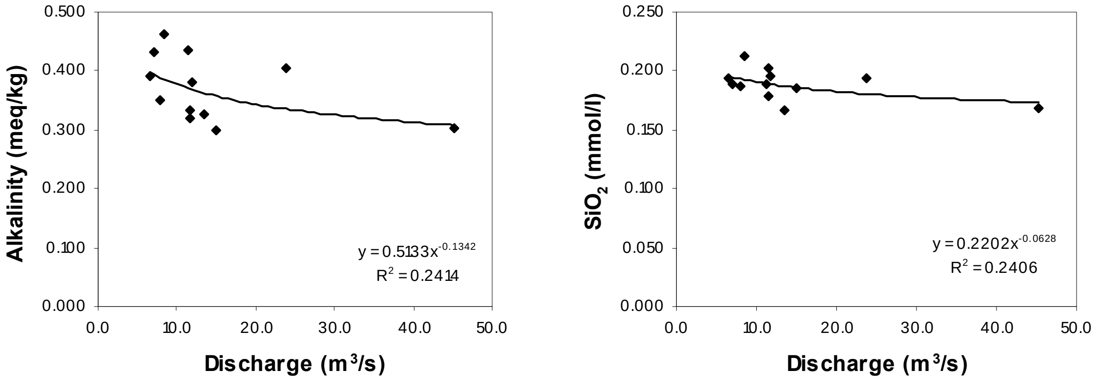


Figure 3. Concentration versus discharge correlations in River Nordurá 2004-2005.



Concentrations corrected for precipitation (except Mo):

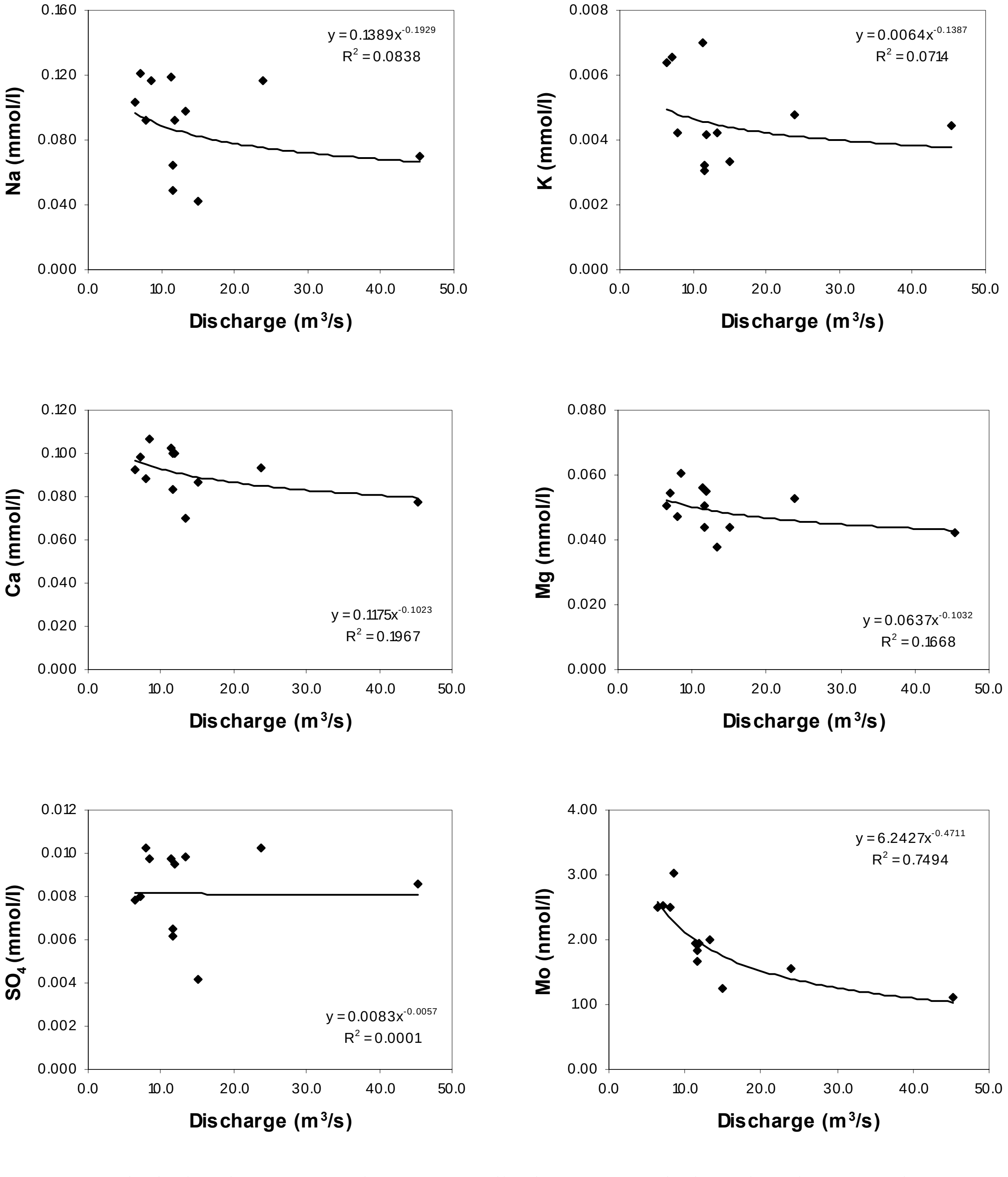


Figure 4. Rock derived concentration versus discharge correlations in River Nordurá 2004-2005.

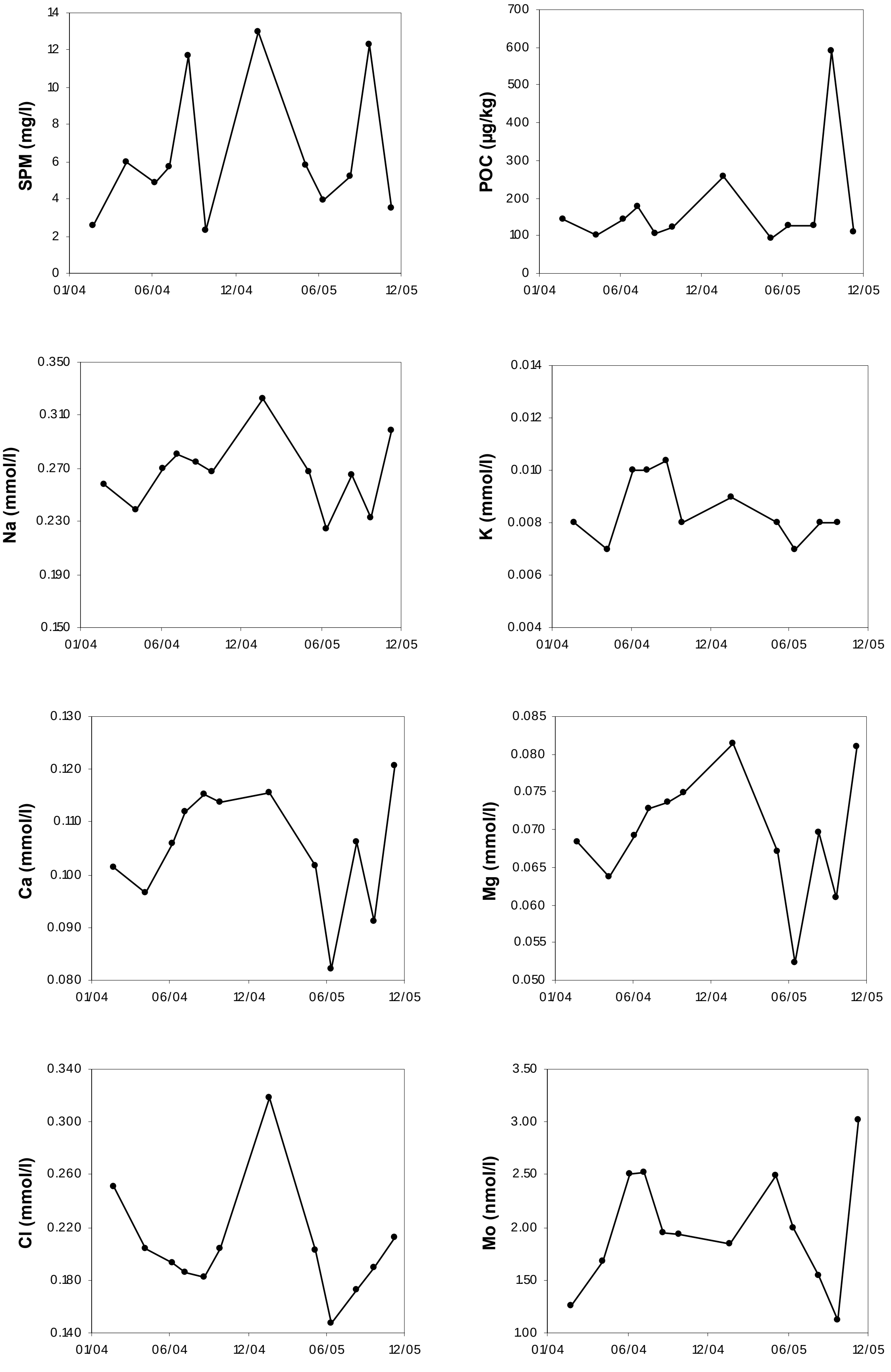


Figure 5. Time series for River Nordurá for 2004-2005.

