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## **Oskarshamn site investigation**

### **Monitoring of shallow groundwater chemistry 2009**

Ulf Ericsson, Medins Biologi AB

June 2010

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# Abstract

In 2009 sampling of shallow ground water in water wells in soil has been performed in a regular programme at eight sites within the site investigation area at Oskarshamn. The purpose of the activity is to monitor (long term observation) and characterise the shallow ground water in the site investigation area.

Some physical and chemical parameters were measured directly in the field but most parameters were analysed at different laboratories. The ground water sampling activity consisted of one programme, chemical programme class 5 (reduced).

The large number of sites and parameters analysed have generated a large amount of data, which will later be used for advanced analysis and modelling. In this report the evaluation aims to give a simple overview of the results and to describe the quality of the data sampled 2009.

As an addition radon activity was measured at fourteen sites in the area. Seven of these sites were the same as in the regular programme.

The results showed a large variation between the wells. The concentrations of major ions and conductivity ranged from low to high or very high values. The concentration of  $\text{HCO}_3$  also varied extensively throughout the investigation area, but since the concentrations were above 60 mg/l in most wells the results indicate a good ground water quality with respect to acidification.

The concentration of heavy metals and trace elements also varied. High concentration of Pb in some of the wells indicated pollution. Since Pb had a similar relation to Al as most other elements it was argued that high concentrations of lead probably can be explained by the natural composition of minerals within the site investigation area.

The ratio of  $\delta^{18}\text{O}$  showed a good relationship with the conductivity. The activity of tritium ( $^3\text{H}$ ) was markedly lower in two of the wells. This might be an indication of older groundwater in these wells. The average hydrogen isotope ratio of deuterium ( $\delta^2\text{H}$ ) varied with similar values in most wells. The  $\delta^2\text{H}$  ratio correlates reasonably well with the  $\delta^{18}\text{O}$  ratio but the linear relation differ markedly from the "Global Meteoric Line" ( $\delta^2\text{H} = 8 \cdot \delta^{18}\text{O} + 10$ ) which is based on precipitation data.

The concentration of  $\text{NO}_3\text{-N}$  varied to some extent between the wells but according to the Swedish Environmental Quality Criteria the concentration was very low. The concentration of  $\text{NH}_4\text{-N}$  and  $\text{PO}_4\text{-P}$  varied with markedly higher values in some of the ground water wells. The site SSM000241 differed even more with extremely high values of  $\text{NH}_4\text{-N}$  and  $\text{PO}_4\text{-P}$ . The concentration of carbon (TOC and DOC) varied with low to moderately high concentrations in most wells. Again the well SSM000241 differed with very high concentrations.

## Sammanfattning

Inom det reguljära programmet har provtagning av ytligt grundvatten i jordrör under 2009 skett vid åtta platser inom platsundersökningsområdet i Oskarshamn. Målsättningen med aktiviteten är att monitera (långtidsövervaka) och karakterisera det ytliga grundvattnet i området.

Några fysiska och kemiska parametrar har mätts direkt i fält men merparten av de insamlade parametrarna är resultatet av laboratorieanalyser. Aktiviteten bestod av ett program, klass 5 (reducerat).

Det stora antalet platser och analyserade parametrar har genererat en stor mängd data som senare kommer att användas för avancerad analys och modellering. I denna rapport har utvärderingen syftat till att ge en enkel översikt över resultaten och att beskriva kvaliteten av de data som samlats in 2009.

Resultaten av undersökningarna visade på en stor variation mellan de olika grundvattenrören i området. Halterna av joner och vattnets och konduktivitet varierade från låga till väldigt höga värden. Även halten av  $\text{HCO}_3$  varierade mycket mellan provplatserna. På de flesta platserna var dock halterna över 60 mg/l vilket visar på en god vattenkvalitet med avseende på försurning.

Koncentrationerna av tungmetaller och spårelement varierade också relativt mycket mellan de olika provplatserna. En hög koncentration av Pb vid några av platserna indikerade föroreningspåverkan. Eftersom relationen mellan koncentrationen av Pb och Al liknade den som flertalet andra metaller och spårelement hade med Al drogs dock slutsatsen att de höga blyhalterna kan förklaras med mineralets naturliga sammansättning i området.

Isotopen  $\delta^{18}\text{O}$  visade en god relation med konduktiviteten i vattnet. Medelvärdet för aktiviteten av tritium ( $^3\text{H}$ ) var märkbart lägre i två av jordrören vilket kan vara en indikation på att grundvattnet är äldre i dessa jordrör. Kvoterna av deuterium ( $\delta^2\text{H}$ ) varierade med liknande värden i de flesta grundvattenrören. Kvoterna av  $\delta^2\text{H}$  var relativt väl korrelerade med kvoterna av  $\delta^{18}\text{O}$  men det linjära sambandet skiljde sig märkbart från "the Global Meteoric Line" ( $\delta^2\text{H}=8\cdot\delta^{18}\text{O}+10$ ) vilken baseras på data från nederbörd.

Koncentrationen av  $\text{NO}_3\text{-N}$  varierade i viss grad men enligt Naturvårdsverkets kriterier var halterna mycket låga i samtliga grundvattenrör. Koncentrationen av  $\text{NH}_4\text{-N}$  och  $\text{PO}_4\text{-P}$  varierade med märkbart högre halter i några av jordrören. Resultaten från jordrören SSM000241 visade på vad som kan klassas som extremt höga halter av  $\text{NH}_4\text{-N}$  och  $\text{PO}_4\text{-P}$ . Koncentrationen av kol (TOC och DOC) varierade med värden som kan betecknas som låga till måttligt höga i de flesta jordrören. Jordröret SSM000241 avvek med betydligt högre halter.

# Contents

<b>1</b>	<b>Introduction</b>	7
<b>2</b>	<b>Objective and scope</b>	9
<b>3</b>	<b>Equipment</b>	11
3.1	Equipment used in the field	11
3.2	Equipment used at the laboratory	11
<b>4</b>	<b>Execution</b>	13
4.1	Sites and sampling frequency	13
4.2	Execution of sampling and treatment of samples	13
4.3	Documentation	14
<b>5</b>	<b>Nonconformities</b>	15
<b>6</b>	<b>Results and discussion</b>	17
6.1	Primary results	17
6.2	Dissolved ions and conductivity	17
6.3	Acidification	18
6.4	Heavy metals and trace elements	19
6.5	Isotopes	22
6.6	Nutrients and carbon	23
	<b>References</b>	25
	<b>Appendix 1</b> Sites, co-ordinates and sampling depths	27
	<b>Appendix 2</b> Schedule – Sampling of shallow ground water 2009	29
	<b>Appendix 3</b> Primary results – Laboratory analysis	31
	<b>Appendix 4</b> Primary results – Field analysis	43

# 1 Introduction

This document reports the data gained by sampling of shallow ground water 2009, which is one of the activities performed within the site investigation programme at Oskarshamn. The work was carried out in accordance with the activity plan AP PS 400-09-002. In Table 1-1 controlling documents for performing this activity are listed. The activity plan is one of SKB's internal controlling documents.

Within the site investigation area water has been sampled from shallow ground water wells in soil. During 2009 sampling was performed in a regular programme at eight sites on four occasions (Figure 1-1). The water was analysed for a large number of parameters.

As an addition field measurement on radon activity was performed in May at fourteen sites in the area (Figure 1-1). Seven of these sites were the same as in the regular programme. Primary data from these measurements are presented in Appendix 4. Description of methods and a full evaluation of the results have been presented in the SKB report R-09-47 /Grolander 2009/.



*Figure 1-1. The site investigation area and the location of the water wells in soil used for sampling of shallow ground water, regular programme and radon measurement programme in 2009.*

**Table 1-1. Controlling documents for the performance of the activity.**

<b>Activity plan</b>	<b>Number</b>	<b>Version</b>
Hydrokemisk jordrörsmonitoring 2009	AP PS 400-09-002	1.0

All original results have been stored in the primary database SICADA. The results are traceable by the activity plan number. The data in the database will later be used for further interpretation (modelling).

## 2 Objective and scope

The purpose of the activity was to monitor and characterise the shallow ground water in the site investigation area. According to the activity plan sampling was planned to be performed at eight different ground water wells, at four occasions during 2009. Two of these water wells are situated in the Ävrö, Hålö and Simpevarp peninsula area, and the rest in the Laxemar area.

Some physical and chemical parameters were measured in the field and water samples for analysis of further parameters were sent to different analyzing laboratories for analysis.

In general the ground water sampling activity was done according to the programme chemical class 5 (reduced). Analysed parameters are presented in Table 2-1. If it was not possible to get a sufficient amount of water for analysis of all components a priority order was set up (Table 2-1). A time schedule for the sampling in 2009 is presented in Appendix 2.