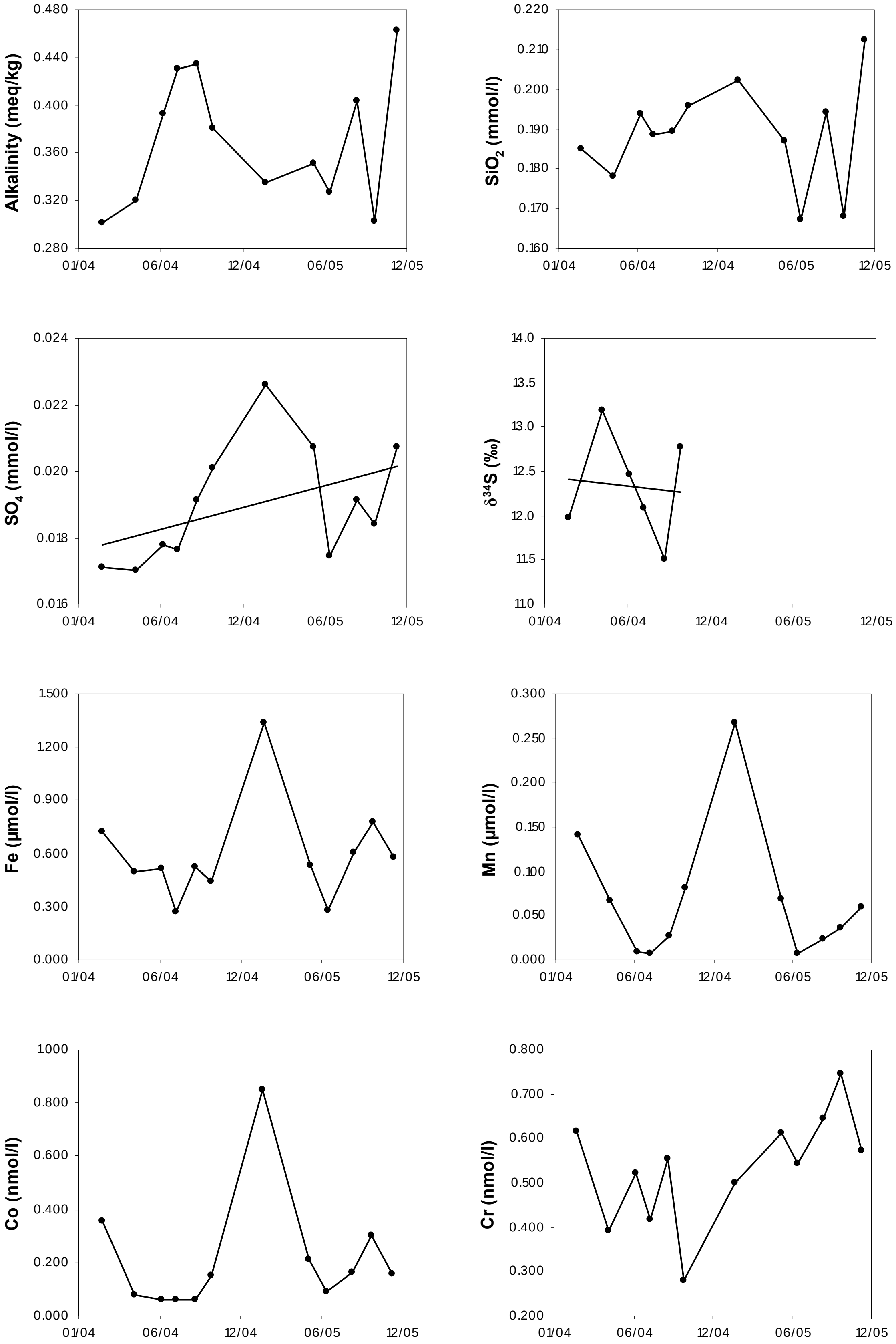


Figure 6. Time series for River Nordurá for 2004-2005.

.

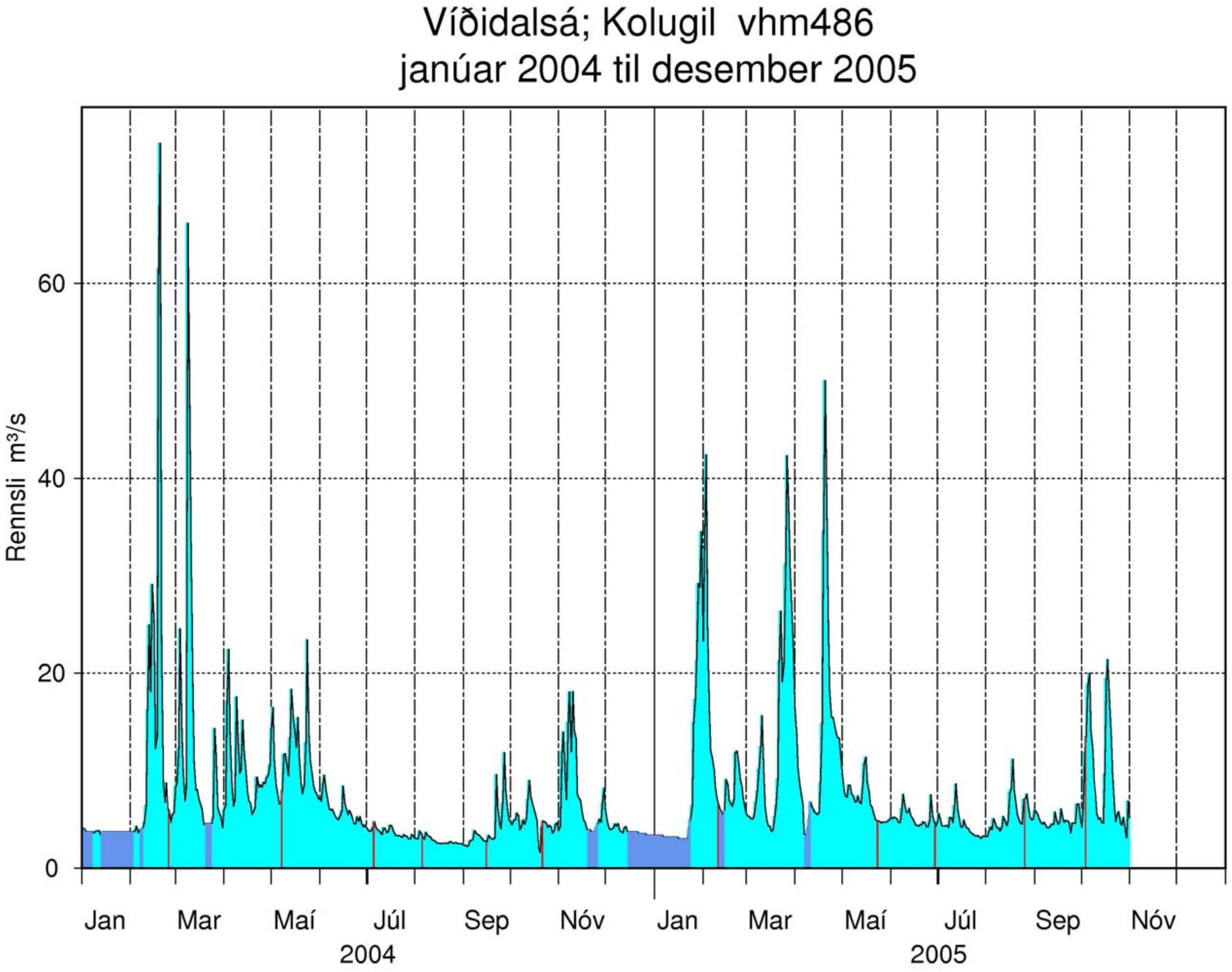


Figure 7. Discharge of River Vídidalsá at Kolugil for 2004 and 2005. Red lines show when samples were taken.

Table 5. Chemical composition, discharge and suspended matter in River Vídidalsá in 2004-2005.