The large number of sites and parameters analysed have generated a large amount of data, which will later be used for advanced analysis and modelling. In this report the evaluation aims to give a simple overview of the results and to describe the quality of the data sampled during 2009.

**Table 2-1. Analysed components and priority order when sampling ground water wells 2009.**

Components	Priority	Components	Priority
Alkalinity, pH, Conductivity	2	Fe <sup>2+</sup> , Fe-tot	7
Anions (F <sup>-</sup> , Cl <sup>-</sup> , Br <sup>-</sup> , SO <sub>4</sub> <sup>2-</sup> )	3	HS <sup>-</sup>	8
Standard elements	1	NH <sub>4</sub> , NO <sub>3</sub> , NO <sub>2</sub> , NO <sub>2</sub> +NO <sub>3</sub> , PO <sub>4</sub>	9
Heavy metals	1	Tot-N and Tot-P	10
Lantanoides	1	DOC	11
Trace elements	1	TOC	12
δ <sup>2</sup> H, δ <sup>18</sup> O	4	POP, PON and POC	13
<sup>3</sup> H	5	Archive (acid rinsed)	14
δ <sup>37</sup> Cl	6	Archive	14



## **3 Equipment**

### **3.1 Equipment used in the field**

Underwater pump (type 12 V Avimex) or a 12 V vacuum pump was used for pumping up water from the ground water wells.

Two litres plastic cans were used as collecting vessels for archive samples. Acid rinsed 500 ml plastic vessels were used when sampling for analysis of  $\text{Fe}^{2+}$ , Fe (tot), standard elements, trace elements, lantanoides, and heavy metals. Archive samples were also taken from the acid rinsed vessels.

Samples for analysis of  $\text{NH}_4\text{-N}$ ,  $\text{NO}_2\text{-N}$ ,  $\text{NO}_3\text{-N}$ ,  $\text{NO}_2/\text{NO}_3\text{-N}$ ,  $\text{PO}_4\text{-P}$  and DOC were filtered with disposable filters  $0.45\mu\text{m}$ .

Sounding apparatus, pH-meter and thermometer were used for field measurements.

### **3.2 Equipment used at the laboratory**

A tube pump was used in the laboratory to filter sampled water.

A  $0.45\ \mu\text{m}$  filter (PALL) Capsule filter was used together with the tube pump.

A  $0.45\ \mu\text{m}$  membrane filter was used together with the tube pump.

## 4 Execution

### 4.1 Sites and sampling frequency

The total number of sampled sites was fifteen (Appendix 1). Eight of the sites were sampled according to the regular programme four times during 2009 for the parameters presented in Table 2-1. At fourteen of the sites field measurements of radon were performed in May (Appendix 1). This was done as an addition to the regular programme. The sampling frequency of the regular programme in 2009 is presented in Appendix 2.

### 4.2 Execution of sampling and treatment of samples

To avoid contamination all sampling was conducted with protective rubber gloves and great care was taken not to contaminate containers or equipment. The day before sampling, each ground water well was visited and water was pumped out, if possible, for at least 15 minutes. On the sampling day, the ground water level was sounded and noted. Field measurements of pH were then performed, before the collecting vessels were filled with water. The samples for analysis of NH<sub>4</sub>-N, NO<sub>2</sub>-N, NO<sub>3</sub>-N, NO<sub>2</sub>/NO<sub>3</sub>-N, PO<sub>4</sub>-P and DOC were filtered in field with a syringe and 0.45 µm filters.

Bottles for most analysis were filled and treated in the field (Table 4-1). Water for archive samples, Fe<sup>2+</sup>, Fe (tot), standard elements, trace elements, lantanoides, and heavy metals were transported in collecting vessels to a preparation room where the samples were divided into smaller bottles and treatments were made (Table 4-1). All work was conducted with protective rubber gloves to minimise the risk of contamination.

Routines for storing and delivery of samples to the different analysing laboratories are presented in Table 4-2. Some of the samples were sent immediately at the end of each day and some were stored in a refrigerator till the end of the week, when they were sent to the laboratory.

**Table 4-1. Field and indoor treatments of samples. Samples which are treated indoor are marked grey.**

Bottle	Number	SKB-label	Components	Filling instructions	Preparation
250 ml	1	green	Alkalinity, pH, Conductivity	Fill up	–
250 ml	1	green	Anions (F <sup>-</sup> , Cl <sup>-</sup> , Br <sup>-</sup> , SO <sub>4</sub> <sup>2-</sup> )	Fill up	–
500 ml acid rinsed PEH bottle.	1	red	Fe <sup>2+</sup> , Fe (tot)	Fill up	Filter with membrane filter, add 5 ml concentrated HCl.
Winkler bottle.	2		S <sup>2-</sup>	Flow over three times	Add 0.5 ml 1M ZnAc and 0.5 ml 1M NaOH.
125 ml	1	red	Standard elements, B-10, environment metals, lantanoides, trace elements.	Fill up	Filter with membrane filter, add 1 ml concentrated HNO <sub>3</sub> .
Test tubes	4	green green	NO <sub>3</sub> <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , (NO <sub>2</sub> <sup>-</sup> +NO <sub>3</sub> <sup>-</sup> ), PO <sub>4</sub> <sup>3-</sup>	Fill 80%	Filter with disposable filter, 0.45 µm in field, heat 60° for 1 hour.
100 ml	1		Tot-N and Tot-P	Fill up	–
1000 ml	1	green	POP, POC and PON	Fill up	–
20 ml scint. vessel.	1	green	DOC	Fill 80%	Filter with disposable filter, 0.45 µm in field, add 1 drop of 1 M HCl.
20 ml scint. vessel.	1	green	TOC	Fill 80%	Add 2 drops of 2 M HCl.
100 ml quadrangular.	1	green	δ <sup>2</sup> H, δ <sup>18</sup> O	Fill 80%	–
500 ml dried.	1	green	<sup>3</sup> H	Flow over	–
250 ml	2	green	Archive	Fill 80%	Filter with "Pallfilter" 0.45 µm.
100 ml	2	red	Archive	Fill 80%	Filter with membrane filter, add 1 ml concentrated HNO <sub>3</sub> .

**Table 4-2. Treatments of samples when storing and delivering to analysing laboratories (Systemekologen is a laboratory at the University of Stockholm).**

Bottle	Number	SKB-label	Components	Storing	Analysing laboratory	Way of delivery
250 ml	1	green	Alkalinity, pH, Conductivity	Refrigerator	Äspö laboratory	Directly
250 ml	1	green	Anions (F <sup>-</sup> , Cl <sup>-</sup> , Br <sup>-</sup> , SO <sub>4</sub> <sup>2-</sup> )	Refrigerator	Äspö laboratory	Directly
500 ml acid rinsed PEH bottle	1	red	Fe <sup>2+</sup> , Fe (tot)	Refrigerator	Äspö laboratory	Directly
Winkler bottle	2		S <sub>2</sub> <sup>-</sup>	Refrigerator	Äspö laboratory	Directly
125 ml	1	red	Standard elements, B-10, environment metals, lantanoides, trace elements.	Refrigerator	ALS	Parcel post
Test tubes	4	green	NO <sub>3</sub> <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , (NO <sub>2</sub> <sup>-</sup> +NO <sub>3</sub> <sup>-</sup> ), PO <sub>4</sub> <sup>3-</sup>	Refrigerator	Systemekologen	Parcel post
100 ml	1	green	Tot-N and Tot-P	Refrigerator	Systemekologen	Parcel post
1,000 ml	1	green	POP, POC and PON	Refrigerator	Systemekologen	Parcel post
20 ml scint. vessel	1	green	DOC	Refrigerator	Systemekologen	Parcel post
20 ml scint. vessel	1	green	TOC	Refrigerator	Systemekologen	Parcel post
100 ml quadrangular	1	green	δ <sup>2</sup> H, δ <sup>18</sup> O	Refrigerator	IFE, Norway	Parcel post
1,000 ml dried	1	green	<sup>3</sup> H	Refrigerator	EIL; Canada	Parcel post
250 ml	2	green	Archive	Freezer	–	–
100 ml	2	red	Archive	Freezer	–	–

### 4.3 Documentation

All activities were continuously documented. Notes were taken on field conditions, time of sampling, markings of samples and so forth. Any deviations from the normal routines were also noted and commented in a special report. Delivery notes with instructions on which components to analyse were always sent with the samples to the different laboratories.

After analysis data has continuously been reported from the laboratories. As a routine a first preliminary quality control of the data was performed before storing them in the database SICADA.

## **5 Nonconformities**

The water well SSM000241 was not possible to sample in November due to lack of water.

## 6 Results and discussion

### 6.1 Primary results

All primary results from the laboratory analysis and from the field measurements are presented in Appendix 3 and 4.

### 6.2 Dissolved ions and conductivity

The concentrations of ions and the conductivity varied much between the sites (Table 6-1). The sites with the highest concentrations of ions are situated close to the coast or under the seabed. The site SSM000042 which is situated quite far from the coast also had comparably high concentrations of ions.

According to the Swedish Environmental Quality Criteria /Naturvårdsverket 1999/ the concentrations of chloride ranged from low to very high at different wells, with concentrations above 100 mg/l termed as high and above 300 mg/l termed as very high.

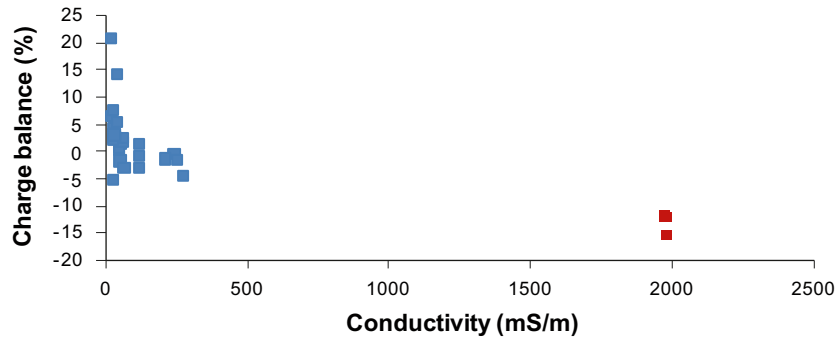
As a quality control the charge balance has been calculated for the samples. In two of the samples there was a positive deviation of more than 10 percent (Table 6-2). This could indicate analytical problems or significant concentrations of negative ions which were not included in the calculation of the charge balance. These samples had a comparatively low conductivity which might be an indication of ions not included in the calculation instead of analytical errors (Figure 6-1). One possible example is organic anions which has not been included. In three cases (Table 6-2) there were negative deviations of more than ten percent. Likewise this could indicate either analytical problems or significant concentrations of positive ions not included in the calculation.

**Table 6-1. Average concentration of major ions and conductivity in shallow ground water wells 2009.**

Site number	Fe <sup>2+</sup> (mg/l)	Fe (tot) (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Li (mg/l)
SSM000014	5.56	6.38	17.0	5.553	24.6	14.2	0.0406
SSM000022	0.879	0.982	225.3	5.69	22.4	6.63	0.0262
SSM000030	2.80	2.95	28.38	2.548	65.7	8.24	0.0099
SSM000041	4.33	5.16	8.975	4.518	31.6	6.69	0.0079
SSM000042	6.52	7.18	58.8	3.998	50.2	11.6	0.0074
SSM000228	6.64	6.95	10.8	1.708	32.1	4.86	0.0084
SSM000240	0.428	0.467	330.3	14.55	77.4	43.2	0.0197
SSM000241	0.972	0.982	2683	128.7	316	438	0.160
Site number	HCO <sub>3</sub> (mg/l)	Cl (mg/l)	SO <sub>4</sub> (mg/l)	SO <sub>4</sub> -S (mg/l)	F (mg/l)	Sr (mg/l)	Conductivity (mS/m)
SSM000014	39.5	29.8	76.23	28.1	2.98	0.099	35.2
SSM000022	257	147	145.5	52.28	4.19	0.291	120
SSM000030	247	12.1	33.13	12.15	2.41	0.283	50.0
SSM000041	55.6	31.5	20.18	7.62	0.838	0.097	27.6
SSM000042	153	59.2	68.38	26.8	1.20	0.136	57.7
SSM000228	102	13.4	25.75	8.61	2.22	0.073	28.7
SSM000240	278	612	51.63	19.55	1.47	0.563	244
SSM000241	5,257	4,773	14.19	12.3	0.670	5.02	1,977

**Table 6-2. Samples with a charge balance which deviates more than 10 percent. Sampling in shallow ground water wells 2009.**

Site number	Sampling date	Sample number	Charge balance (%)
SSM000041	2009-08-25	19043	20.71
SSM000042	2009-11-12	19175	14.27
SSM000241	2009-04-16	15853	-15.30
SSM000241	2009-06-03	15955	-11.86
SSM000241	2009-09-02	19049	-11.98



**Figure 6-1.** Relation of charge balance and conductivity in samples from all ground water wells 2009. Red dots show the site SSM000241.

### 6.3 Acidification

As with other ions the concentration of  $\text{HCO}_3$  varied extensively throughout the investigation area (Table 6-3). In most of the wells the average concentration of  $\text{HCO}_3$  was higher than 60 mg/l which is termed as a high or very high concentration according to the Swedish Environmental Quality Criteria /Naturvårdsverket 1999/. These results indicate a good ground water quality with respect to acidification at the investigated sites. The wells SSM000014 and SSM000041 differed with an average concentration of  $\text{HCO}_3$  below 60 mg/l. This might indicate problem with acidification at these sites.

The field measurements of pH had a poor relation with the measurements in the laboratory (Figure 6-2). Likewise the field measurements of pH were poorly correlated to  $\text{HCO}_3$  (Figure 6-3).

**Table 6-3. Average concentration of  $\text{HCO}_3$ , calculated alkalinity ( $\text{HCO}_3$ ) and pH in shallow ground water wells 2009.**

Site number	$\text{HCO}_3$ (mg/l)	Alkalinity (meq/l)	pH-lab	pH-field
SSM000014	39.5	0.647	6.10	6.33
SSM000022	257	4.20	7.98	6.83
SSM000030	247	4.05	7.20	6.55
SSM000041	55.6	0.912	6.14	6.46
SSM000042	153	2.50	6.75	6.55
SSM000228	102	1.68	6.53	6.67
SSM000240	278	4.55	7.47	6.54
SSM000241	5,257	86.2	6.85	6.87

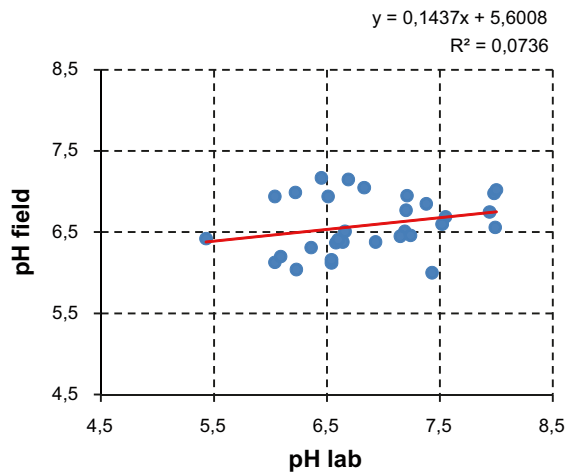


Figure 6-2. Relation of pH measured in the laboratory and in the field in ground water wells 2009.

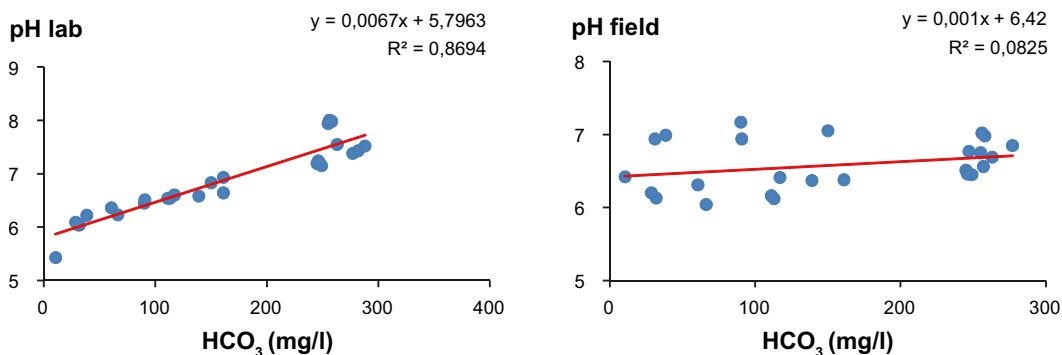


Figure 6-3. Relation of pH measured in the laboratory and  $\text{HCO}_3$  and relation of pH measured in the field and  $\text{HCO}_3$  in ground water wells 2009. Data from the well SSM000241 is not included.

## 6.4 Heavy metals and trace elements

The concentrations of heavy metals and trace elements are presented as averages in Table 6-4 and 6-5. The results varied quite much between the wells but most elements had a strong relation with aluminium, examples are shown in Figure 6-4. This indicates a good quality of the analysis performed. However, in two cases apparent outliers exist, indicating pollution, contamination or analytical errors. The cases are Zn (SSM000240 and SSM000241, sample numbers 15852 and 19049) (Figure 6-5). Similar outliers exist for some other elements at site SSM00241 (Figure 6-6). This ground water well seems to have a different type of water and therefore the poor relation with aluminium is probably not an indication of pollution, contamination or analytical errors.