Sample number	Date	Discharge m^3/s	Water T °C	Air T °C	pH	T °C (pH/cond.)	Cond. µS/cm	SiO$_2$ mmol/l	Na mmol/l	K mmol/l	Ca mmol/l	Mg mmol/l	Alk (a) meq./kg	DIC mmol/l	SO$_4$ mmol/l ICP-AES	SO$_4$ mmol/l I.chrom	∂^{34}S ‰	Cl mmol/l I.chrom	F µmol/l I.chrom	Charge balance	Error %	TDS mg/l meas.	TDS mg/kg calc.	DOC mmol/l	POC µg/kg	PON µg/kg	C/N mol
04N003	2/25/2004 18:50	5.9	0.0	-5.5	7.60	19.9	84	0.263	0.247	0.016	0.130	0.118	0.516	0.547	0.014	0.016	14.8	0.221	2.26	-0.01	0.6	66	72	0.042	162	17.6	10.7
04N007	5/7/2004 11:30	6.4	2.8	3.2	7.63	22.9	84	0.267	0.241	0.013	0.130	0.120	0.640	0.674	0.013	0.014	15.5	0.216	2.58	-0.13	8.1	50	80	0.068	190	22.9	9.71
04N010	7/5/2004 11:30	4.9	12.2	13.3	7.74	23.4	87	0.289	0.256	0.018	0.145	0.124	0.598	0.623	0.011	0.013	13.7	0.190	3.10	0.00	0.2	77	78	0.077	246	38.8	7.41
04N013	8/5/2004 11:55	3.2	11.5	15.3	7.80	19.8	98	0.273	0.271	0.016	0.158	0.132	0.679	0.705	0.006	0.010	14.2	0.190	2.86	-0.03	1.5	78	82	0.050	166	19.6	9.89
04N016	9/15/2004 14:35	2.6	5.5	12.9	7.63	21.7	94	0.282	0.264	0.013	0.158	0.133	0.664	0.700	0.008	0.011	14.5	0.192	2.68	-0.02	1.2	69	83	0.039	159	15.1	12.2
04N019	10/21/2004 12:59	4.8	0.1	4.8	7.41	24.1	113	0.308	0.304	0.016	0.184	0.163	0.719	0.782	0.016	0.016	16.0	0.264	2.61	0.00	0.2	78	95	0.058	309	33.5	10.8
05N002	2/10/2005 14:22	6.6	-0.1	-5.6	7.75	21.5	97	0.334	0.321	0.015	0.161	0.158	0.627	0.652	0.018	0.015		0.292	2.00	0.02	1.0	82	90	0.056	216	27.5	9.15
05N005	5/23/2005 14:35	4.7	5.1	6.3	7.88	19.9	77	0.307	0.248	0.016	0.133	0.119	0.528	0.544	0.012	0.011		0.172	2.15	0.04	2.9	59	73	0.044	183	23.2	9.21
05N008	6/29/2005 17:05	4.2	14.1	14.8	8.11	20.9	83	0.319	0.267	0.019	0.147	0.129	0.613	0.624	0.011	0.009		0.169	2.23	0.03	2.0	34	80	0.054	176	19.3	10.6
05N011	8/25/2005 14:15	6.9	5.1	4.6	8.03	20.1	98	0.326	0.278	0.016	0.176	0.163	0.749	0.766	0.012	0.009		0.198	2.33	0.00	0.1	61	92	0.106	195	20.5	11.1
05N014	10/3/2005 13:30	12.8	2.8	6.5	7.69	20.1	98	0.318	0.275	0.017	0.158	0.154	0.667	0.700	0.014	0.012		0.217	1.69	0.00	0.1	64	87	0.087	878	74.8	13.7
05N017	11/18/2005 13:37	5.0	0.1	1.8	7.61	21.6	94	0.345	0.271	0.017	0.169	0.152	0.728	0.770	0.015	0.012		0.188	1.93	-0.02	1.0	66	92	0.057	203	18.4	12.9
Average 2004-2005		5.7	4.9	6.0	7.74	21.3	92	0.303	0.270	0.016	0.154	0.139	0.644	0.674	0.013	0.012	14.8	0.209	2.37	-0.01	1.6	65	84	0.062	257	27.6	10.6

Sample number	Date	SPM (b) mg/l	P µmol/l	PO$_4$-P µmol/l	NO$_3$-N µmol/l	NO$_2$-N µmol/l	NH$_4$-N µmol/l	N$_{total}$ µmol/l	Al µmol/l	Fe µmol/l	B µmol/l	Mn µmol/l	Sr µmol/l	As nmol/l	Ba nmol/l	Cd nmol/l	Co nmol/l	Cr nmol/l	Cu nmol/l	Ni nmol/l	Pb nmol/l	Zn nmol/l	Hg nmol/l	Mo nmol/l	Ti nmol/l	V µmol/l
04N003	2/25/2004 18:50	83	0.108	0.491	2.32	0.118	0.887		0.143	1.03	0.220	0.069	0.155	<0.667	2.17	0.060	0.214	1.63	6.42	3.73	<0,048	11.5	<0.010	0.809	2.59	0.028
04N007	5/7/2004 11:30	10	0.092	0.243	0.474	0.105	1.71		0.148	1.75	0.197	0.159	0.155	<0.667	1.99	0.031	0.392	1.23	8.17	5.79	0.076	31.7	<0.010	0.789	4.03	0.030
04N010	7/5/2004 11:30	2	0.106	0.146	0.155	0.111	3.19		0.146	0.859	0.249	0.029	0.178	<0.667	1.89	0.026	0.159	1.23	11.6	2.74	0.066	19.6	<0.010	0.947	2.01	0.048
04N013	8/5/2004 11:55	1	0.045	0.114	0.377	0.089	0.869	5.57	0.144	0.698	0.236	0.019	0.189	1.00	1.76	0.023	0.257	2.19	6.23	2.40	0.060	11.9	<0.010	1.07	1.86	0.046
04N016	9/15/2004 14:35	3	0.043	0.265	1.42	0.183	*6.15*	6.08	0.102	1.07	0.171	0.018	0.184	1.13	1.98	0.037	0.229	2.42	6.40	3.27	0.124	5.32	<0.010	1.18	2.84	0.031
04N019	10/21/2004 12:59	4	0.068	0.178	0.310	0.089	0.906	7.21	0.149	1.49	0.224	0.109	0.216	1.33	1.94	0.027	0.372	1.50	7.73	2.67	0.136	7.08	0.011	0.821	7.39	0.027
05N002	2/10/2005 14:22	24	0.119	0.146	1.68	0.064	0.697	9.74	0.150	3.26	0.283	0.143	0.189	<9.34	2.36	0.028	0.420	1.70	9.22	2.91	0.214	14.5	<0.010	0.642	2.94	0.029
05N005	5/23/2005 14:35	7	0.073	0.112	0.178	0.087	0.668	4.84	0.120	1.44	0.194	0.058	0.146	<4.00	1.58	0.061	0.178	1.09	6.92	2.32	0.138	5.32	<0.010	0.862	2.55	0.037
05N008	6/29/2005 17:05	8	0.067	0.417	0.145	0.021	0.308	5.87	0.174	1.37	0.239	0.022	0.164	<2.67	1.63	<0.018	0.176	0.981	6.11	1.59	0.080	<3.06	<0.010	0.902	1.77	0.054
05N011	8/25/2005 14:15	5	0.050	0.084	0.195	0.031	0.406	6.40	0.096	1.88	0.218	0.051	0.207	<1.33	1.50	<0.018	0.340	0.817	5.90	2.30	0.082	<3.06	<0.010	0.745	2.78	0.033
05N014	10/3/2005 13:30	18	0.067	0.112	0.345	0.054	0.330	7.76	0.122	1.60	0.235	0.181	0.188	<0.667	2.13	<0.018	0.489	0.733	6.37	2.83	0.050	<3.06	<0.010	<0.521	3.32	0.020
05N017	11/18/2005 13:37	6	0.052	0.150	1.97	0.046	<0.200	5.95	0.060	0.741	0.220	0.137	0.195	<0.667	2.12	<0.018	0.305	1.18	5.13	2.20	<0.048	<3.06	<0.010	0.741	1.51	0.021
Average 2004-2005		14	0.074	0.205	0.797	0.083	<1.36	6.60	0.129	1.43	0.224	0.083	0.181	<2.01	1.92	<0.030	0.294	1.39	7.19	2.90	<0.093	<9.93	<0.010	<0.836	2.97	0.034

(a) Akalinity.
(b) Total inorganic suspended particulate matter.

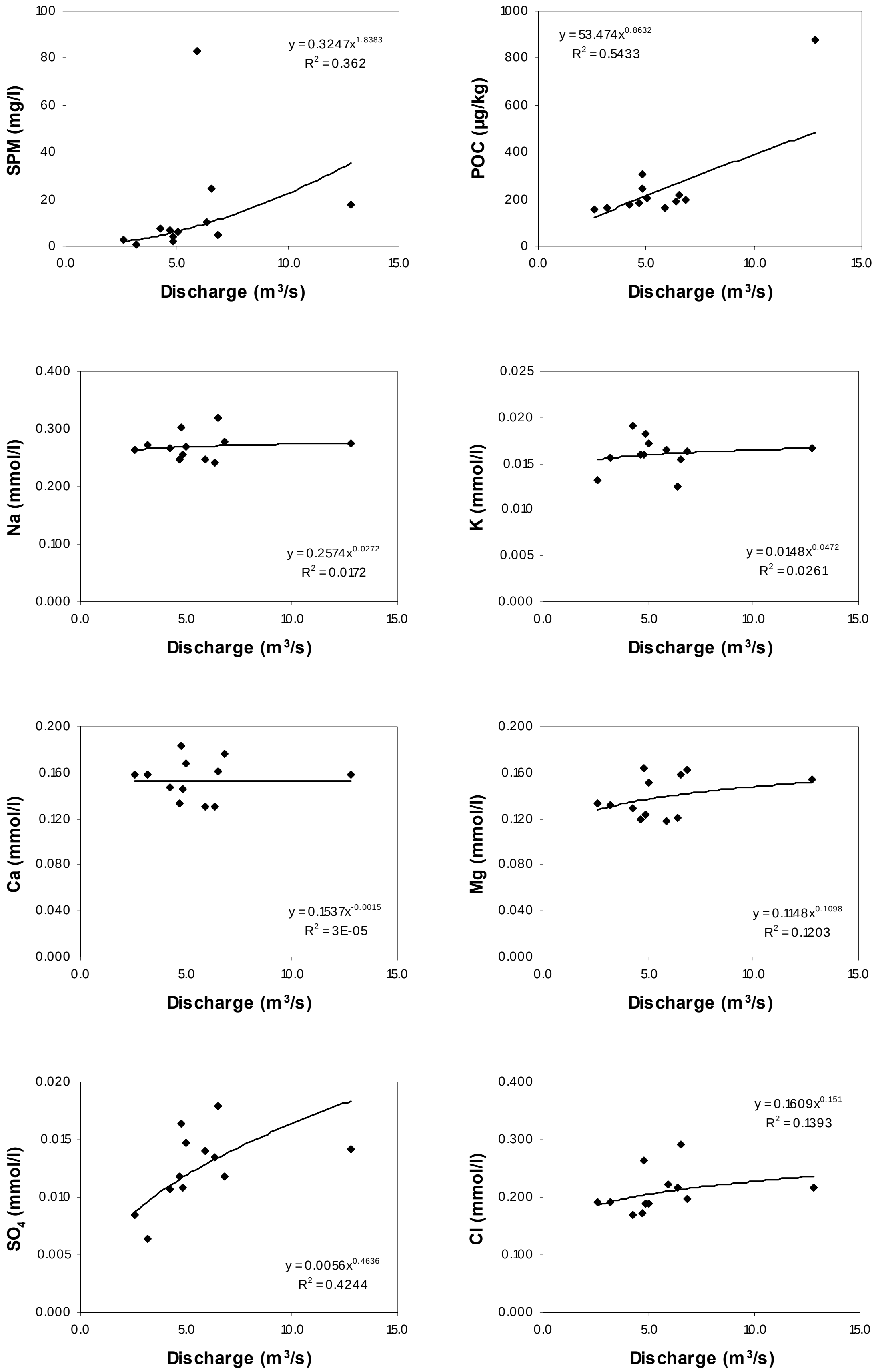
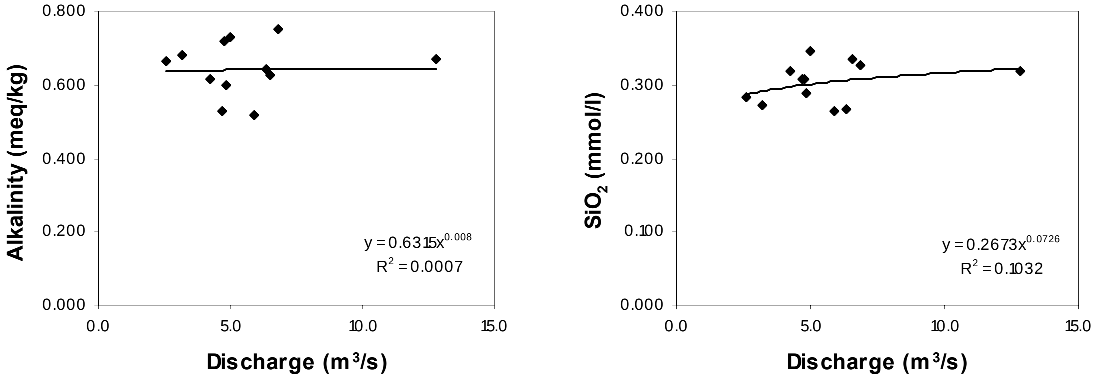