Some of the heavy metals can be classified according to the Swedish Environmental Quality Criteria's /Naturvårdsverket 1999/. According to these criteria's the concentration of Cd and Zn was low to moderately high in the different wells. These results are what to be expected in an unpolluted area. However, the average concentration of Pb was very high ( $> 10 \mu\text{g/l}$ ) in one well (SSM000014) (Table 6-4 and Figure 6-7). This could be an indication of some kind of pollution. However, since the relation to aluminium is similar to most other elements the high concentration of Pb in this well can probably be explained as a natural composition of the mineral at the site.

**Table 6-4. Average concentration of heavy metals in shallow ground water wells 2009. Figures in italic indicate that some or all individual values in the calculation were below the report limit of the laboratory.**

Site number	Al (µg/l)	Ba (µg/l)	Cd (µg/l)	Cr (µg/l)	Cu (µg/l)	Co (µg/l)	Hg (µg/l)	Mo (µg/l)	Ni (µg/l)	Pb (µg/l)	Se (µg/l)	V (µg/l)	Zn (µg/l)
SSM000014	2,890	55.7	0.0547	4.18	10.7	4.46	<i>0.0030</i>	0.390	11.1	10.9	–	7.75	16.6
SSM000022	41.3	29.0	<i>0.0023</i>	0.271	<i>0.163</i>	0.067	<i>0.0035</i>	12.0	0.360	0.069	–	0.832	1.47
SSM000030	370	38.3	<i>0.0084</i>	1.35	0.882	0.317	<i>0.0022</i>	0.774	1.1	0.794	–	6.55	3.96
SSM000041	2,393	41.9	0.0510	4.96	7.88	2.46	<i>0.0029</i>	0.418	6.5	3.24	0.147	7.94	16.7
SSM000042	868	75.9	0.0203	2.95	5.40	0.981	<i>0.0028</i>	1.35	2.1	1.63	0.084	6.37	8.20
SSM000228	445	23.1	<i>0.0020</i>	1.74	0.439	0.307	<i>0.0028</i>	0.390	0.549	0.336	0.156	9.26	2.00
SSM000240	11.4	83.6	<i>0.0022</i>	0.737	<i>0.120</i>	0.041	<i>0.0026</i>	0.375	0.254	0.027	0.102	5.41	5.49
SSM000241	26.9	810	<i>0.0590</i>	8.28	<i>0.500</i>	4.50	<i>0.0020</i>	<i>0.500</i>	2.2	0.326	–	16.4	10.4

**Table 6-5. Average concentration of trace elements in shallow ground water wells 2009. Figures in italic indicate that some or all individual values in the calculation were below the report limit of the laboratory.**

Site number	U (µg/l)	Th (µg/l)	Sc (µg/l)	Rb (µg/l)	Y (µg/l)	Zr (µg/l)	Sb (µg/l)	Cs (µg/l)
SSM000014	4.95	1.84	0.757	10.8	11.5	3.45	0.0758	0.575
SSM000022	1.89	<i>0.052</i>	<i>0.050</i>	2.26	0.476	0.530	0.0638	<i>0.032</i>
SSM000030	0.412	0.665	0.164	5.76	1.6888	2.05	0.0304	0.496
SSM000041	0.914	1.66	0.861	11.4	11.5	3.27	0.0637	0.534
SSM000042	1.04	1.50	0.512	6.36	6.26	2.17	0.0386	0.566
SSM000228	0.645	0.548	0.462	1.97	11.0	2.45	0.0598	0.064
SSM000240	0.259	0.074	<i>0.050</i>	8.76	0.960	1.95	0.152	0.567
SSM000241	0.040	<i>0.200</i>	<i>0.500</i>	69.5	0.386	13.5	0.385	2.51

Site number	La (µg/l)	Hf (µg/l)	Tl (µg/l)	Ce (µg/l)	Pr (µg/l)	Nd (µg/l)	Sm (µg/l)	Eu (µg/l)
SSM000014	19.1	0.122	0.051	34.9	4.62	18.4	3.22	0.518
SSM000022	0.386	0.009	<i>0.010</i>	0.637	0.087	0.365	0.066	<i>0.007</i>
SSM000030	2.83	0.049	<i>0.014</i>	5.45	0.638	2.43	0.437	0.064
SSM000041	21.7	0.128	0.050	42.8	5.78	22.5	3.93	0.547
SSM000042	12.4	0.082	<i>0.022</i>	20.9	2.73	10.8	1.76	0.250
SSM000228	15.5	0.089	<i>0.010</i>	28.4	3.41	14.4	2.33	0.394
SSM000240	0.278	0.038	<i>0.010</i>	0.532	0.077	0.358	0.083	0.010
SSM000241	0.524	0.115	<i>0.100</i>	0.513	<i>0.073</i>	0.235	<i>0.060</i>	<i>0.050</i>

Site number	Gd (µg/l)	Tb (µg/l)	Dy (µg/l)	Ho (µg/l)	Er (µg/l)	Tm (µg/l)	Yb (µg/l)	Lu (µg/l)
SSM000014	2.47	0.291	1.77	0.352	1.01	0.137	0.936	0.160
SSM000022	0.061	0.008	0.052	0.012	0.038	0.005	0.034	0.007
SSM000030	0.325	0.044	0.288	0.059	0.173	0.024	0.170	0.028
SSM000041	2.89	0.339	1.99	0.386	1.10	0.147	1.03	0.169
SSM000042	1.43	0.167	0.977	0.193	0.538	0.068	0.454	0.075
SSM000228	2.10	0.233	1.40	0.306	0.888	0.116	0.786	0.142
SSM000240	0.106	0.014	0.102	0.027	0.094	0.014	0.106	0.023
SSM000241	<i>0.052</i>	<i>0.050</i>	<i>0.057</i>	<i>0.050</i>	<i>0.134</i>	<i>0.050</i>	<i>0.052</i>	<i>0.050</i>



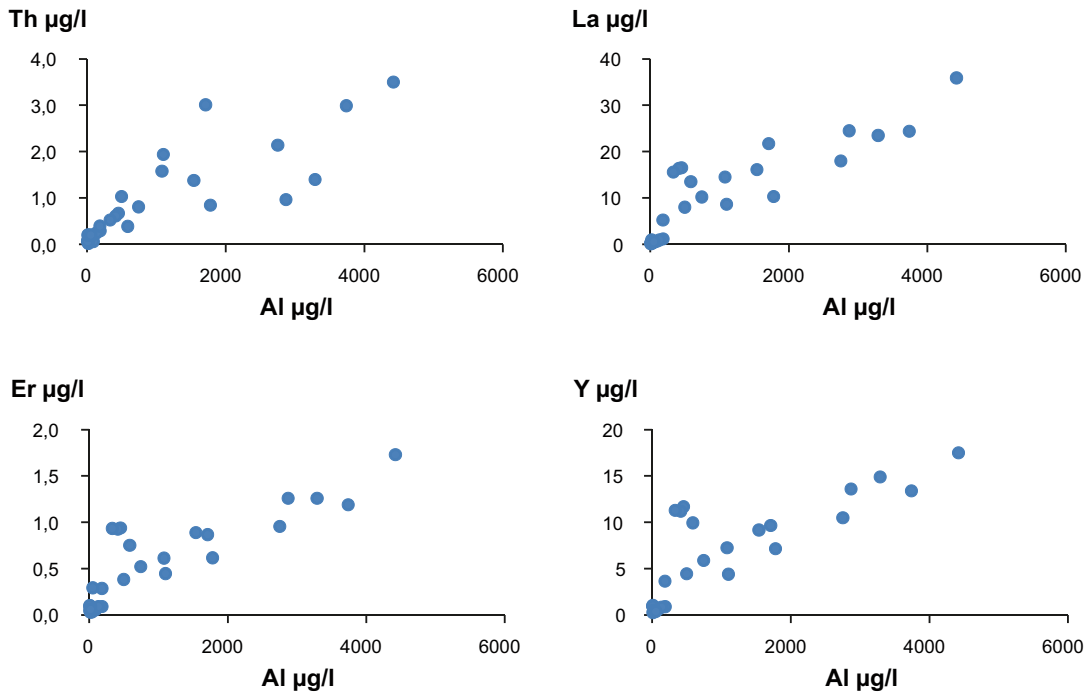


Figure 6-4. Relations between concentrations of Al and some other elements in ground water wells 2009.

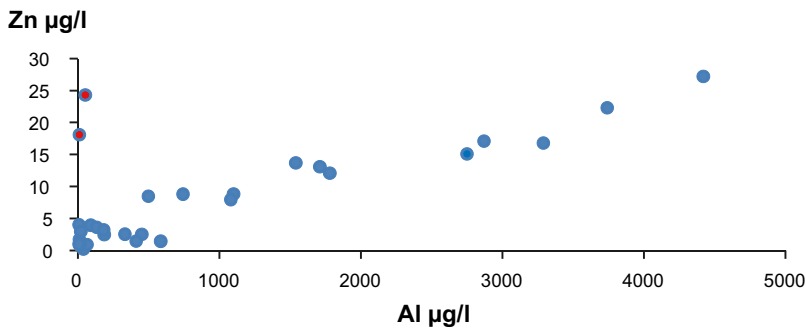


Figure 6-5. Relations between concentrations of Al and Zn in ground water wells 2009. Apparent outliers are marked red.

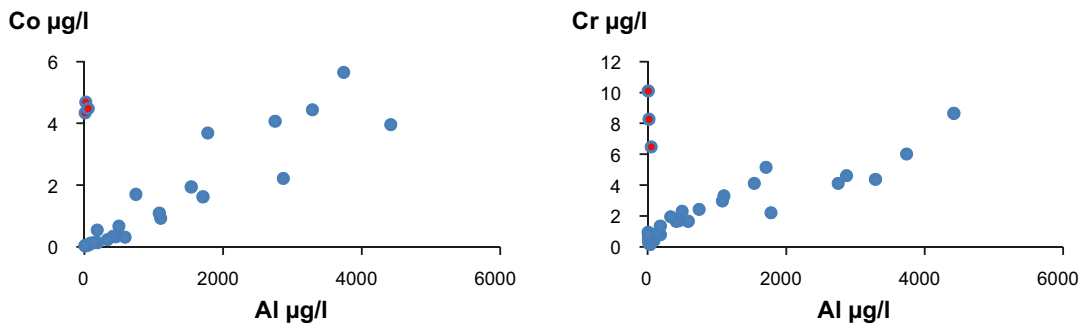


Figure 6-6. Relations between concentrations of Al and Co and Al and Cr in ground water wells 2009. Results from SSM00241 are marked red.

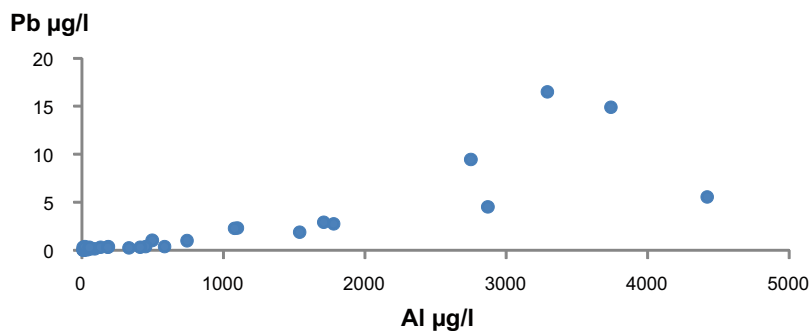


Figure 6-7. Relation between concentrations of Al and Pb in ground water wells 2009.

## 6.5 Isotopes

The results of the measurements of isotopes are presented in Table 6-6. The ratio of  $\delta^{18}\text{O}$  showed a good relationship with the conductivity (Figure 6-8).

The activity of tritium ( $^3\text{H}$ ) was markedly lower in the wells SSM000022 and SSM000241. This might be an indication of older groundwater in these wells. The average hydrogen isotope ratio of deuterium ( $\delta^2\text{H}$ ) varied with similar values in most wells. The  $\delta^2\text{H}$  ratio correlates reasonable well with the  $\delta^{18}\text{O}$  ratio but the linear relation differ from the “Global Meteoric Line” ( $\delta^2\text{H}=8\cdot\delta^{18}\text{O}+10$ ) which is based on precipitation data (Figure 6-9).

Table 6-6. Average ratio of  $\delta^2\text{H}$ ,  $\delta^{18}\text{O}$  and  $\delta^{37}\text{Cl}$  and average activity of tritium in shallow ground water wells 2009.

Site number	$\delta^2\text{H}$ (‰ VSMOW)	$\delta^{18}\text{O}$ (‰ VSMOW)	$^3\text{H}$ (TU)	$\delta^{37}\text{Cl}$ (‰ SMOC)
SSM000014	-69.0	-10.0	11.0	-
SSM000022	-73.5	-10.6	0.80	-
SSM000030	-74.8	-10.9	8.83	-
SSM000041	-72.9	-10.7	9.33	-
SSM000042	-73.0	-10.9	7.20	-
SSM000228	-73.1	-10.7	10.7	-
SSM000240	-71.5	-10.4	8.75	-
SSM000241	-62.4	-8.9	1.30	-0.353

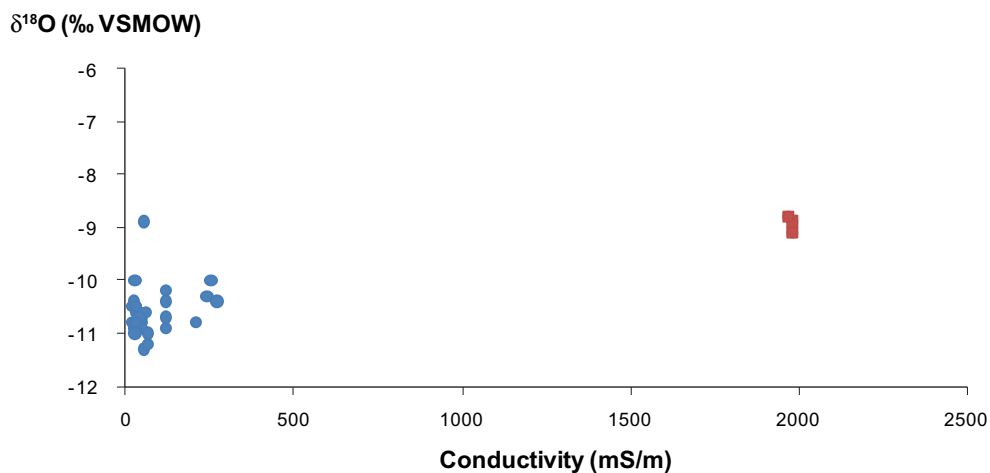
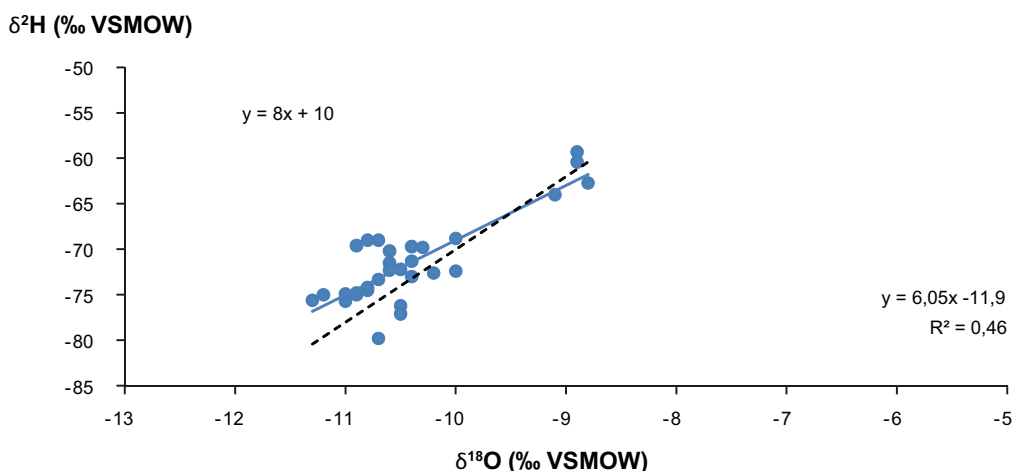


Figure 6-8. The relationship between the conductivity and the ratio of  $\delta^{18}\text{O}$  in ground water wells 2009. Red dots show the site SSM000241.



**Figure 6-9.** The local relationship between the ratios of  $\delta^2H$  and  $\delta^{18}O$  in ground water wells 2008. The dotted line shows Global Meteoric Line" ( $\delta^2H = 8 \cdot \delta^{18}O + 10$ ).

## 6.6 Nutrients and carbon

The concentration of nitrate varied to some extent between the wells (Table 6-7), but according to the Swedish Environmental Quality Criteria /Naturvårdsverket 1999/ the concentration of nitrate was very low in all the wells. The concentration of  $NH_4-N$  and  $PO_4-P$  varied with markedly higher values in some of the ground water wells. The site SSM000241 differed even more with extremely high values of  $NH_4-N$  and  $PO_4-P$ . The concentration of carbon (TOC and DOC) varied with results between 5 and 15 mg/l in most wells (Table 6-7). Again the well SSM000241 differed markedly with a markedly higher average.