Figure 8. Concentration versus discharge correlations in River Vídidalsá 2004-2005.



Concentrations corrected for precipitation (except Mo):

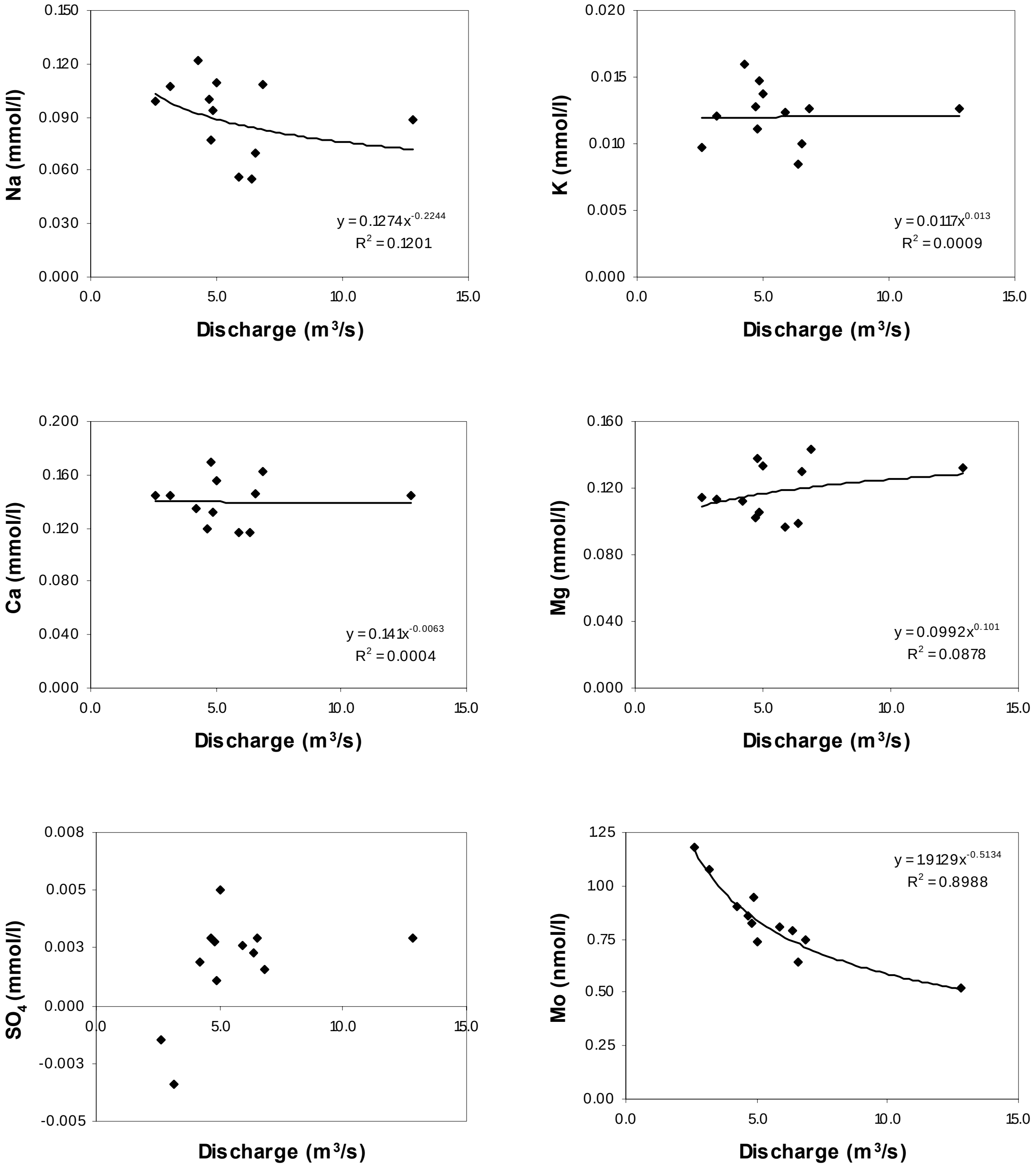


Figure 9. Rock derived concentration versus discharge correlations in River Vídidalsá 2004-2005.

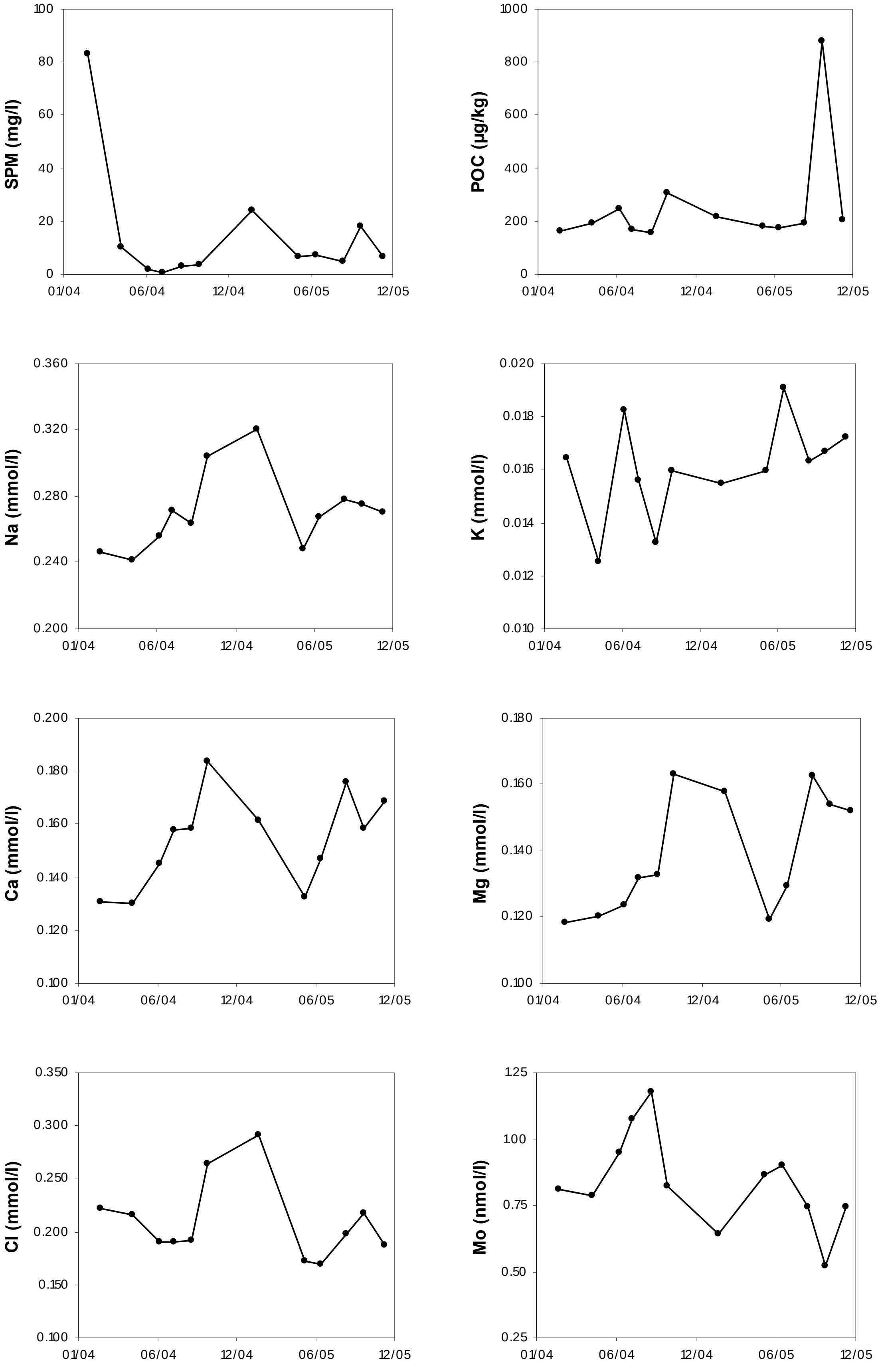


Figure 10. Time series for River Vídidalsá for 2004-2005.