**Table 6-7. Average concentration of nitrogen and phosphorus compounds and carbon in shallow ground water wells 2009. Figures in italic indicate that some or all individual values in the calculation were below the report limit of the laboratory.**

Site number	$NO_2-N$ (mg/l)	$NO_3-N$ (mg/l)	$NO_2/NO_3-N$ (mg/l)	$NH_4-N$ (mg/l)	PON (mg/l)	N-tot (mg/l)
SSM000014	0.00045	0.0277	0.0281	0.06758	0.141	0.433
SSM000022	<i>0.0009</i>	0.0029	0.0037	0.701	0.0073	0.808
SSM000030	<i>0.0007</i>	0.0145	0.0151	1.56	0.0591	1.79
SSM000041	<i>0.0004</i>	0.0392	0.0396	0.134	0.258	0.732
SSM000042	<i>0.0081</i>	0.2064	0.2143	0.252	0.0760	0.605
SSM000228	<i>0.0005</i>	<i>0.0018</i>	0.0022	0.111	0.0053	0.472
SSM000240	<i>0.0027</i>	<i>0.0062</i>	<i>0.0087</i>	2.77	0.0099	3.07
SSM000241	<i>0.0004</i>	<i>0.0020</i>	<i>0.0022</i>	620	0.170	627
Site number	$PO_4-P$ (mg/l)	POP (mg/l)	P-tot (mg/l)	TOC (mg/l)	DOC (mg/l)	POC (mg/l)
SSM000014	0.0044	0.104	0.242	11.9	11.7	2.23
SSM000022	0.01243	0.0012	0.015125	5.025	5.25	0.07175
SSM000030	0.0732	0.0102	0.182	8.48	8.40	0.554
SSM000041	0.0145	0.197	0.462	12.7	12.1	3.37
SSM000042	<i>0.0010</i>	0.116	0.144	7.55	7.38	1.70
SSM000228	0.0055	0.0020	0.0159	14.9	15.5	0.0785
SSM000240	1.92	0.0029	1.94	10.7	10.4	0.0640
SSM000241	29.6	0.0381	34.6	71.8	70.5	1.17

## References

SKB's (Svensk Kärnbränslehantering AB) publications can be found at [www.skb.se/publications](http://www.skb.se/publications).

**Grolander S, 2009.** Radon as a groundwater tracer in Forsmark and Laxemar. SKB R-09-47, Svensk Kärnbränslehantering AB.

**Naturvårdsverket, 1999.** Bedömningsgrunder för miljö kvalitet. Grundvatten (in Swedish). Rapport 4915, Naturvårdsverket (Swedish Environmental Protection Agency).

## Sites, co-ordinates and sampling depths

### Regular programme 2009. Sites, sample depths and location co-ordinates.

ID-code	Co-ordinate (X)	Co-ordinate (Y)	Sampling depth (m)
SSM000014	6366286	1550813	2–3
SSM000022	6367458	1553120	5–7
SSM000030	6367908	1546986	4–5
SSM000041	6365332	1548655	2–4
SSM000042	6365541	1549488	3–5
SSM000228	6366504	1548718	6–7
SSM000240	6368093	1550283	5–6
SSM000241	6368695	1550739	32–33

### Sites where field measurements of radon were performed 2009, sample depths and location co-ordinates.

ID-code	Co-ordinate (X)	Co-ordinate (Y)	Sampling depth (m)
SSM000009	6367044	1548244	3–4
SSM000014	6366286	1550813	2–3
SSM000022	6367458	1553120	5–7
SSM000030	6367908	1546986	4–5
SSM000031	6368133	1548563	3–4
SSM000037	6367186	1547490	3–4
SSM000041	6365332	1548655	2–4
SSM000042	6365541	1549488	3–5
SSM000218	6367334	1548814	2–3
SSM000228	6366504	1548718	6–7
SSM000230	6366220	1550069	4–5
SSM000240	6368093	1550283	5–6
SSM000264	6366070	1549020	3–5
SSM000267	6366240	1549599	4–6

## Schedule – Sampling of shallow ground water 2009

### Sampling occasions 2009.

ID-code	March-April Week number 11–12, 16	May-June Week number 22–23	August Week number 35–36	November Week number 46–47
SSM000014	x	x	x	x
SSM000022	x	x	x	x
SSM000030	x	x	x	x
SSM000041	x	x	x	x
SSM000042	x	x	x	x
SSM000228	x	x	x	x
SSM000240	x	x	x	x
SSM000241	x	x	x	

## Primary results – Laboratory analysis

(Figures in *italic* indicates that the value were below the report limit of the laboratory.)

Site number	Date	Sample number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	HCO <sub>3</sub> (mg/l)	Cl (mg/l)	SO <sub>4</sub> (mg/l)	SO <sub>4</sub> -S (mg/l)
SSM000014	2009-03-12	15849	10.1	4.61	20.1	11.9	31.1	13.4	64.5	23.7
SSM000014	2009-05-26	15951	10.2	5.51	24.1	13.6	31.9	13.2	85.3	31.0
SSM000014	2009-08-27	19045	20.7	5.74	22.4	12.5	66.3	13.3	66.3	26.1
SSM000014	2009-11-10	19170	27.0	6.35	31.8	18.7	28.6	79.1	88.8	31.6
SSM000022	2009-03-10	15847	240	5.57	21.8	6.79	258	150	146	51.2
SSM000022	2009-05-26	15948	214	5.44	22.5	6.67	256	144	145	53.6
SSM000022	2009-08-25	19042	224	5.49	23.0	6.52	255	148	147	53.1
SSM000022	2009-11-09	19171	223	6.26	22.1	6.55	257	145	144	51.2
SSM000030	2009-03-12	15850	31.4	2.35	63.6	8.32	247	12.4	34.5	12.8
SSM000030	2009-05-28	15952	27.9	2.72	67.1	8.84	245	12.7	35.5	13.3
SSM000030	2009-08-27	19046	27.6	2.45	66.6	7.97	249	12.1	32.3	11.7
SSM000030	2009-11-10	19172	26.6	2.67	65.4	7.81	246	11.0	30.2	10.8
SSM000041	2009-03-10	15846	8.40	3.49	20.9	5.34	38.4	25.5	18.5	6.63
SSM000041	2009-05-26	15949	9.50	3.95	33.1	6.52	60.6	30.0	22.3	8.88
SSM000041	2009-08-25	19043	8.80	5.56	24.8	7.18	10.5	35.8	18.2	7.18
SSM000041	2009-11-12	19174	9.20	5.07	47.5	7.72	113	34.5	21.7	7.79
SSM000042	2009-03-10	15848	52.4	3.37	47.8	11.9	150	58.1	75.1	26.6
SSM000042	2009-05-26	15950	49.2	3.51	50.7	10.9	161	67.3	79.6	27.7
SSM000042	2009-08-25	19044	65.5	4.21	50.9	12.3	161	74.9	68.3	25.6
SSM000042	2009-11-12	19175	68.1	4.90	51.4	11.3	139	36.4	50.5	27.3
SSM000228	2009-03-12	15851	10.1	1.58	28.6	4.72	90.1	8.9	25.3	9.23
SSM000228	2009-05-28	15953	7.70	1.22	25.1	3.72	90.7	12.8	28.1	7.41
SSM000228	2009-08-27	19047	12.1	1.86	36.9	5.39	111	15.3	24.8	8.84
SSM000228	2009-11-10	19173	13.3	2.17	37.7	5.62	117	16.4	24.8	8.96
SSM000240	2009-03-12	15852	342	14.4	79.9	43.3	277	611	48.8	19.1
SSM000240	2009-06-02	15954	283	12.4	66.3	38.0	263	503	44.2	16.0
SSM000240	2009-09-01	19048	349	14.8	78.1	47.2	288	631	53.6	24.4
SSM000240	2009-11-18	19176	347	16.6	85.3	44.3	282	701	59.9	18.7
SSM000241	2009-04-16	15853	2,620	122	302	433	5,500	4,810	11.9	12.5
SSM000241	2009-06-03	15955	2,760	138	329	457	5,280	4,830	25.4	13.1
SSM000241	2009-09-02	19049	2,670	126	316	424	4,990	4,680	5.27	11.3