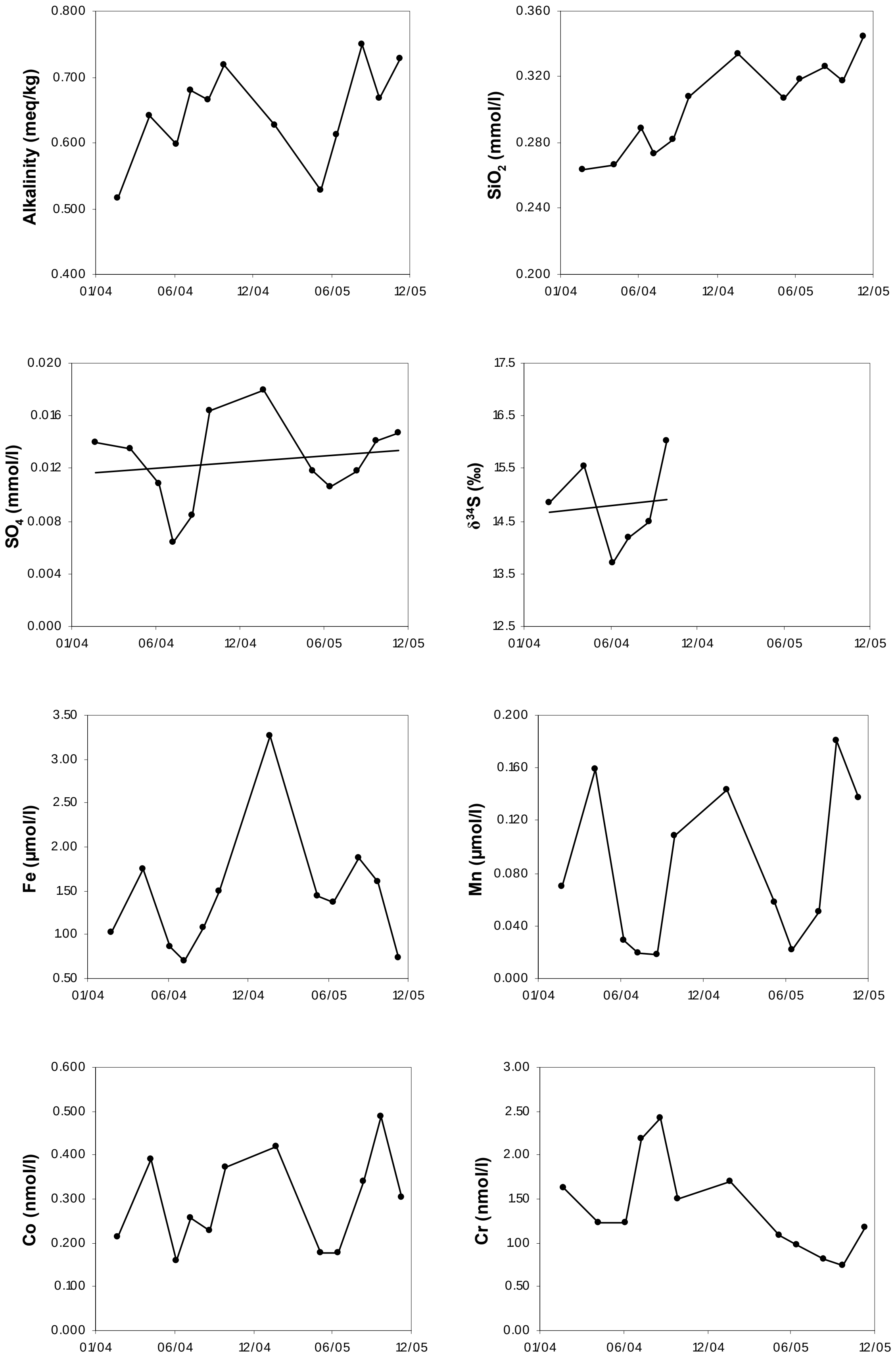


Figure 11. Time series for River Vídidalsá for 2004-2005.

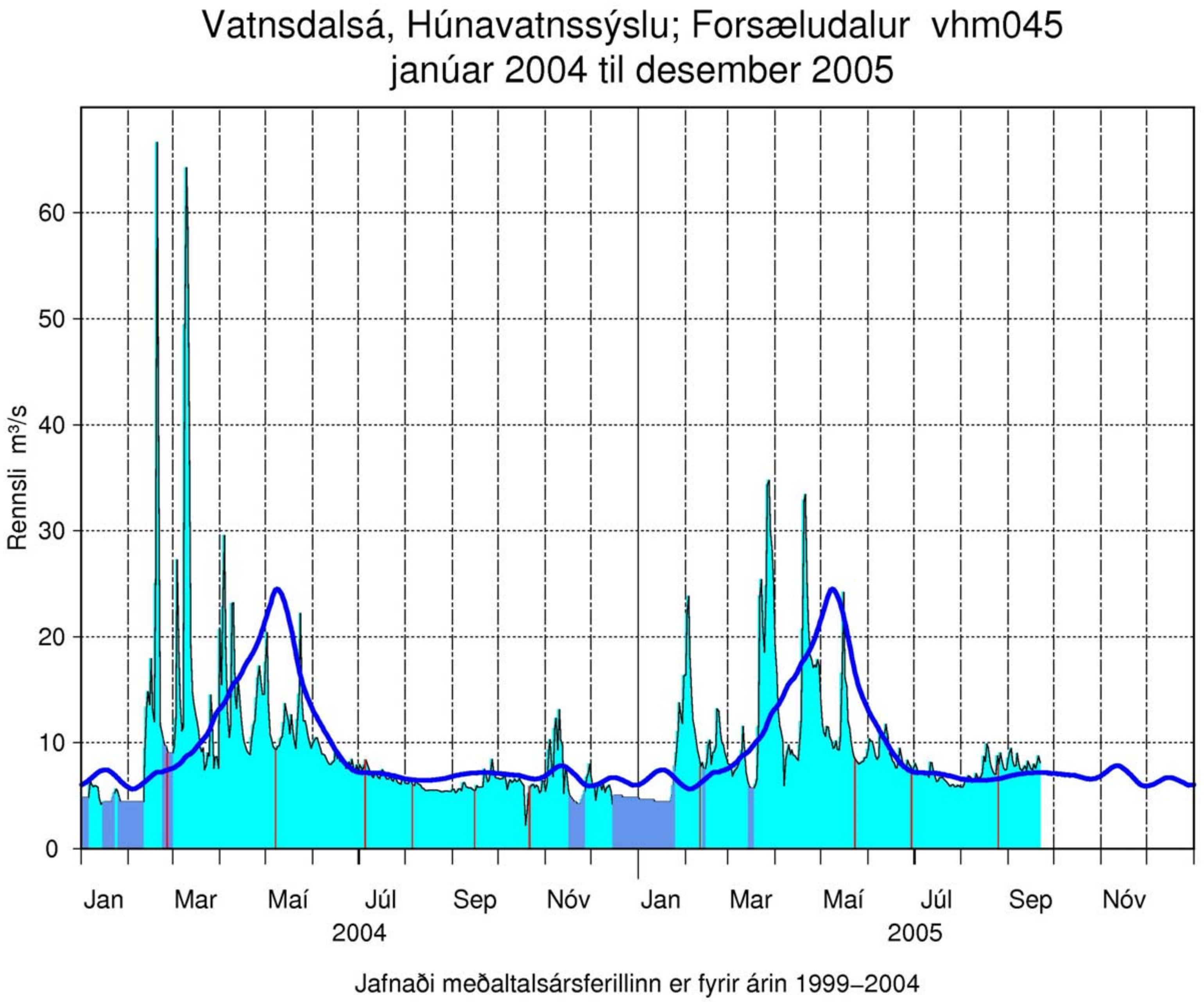


Figure 12. Discharga of River Vatnsdalsá at Forsaeludalur for 2004 and 2005. Red lines show when samples were taken.

Table 6. Chemical composition, discharge and suspended matter in River Vatnsdalsá in 2004-2005.