Site number	Date	Sample number	Br (mg/l)	F (mg/l)	Si (mg/l)	Fe (mg/l)	Fe-tot (mg/l)	Fe <sup>2+</sup> (mg/l)	Mn (mg/l)	Li (mg/l)
SSM000014	2009-03-12	15849	0.200	2.79	15.9	8.91	6.05	4.89	0.567	0.032
SSM000014	2009-05-26	15951	0.200	3.36	18.9	9.69	7.15	6.52	0.605	0.043
SSM000014	2009-08-27	19045	0.200	2.97	16.1	10.5	7.11	6.20	0.624	0.045
SSM000014	2009-11-10	19170	0.399	2.81	16.5	5.25	5.21	4.64	0.536	0.042
SSM000022	2009-03-10	15847	0.514	4.27	6.00	0.117	0.09	0.076	0.074	0.023
SSM000022	2009-05-26	15948	0.502	4.24	6.10	0.203	0.10	0.093	0.073	0.025
SSM000022	2009-08-25	19042	0.529	4.19	5.65	0.101	3.66	3.28	0.072	0.027
SSM000022	2009-11-09	19171	0.521	4.07	5.78	0.084	0.09	0.067	0.065	0.029
SSM000030	2009-03-12	15850	0.200	2.43	9.62	2.01	1.92	1.790	0.560	0.010
SSM000030	2009-05-28	15952	0.200	2.51	11.8	3.51	2.69	2.52	0.541	0.011
SSM000030	2009-08-27	19046	0.200	2.35	9.11	2.27	5.28	5.01	0.563	0.009
SSM000030	2009-11-10	19172	0.200	2.36	9.08	1.98	1.91	1.87	0.541	0.010
SSM000041	2009-03-10	15846	0.200	0.74	16.1	7.84	3.82	2.93	0.263	0.007
SSM000041	2009-05-26	15949	0.200	0.84	15.3	5.59	4.29	3.52	0.304	0.006
SSM000041	2009-08-25	19043	0.257	0.85	20.6	14.8	6.74	5.30	0.286	0.011
SSM000041	2009-11-12	19174	0.248	0.92	14.0	6.49	5.80	5.58	0.471	0.009
SSM000042	2009-03-10	15848	0.392	1.18	12.0	10.2	8.82	7.93	0.652	0.006
SSM000042	2009-05-26	15950	0.384	1.02	11.7	7.72	8.12	7.49	0.602	0.005
SSM000042	2009-08-25	19044	0.422	1.34	13.2	9.92	6.75	6.11	0.630	0.010
SSM000042	2009-11-12	19175	0.271	1.25	10.4	5.05	5.01	4.53	0.604	0.008
SSM000228	2009-03-12	15851	0.200	2.19	12.4	6.62	6.23	6.03	0.442	0.009
SSM000228	2009-05-28	15953	0.200	2.23	8.89	6.60	7.80	6.95	0.413	0.006
SSM000228	2009-08-27	19047	0.200	2.19	11.4	7.52	6.87	6.53	0.497	0.008
SSM000228	2009-11-10	19173	0.200	2.25	11.3	7.91	6.91	7.04	0.492	0.010
SSM000240	2009-03-12	15852	2.840	1.47	10.6	0.582	0.600	0.578	0.698	0.018
SSM000240	2009-06-02	15954	2.460	1.54	10.4	0.324	0.360	0.336	0.438	0.017
SSM000240	2009-09-01	19048	2.950	1.44	10.2	0.308	0.337	0.299	0.562	0.022
SSM000240	2009-11-18	19176	3.240	1.44	10.5	0.586	0.572	0.500	0.636	0.021
SSM000241	2009-04-16	15853	159	0.420	23.1	0.965	0.942	0.940	0.597	0.145
SSM000241	2009-06-03	15955	160	0.890	24.3	1.02	0.895	0.897	0.808	0.164
SSM000241	2009-09-02	19049	158	0.700	22.3	0.986	1.11	1.08	0.776	0.170



Site number	Date	Sample number	Sr (mg/l)	pH	Conductivity (mS/m)	S2 (mg/l)	P (mg/l)	Charge balance (%)
SSM000014	2009-03-12	15849	0.078	6.04	26.5	0.006	0.111	4.31
SSM000014	2009-05-26	15951	0.092	6.04	31.0	0.006	0.143	2.61
SSM000014	2009-08-27	19045	0.087	6.23	30.9	0.006	0.094	2.96
SSM000014	2009-11-10	19170	0.137	6.09	52.3	0.006	0.033	-1.79
SSM000022	2009-03-10	15847	0.289	7.98	121	0.026	0.014	1.47
SSM000022	2009-05-26	15948	0.286	8.00	121	0.055	0.016	-3.05
SSM000022	2009-08-25	19042	0.294	7.94	119	0.051	0.013	-0.85
SSM000022	2009-11-09	19171	0.296	7.99	119	0.032	0.013	-0.88
SSM000030	2009-03-12	15850	0.288	7.20	50.0	0.022	0.154	0.47
SSM000030	2009-05-28	15952	0.284	7.19	52.1	0.043	0.351	1.29
SSM000030	2009-08-27	19046	0.273	7.15	49.4	0.040	0.160	1.60
SSM000030	2009-11-10	19172	0.285	7.24	48.4	0.028	0.148	0.81
SSM000041	2009-03-10	15846	0.071	6.22	20.8	0.006	0.237	6.57
SSM000041	2009-05-26	15949	0.098	6.36	26.9	0.006	0.112	7.62
SSM000041	2009-08-25	19043	0.087	5.43	20.5	0.009	0.327	20.71
SSM000041	2009-11-12	19174	0.131	6.54	42.3	0.037	0.080	5.53
SSM000042	2009-03-10	15848	0.128	6.83	59.8	0.024	0.112	1.81
SSM000042	2009-05-26	15950	0.128	6.93	66.6	0.024	0.060	-3.06
SSM000042	2009-08-25	19044	0.138	6.64	64.3	0.018	0.087	2.49
SSM000042	2009-11-12	19175	0.148	6.58	39.9	0.014	0.012	14.27
SSM000228	2009-03-12	15851	0.064	6.45	25.6	0.023	0.018	2.21
SSM000228	2009-05-28	15953	0.055	6.51	27.6	0.032	0.018	-5.17
SSM000228	2009-08-27	19047	0.081	6.54	30.0	0.024	0.013	3.23
SSM000228	2009-11-10	19173	0.090	6.60	31.4	0.025	0.012	3.05
SSM000240	2009-03-12	15852	0.567	7.38	242	0.282	0.077	-0.49
SSM000240	2009-06-02	15954	0.481	7.55	210	0.465	3.09	-1.31
SSM000240	2009-09-01	19048	0.580	7.52	253	0.672	4.05	-1.62
SSM000240	2009-11-18	19176	0.622	7.43	272	0.268	0.402	-4.48
SSM000241	2009-04-16	15853	4.90	6.69	1,980	3.33	27.9	-15.30
SSM000241	2009-06-03	15955	5.44	7.21	1,970	4.23	31.8	-11.86
SSM000241	2009-09-02	19049	4.71	6.66	1,980	1.26	32.5	-11.98

Site number	Date	Sample number	Al (µg/l)	Ba (µg/l)	Cd (µg/l)	Cr (µg/l)	Cu (µg/l)	Co (µg/l)	Hg (µg/l)
SSM000014	2009-03-12	15849	3,290	57.5	0.0519	4.37	14.7	4.44	0.0061
SSM000014	2009-05-26	15951	3,740	57.5	0.0617	6.01	12.5	5.65	0.0020
SSM000014	2009-08-27	19045	2,750	51.1	0.0310	4.12	9.22	4.07	0.0020
SSM000014	2009-11-10	19170	1,780	56.8	0.0742	2.21	6.20	3.69	0.0020
SSM000022	2009-03-10	15847	38.6	30.3	0.0030	0.153	0.100	0.060	0.0059
SSM000022	2009-05-26	15948	90.7	28.2	0.0020	0.422	0.291	0.126	0.0020
SSM000022	2009-08-25	19042	19.9	28.8	0.0020	0.216	0.159	0.040	0.0042
SSM000022	2009-11-09	19171	15.9	28.5	0.0020	0.291	0.100	0.043	0.0020
SSM000030	2009-03-12	15850	63.2	35.5	0.0020	0.474	0.307	0.067	0.0027
SSM000030	2009-05-28	15952	1100	46.4	0.0268	3.30	2.21	0.928	0.0020
SSM000030	2009-08-27	19046	186	36.5	0.0020	0.789	0.642	0.139	0.0020
SSM000030	2009-11-10	19172	132	34.6	0.0029	0.855	0.367	0.135	0.0020
SSM000041	2009-03-10	15846	2870	46.3	0.0614	4.62	12.8	2.22	0.0055
SSM000041	2009-05-26	15949	1,540	34.8	0.0722	4.12	6.98	1.94	0.0020
SSM000041	2009-08-25	19043	4,420	56.8	0.0451	8.65	9.46	3.96	0.0020
SSM000041	2009-11-12	19174	743	29.5	0.0254	2.43	2.27	1.70	0.0020
SSM000042	2009-03-10	15848	1,080	79.0	0.0228	2.97	7.67	1.09	0.0053
SSM000042	2009-05-26	15950	497	62.8	0.0372	2.31	2.78	0.670	0.0020
SSM000042	2009-08-25	19044	1,710	79.9	0.0147	5.15	9.17	1.62	0.0020
SSM000042	2009-11-12	19175	183	81.7	0.0066	1.35	1.98	0.544	0.0020
SSM000228	2009-03-12	15851	585	22.0	0.0020	1.66	0.501	0.312	0.0051
SSM000228	2009-05-28	15953	451	22.3	0.0020	1.70	0.502	0.331	0.0020
SSM000228	2009-08-27	19047	412	24.1	0.0020	1.65	0.266	0.345	0.0020
SSM000228	2009-11-10	19173	332	24.1	0.0020	1.95	0.487	0.238	0.0020
SSM000240	2009-03-12	15852	10.7	94.7	0.0028	0.543	0.100	0.042	0.0043
SSM000240	2009-06-02	15954	9.49	59.5	0.0020	0.822	0.129	0.045	0.0020
SSM000240	2009-09-01	19048	17.1	82.6	0.0020	0.634	0.134	0.042	0.0020
SSM000240	2009-11-18	19176	8.28	97.6	0.0020	0.947	0.115	0.036	0.0020
SSM000241	2009-04-16	15853	8.46	789	0.0769	10.1	0.500	4.34	0.0020
SSM000241	2009-06-03	15955	20.2	841	0.0500	8.27	0.500	4.69	0.0020
SSM000241	2009-09-02	19049	52.1	800	0.0500	6.48	0.500	4.48	0.0020