Sample number	Date	Discharge m^3/s	Water T °C	Air T °C	pH	T °C (pH/cond.)	Cond. µS/cm	SiO$_2$ mmol/l	Na mmol/l	K mmol/l	Ca mmol/l	Mg mmol/l	Alk (a) meq./kg	DIC mmol/l	SO$_4$ mmol/l ICP-AES	SO$_4$ mmol/l I.chrom	∂^{34}S ‰	Cl mmol/l I.chrom	F µmol/l I.chrom	Charge balance	Error %	TDS mg/l meas.	TDS mg/kg calc.	DOC mmol/l	POC µg/kg	PON µg/kg	C/N mol
04N005	2/26/2004 18:15	9.0	0.0	-8.9	7.54	19.3	96	0.323	0.377	0.025	0.148	0.117	0.720	0.770	0.015	0.017	11.2	0.181	4.69	-0.01	0.4	74	92	0.052			
04N006	5/7/2004 8:20	9.1	1.8	2.8	7.48	23.1	107	0.301	0.329	0.022	0.128	0.101	0.537	0.578	0.013	0.015	11.7	0.149	4.56	0.09	5.8	57	75	0.045	335	44.3	8.84
04N011	7/5/2004 13:10	8.4	11.3	15.8	7.87	23.4	92	0.316	0.357	0.025	0.142	0.111	0.685	0.705	0.012	0.014	11.0	0.148	5.19	0.02	1.3	74	85	0.062	235	37.7	7.28
04N014	8/5/2004 14:20	6.0	10.9	16.2	8.14	19.8	92	0.304	0.390	0.024	0.147	0.109	0.773	0.787	0.011	0.013	11.2	0.147	5.07	-0.03	1.4	74	90	0.053	235	26.1	10.5
04N017	9/15/2004 17:10	5.5	5.4	11.0	7.85	21.8	102	0.313	0.393	0.024	0.146	0.107	0.807	0.834	0.009	0.014	10.7	0.150	4.98	-0.06	3.4	73	93	0.042	294	32.1	10.7
04N020	10/21/2004 15:15	6.1	0.0	-3.3	7.54	23.6	110	0.352	0.428	0.026	0.154	0.120	0.797	0.849	0.013	0.016	11.1	0.177	4.99	-0.01	0.4	85	100	0.041	234	28.9	9.44
05N003	2/10/2005 17:55	8.2	-0.2	-1.6	7.80	21.2	98	0.377	0.393	0.026	0.149	0.127	0.723	0.749	0.016	0.014		0.179	3.56	0.03	1.7	80	95	0.047	328	44.5	8.60
05N006	5/23/2005 17:13	8.2	4.3	5.4	7.98	19.8	85	0.342	0.363	0.025	0.133	0.108	0.660	0.676	0.013	0.011		0.134	3.54	0.05	2.8	67	84	0.035	252	32.6	9.03
05N009	6/29/2005 19:15	7.2	11.7	14.1	8.18	20.9	89	0.360	0.358	0.027	0.132	0.105	0.721	0.731	0.014	0.011		0.130	3.75	-0.02	1.3	62	89	0.052	240	27.5	10.2
05N012	8/25/2005 16:25	8.0	4.0	4.5	8.08	20.2	99	0.374	0.384	0.026	0.159	0.133	0.813	0.829	0.014	0.011		0.144	3.73	0.00	0.2	61	98	0.082	369	32.3	13.3
05N015	10/3/2005 15:23	10.9	2.5	6.2	7.73	20.4	97	0.355	0.358	0.024	0.156	0.130	0.771	0.805	0.014	0.011		0.144	3.24	0.01	0.4	63	95	0.063	941	96.4	11.4
05N018	11/18/2005 15:55	8.2	0.8	2.9	7.63	21.7	96	0.370	0.388	0.027	0.153	0.122	0.793	0.836	0.015	0.013		0.142	3.68	0.00	0.2	69	98	0.039	538	53.4	11.8
Average 2004-2005		7.9	4.4	5.4	7.82	21.3	97	0.341	0.377	0.025	0.146	0.116	0.733	0.763	0.013	0.013	11.1	0.152	4.25	0.01	1.6	70	91	0.051	364	41.4	10.1

Sample number	Date	SPM (b) mg/l	P µmol/l	PO$_4$-P µmol/l	NO$_3$-N µmol/l	NO$_2$-N µmol/l	NH$_4$-N µmol/l	N$_{total}$ µmol/l	Al µmol/l	Fe µmol/l	B µmol/l	Mn µmol/l	Sr µmol/l	As nmol/l	Ba nmol/l	Cd nmol/l	Co nmol/l	Cr nmol/l	Cu nmol/l	Ni nmol/l	Pb nmol/l	Zn nmol/l	Hg nmol/l	Mo nmol/l	Ti nmol/l	V µmol/l
04N005	2/26/2004 18:15	13	0.455	0.470	2.79	0.074			0.168	1.06	0.324	0.079	0.134	<0.667	2.23	0.040	0.403	4.98	5.92	3.46	<0.048	7.13	<0.010	2.54	4.53	0.283
04N006	5/7/2004 8:20	7	0.462	0.555	0.464	0.147	0.906		0.215	1.59	0.271	0.098	0.111	<0.667	1.98	0.049	0.350	4.71	8.21	4.58	0.080	54.0	<0.010	2.61	3.99	0.320
04N011	7/5/2004 13:10	2	0.387	0.351	0.213	0.065	1.03		0.274	1.70	0.307	0.012	0.126	<0.667	1.71	0.021	0.162	5.02	6.12	2.44	0.069	9.63	0.012	2.87	2.84	0.406
04N014	8/5/2004 14:20	2	0.247	0.232	0.435	0.089	0.272	7.04	0.356	2.18	0.320	0.017	0.124	3.22	1.40	0.020	0.364	6.77	5.92	2.25	0.118	10.0	<0.010	3.14	8.04	0.452
04N017	9/15/2004 17:10	9	0.234	0.189	1.56	0.120	*9.30*	6.93	0.108	1.38	0.312	0.011	0.122	2.34	1.42	<0.018	0.262	5.96	4.14	2.30	0.077	<3.06	<0.010	3.17	2.76	0.444
04N020	10/21/2004 15:15	3	0.358	1.19	1.05	0.131	0.785	13.0	0.158	1.27	0.338	0.027	0.128	1.60	1.49	0.036	0.239	5.98	6.04	2.62	0.095	7.43	<0.010	3.07	5.93	0.373
05N003	2/10/2005 17:55	14	0.494	0.437	2.75	0.051	0.434	7.46	0.171	1.79	0.314	0.090	0.128	<6.67	2.21	0.020	0.363	5.00	6.25	2.28	0.154	8.03	<0.010	2.27	4.28	0.304
05N006	5/23/2005 17:13	8	0.488	0.122	0.195	0.046	0.409	4.86	0.231	1.59	0.283	0.065	0.108	<2.67	1.37	<0.018	0.285	4.92	4.77	1.87	0.057	<3.06	<0.010	2.43	4.55	0.357
05N009	6/29/2005 19:15	1	0.446	0.160	0.178	0.036	0.316	6.46	0.304	1.83	0.324	0.015	0.114	3.03	1.58	<0.018	0.285	5.56	5.82	1.70	0.073	<3.06	<0.010	2.68	2.53	0.426
05N012	8/25/2005 16:25	5	0.267	0.236	0.170	0.049	0.305	4.91	0.161	2.35	0.283	0.028	0.136	2.03	1.41	<0.018	0.324	4.75	4.58	2.23	0.062	<3.06	<0.010	2.71	2.99	0.310
05N015	10/3/2005 15:23	6	0.278	0.274	0.120	0.054	0.434	5.61	0.147	1.57	0.287	0.078	0.145	1.19	2.01	<0.018	0.370	3.42	5.32	2.64	<0.048	<3.06	<0.010	2.15	3.97	0.241
05N018	11/18/2005 15:55	11	0.394	0.417	2.73	0.044	<0.200	7.95	0.102	0.774	0.326	0.039	0.123	0.806	2.13	<0.018	0.158	4.50	4.78	1.74	<0.048	<3.06	<0.010	2.58	2.72	0.294
Average 2004-2005		7	0.376	0.386	1.06	0.075	<1.31	7.14	0.200	1.59	0.307	0.047	0.125	<2.13	1.75	<0.024	0.297	5.13	5.66	2.51	<0.078	<9.55	<0.010	2.68	4.09	0.351

(a) Alkalinity.

(b) Total inorganic suspended particulate matter.

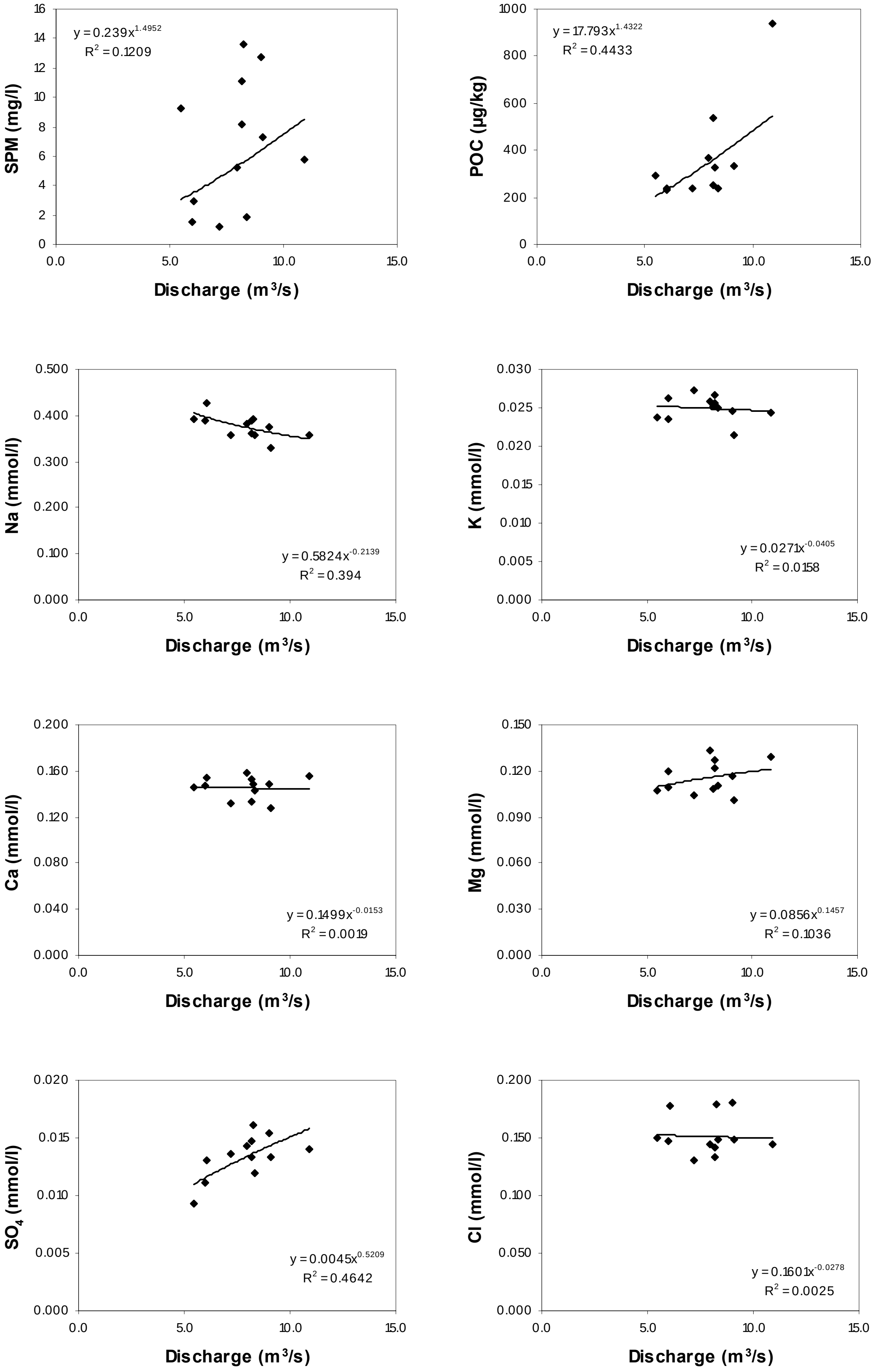
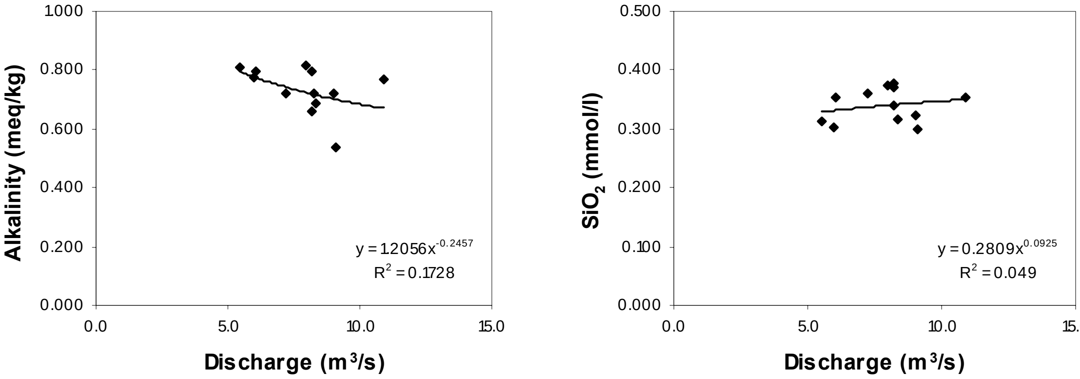


Figure 13. Concentration versus discharge correlations in River Vatnsdalsá 2004-2005.



Concentrations corrected for precipitation (except Mo):

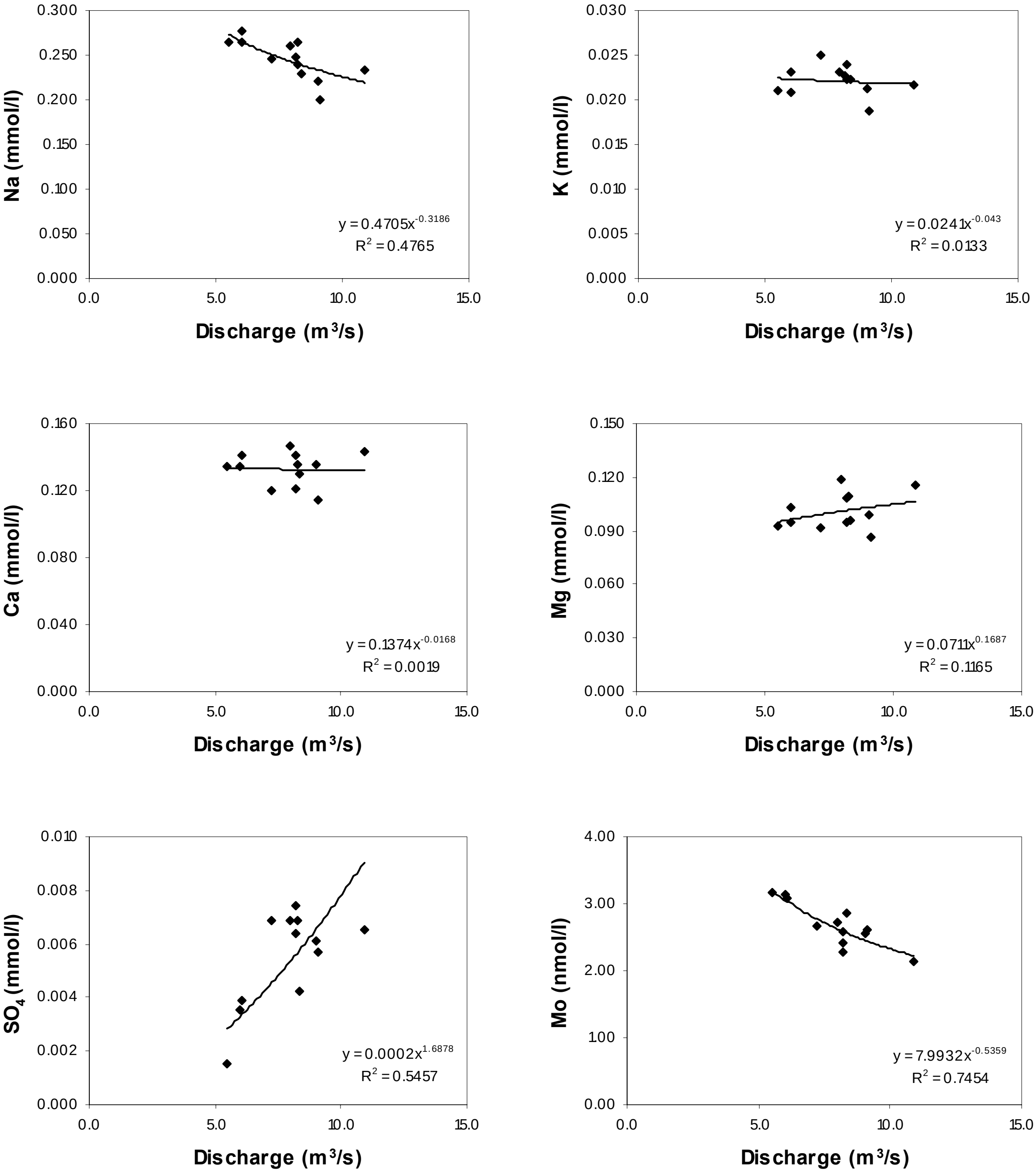


Figure 14. Rock derived concentration versus discharge correlations in River Vatnsdalsá 2004-2005.

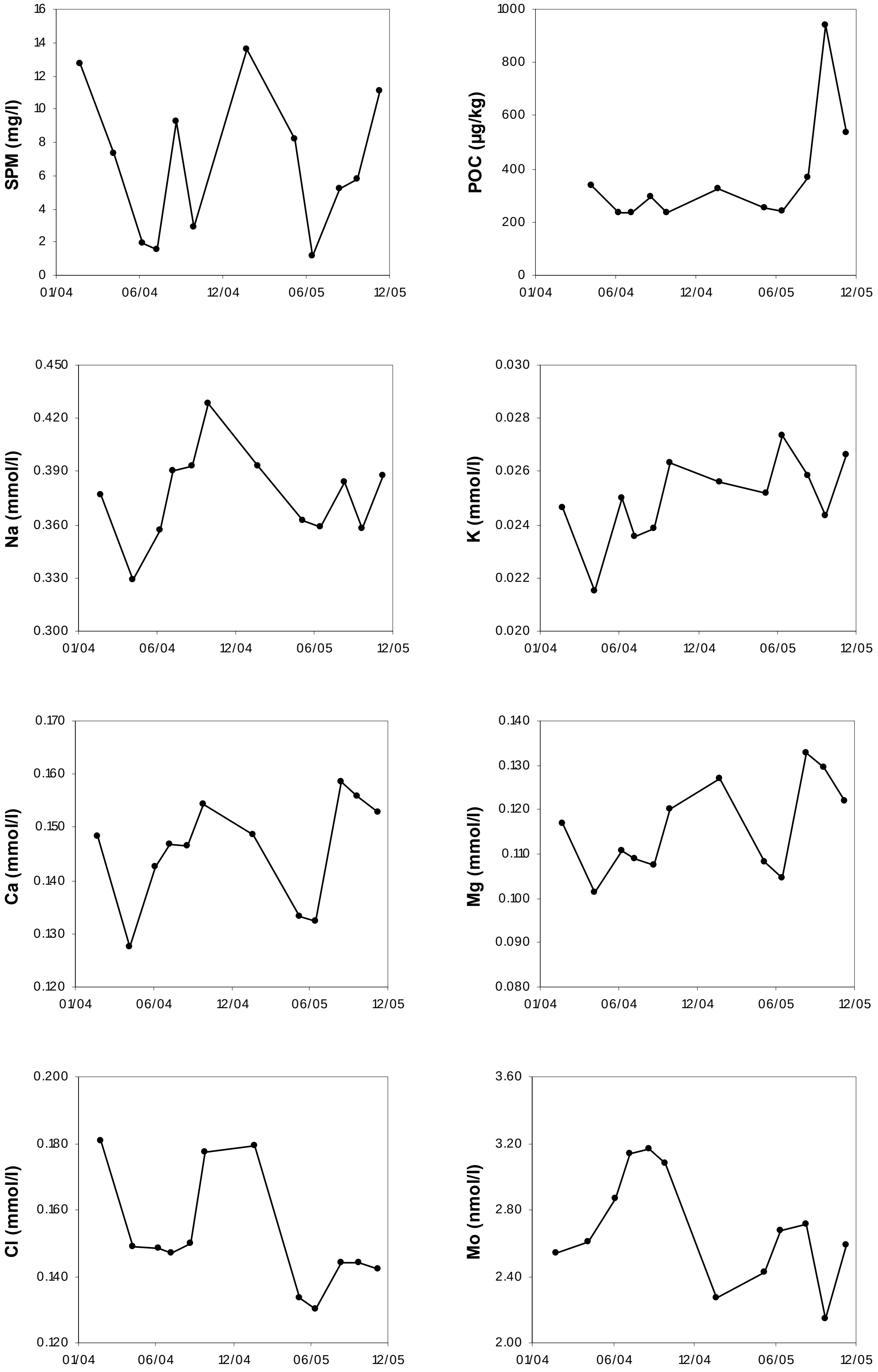


Figure 15. Time series for River Vatnsdalsá for 2004-2005.

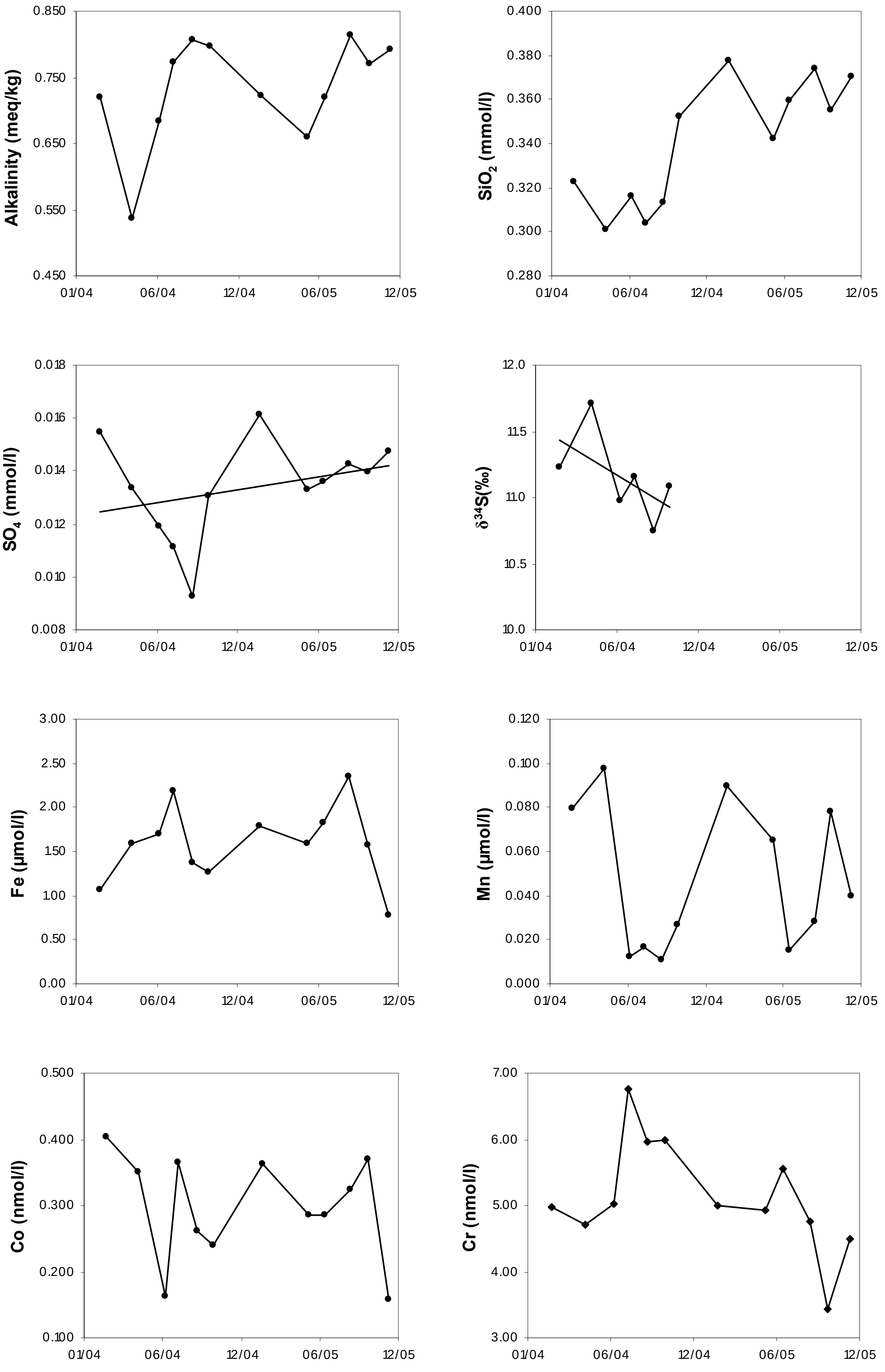


Figure 16. Time series for River Vatnsdalsá for 2004-2005.

Table 7. Detection limits and relative errors between measurements.

Measured element	**Detection limit µmol/l**	**Error proportional error**	**Std. dev.**
Conductivity		± 1.0	
T °C		± 0.1	
pH		± 0.05	
SiO_2 ICP-AES (RH)	1.66	2%	1.8
SiO_2 ICP-AES (SGAB)	1.00	4%	
Na ICP-AES (RH)	0.435	3.3%	2.8
Na ICP-AES (SGAB)	4.35	4%	
K Ion Chromatograph (RH)	1.28	3%	
K ICP-AES (RH)	12.8		
K ICP-AES (SGAB)	10.2	4%	
K AA	1.10	4%	
Ca ICP-AES (RH)	0.025	2.6%	1.6
Ca ICP-AES (SGAB)	2.50	4%	
Mg ICP-AES (RH)	0.206	1.6%	1.6
Mg ICP-AES (SGAB)	3.70	4%	
Alk.		3%	
CO_2		3%	
SO_4 ICP-AES (RH)	10.4	10%	8.2
SO_4 HPLC	0.520	5%	
SO_4 ICP-AES (SGAB)	1.67	15%	
Cl	28.2	5%	
F	1.05	1.05-1.58 µmol/l ±10% >1.58 µmol/l ±3%	
P ICP-MS (SGAB)	0.032	3%	
P-PO_4	0.065	0.065-0.484 µmol/l ±1 µmol/l >0.484 µmol/l ±5%	
N-NO_2	0.040	0.040-0.214 µmol/l ±0.014 µmol/l >0.214 µmol/l ±5%	
N-NO_3	0.143	0.142-0.714 µmol/l ±0.071 µmol/l >0.714 µmol/l ±10%	
N-NH_4	0.200	10%	
Al ICP-AES (RH)	0.371	3.8%	3.2
B ICP-AES (SGAB)	0.925		
B ICP-MS (SGAB)	0.037		
Sr ICP-AES (RH)	0.023	15%	
Sr ICP-MS (SGAB)	0.023	4%	
Ti ICP-MS (SGAB)	0.002	4%	
Fe ICP-AES (RH)	0.358	12%	15
Fe ICP-AES (SAGB)	0.143	10%	
Mn ICP-AES (RH)	0.109	26%	24
	nmol/l		
Mn ICP-MS (SGAB)	0.546	8%	
Al ICP-MS (SGAB)	7.412	12%	
As ICP-MS (SGAB)	at least 0.667 (a)	9%	
Cr ICP-MS (SGAB)	0.192	9%	
Ba ICP-MS (SGAB)	0.073	6%	
Fe ICP-MS (SAGB)	7.162	4%	
Co ICP-MS (SGAB)	0.058	8%	
Ni ICP-MS (SGAB)	0.852	8%	
Cu ICP-MS (SGAB)	1.574	8%	
Zn ICP-MS (SGAB)	3.059	12%	
Mo ICP-MS (SGAB)	0.521	12%	
Cd ICP-MS (SGAB)	0.018	9%	
Hg ICP-AF (SGAB)	0.010	4%	
Pb ICP-MS (SGAB)	0.048	8%	
V ICP-MS (SGAB)	0.098	5%	
Th ICP-MS (SGAB)	0.039		
U ICP-MS (SGAB)	0.002	12%	
Sn ICP-MS (SGAB)	0.421	10%	
Sb ICP-MS (SGAB)	0.082	15%	

(a) Chloride interferes with As during the analysis causing variable detection limits.