Site number	Date	Sample number	Mo (µg/l)	Ni (µg/l)	Pb (µg/l)	Se (µg/l)	V (µg/l)	Zn (µg/l)
SSM000014	2009-03-12	15849	0.341	10.1	16.5	–	9.06	16.8
SSM000014	2009-05-26	15951	0.361	12.9	14.9	–	10.2	22.3
SSM000014	2009-08-27	19045	0.612	10.1	9.46	–	8.66	15.1
SSM000014	2009-11-10	19170	0.246	11.2	2.76	–	3.06	12.1
SSM000022	2009-03-10	15847	12.3	0.247	0.052	–	0.853	0.243
SSM000022	2009-05-26	15948	12.1	0.536	0.139	–	0.910	3.96
SSM000022	2009-08-25	19042	11.9	0.350	0.046	–	0.770	0.953
SSM000022	2009-11-09	19171	11.7	0.307	0.041	–	0.793	0.717
SSM000030	2009-03-12	15850	0.757	0.486	0.163	–	4.20	0.921
SSM000030	2009-05-28	15952	0.685	2.29	2.32	–	12.5	8.83
SSM000030	2009-08-27	19046	0.852	1.21	0.369	–	4.84	2.49
SSM000030	2009-11-10	19172	0.800	0.485	0.322	–	4.65	3.61
SSM000041	2009-03-10	15846	0.237	6.12	4.53	0.147	8.02	17.1
SSM000041	2009-05-26	15949	0.415	5.63	1.89	–	5.69	13.7
SSM000041	2009-08-25	19043	0.462	9.57	5.55	–	13.8	27.2
SSM000041	2009-11-12	19174	0.556	4.83	1.00	–	4.25	8.80
SSM000042	2009-03-10	15848	1.13	1.95	2.28	0.084	7.24	7.95
SSM000042	2009-05-26	15950	1.19	1.92	1.03	–	4.42	8.49
SSM000042	2009-08-25	19044	1.62	3.31	2.91	–	10.6	13.1
SSM000042	2009-11-12	19175	1.47	1.10	0.319	–	3.22	3.24
SSM000228	2009-03-12	15851	0.281	0.479	0.393	0.156	8.96	1.45
SSM000228	2009-05-28	15953	0.285	0.472	0.379	–	9.07	2.54
SSM000228	2009-08-27	19047	0.391	0.371	0.318	–	9.63	1.47
SSM000228	2009-11-10	19173	0.602	0.874	0.253	–	9.37	2.55
SSM000240	2009-03-12	15852	0.407	0.188	0.016	0.102	5.11	18.1
SSM000240	2009-06-02	15954	0.414	0.255	0.045	–	5.57	1.73
SSM000240	2009-09-01	19048	0.375	0.284	0.021	–	5.60	1.13
SSM000240	2009-11-18	19176	0.305	0.290	0.025	–	5.34	1.00
SSM000241	2009-04-16	15853	0.500	2.24	0.300	–	16.2	4.04
SSM000241	2009-06-03	15955	0.500	2.11	0.379	–	17.1	2.97
SSM000241	2009-09-02	19049	0.500	2.27	0.300	–	15.8	24.3

Site number	Date	Sample number	U (µg/l)	Th (µg/l)	Sc (µg/l)	Rb (µg/l)	Y (µg/l)	Zr (µg/l)	Sb (µg/l)	Cs (µg/l)
SSM000014	2009-03-12	15849	6.80	1.40	0.917	10.6	14.9	3.98	0.1040	0.656
SSM000014	2009-05-26	15951	5.18	2.99	1.04	14.1	13.4	5.29	0.0771	0.827
SSM000014	2009-08-27	19045	4.92	2.14	0.722	10.5	10.5	3.16	0.0678	0.575
SSM000014	2009-11-10	19170	2.89	0.844	0.348	7.90	7.15	1.38	0.0543	0.242
SSM000022	2009-03-10	15847	1.98	0.100	0.050	2.25	0.424	0.668	0.0291	0.030
SSM000022	2009-05-26	15948	1.80	0.059	0.050	2.41	0.628	0.612	0.1230	0.040
SSM000022	2009-08-25	19042	1.91	0.020	0.050	2.24	0.437	0.376	0.0474	0.030
SSM000022	2009-11-09	19171	1.86	0.031	0.050	2.15	0.416	0.462	0.0556	0.030
SSM000030	2009-03-12	15850	0.143	0.187	0.063	4.70	0.615	1.63	0.0246	0.359
SSM000030	2009-05-28	15952	1.12	1.94	0.434	9.04	4.40	3.90	0.0299	0.939
SSM000030	2009-08-27	19046	0.210	0.290	0.077	4.91	0.899	1.53	0.0231	0.353
SSM000030	2009-11-10	19172	0.174	0.243	0.082	4.37	0.841	1.14	0.0441	0.334
SSM000041	2009-03-10	15846	1.05	0.963	1.03	12.0	13.6	4.41	0.0782	0.602
SSM000041	2009-05-26	15949	0.734	1.38	0.582	9.18	9.18	3.24	0.0607	0.425
SSM000041	2009-08-25	19043	1.15	3.50	1.48	17.7	17.5	3.75	0.0645	0.895
SSM000041	2009-11-12	19174	0.721	0.808	0.353	6.64	5.88	1.68	0.0514	0.214
SSM000042	2009-03-10	15848	1.26	1.58	0.702	6.78	7.25	2.88	0.0337	0.783
SSM000042	2009-05-26	15950	0.945	1.03	0.353	5.05	4.46	2.07	0.0415	0.382
SSM000042	2009-08-25	19044	1.25	3.01	0.839	9.08	9.65	2.78	0.0473	0.925
SSM000042	2009-11-12	19175	0.702	0.394	0.153	4.53	3.66	0.959	0.0319	0.174
SSM000228	2009-03-12	15851	0.611	0.386	0.429	1.86	9.94	2.53	0.0727	0.068
SSM000228	2009-05-28	15953	0.609	0.670	0.488	2.05	11.7	2.93	0.0521	0.071
SSM000228	2009-08-27	19047	0.676	0.609	0.492	2.10	11.2	2.19	0.0588	0.060
SSM000228	2009-11-10	19173	0.685	0.525	0.438	1.88	11.3	2.13	0.0554	0.058
SSM000240	2009-03-12	15852	0.283	0.086	0.050	8.31	0.912	2.26	0.1020	0.507
SSM000240	2009-06-02	15954	0.274	0.080	0.050	7.87	1.06	2.38	0.1900	0.496
SSM000240	2009-09-01	19048	0.278	0.073	0.050	9.66	0.889	1.62	0.2720	0.653
SSM000240	2009-11-18	19176	0.199	0.057	0.050	9.20	0.979	1.52	0.0455	0.610
SSM000241	2009-04-16	15853	0.029	0.200	0.500	70.4	0.256	15.1	0.2200	2.59
SSM000241	2009-06-03	15955	0.057	0.200	0.500	67.8	0.525	14.7	0.2080	2.46
SSM000241	2009-09-02	19049	0.032	0.200	0.500	70.4	0.376	10.6	0.7270	2.48

Site number	Date	Sample number	La (µg/l)	Hf (µg/l)	Tl (µg/l)	Ce (µg/l)	Pr (µg/l)	Nd (µg/l)	Sm (µg/l)	Eu (µg/l)
SSM000014	2009-03-12	15849	23.5	0.1080	0.0586	42.8	6.11	23.7	4.08	0.6750
SSM000014	2009-05-26	15951	24.4	0.1630	0.0712	45.7	5.67	22.8	3.93	0.6030
SSM000014	2009-08-27	19045	18.0	0.1500	0.0449	32.7	4.27	17.0	3.02	0.5000
SSM000014	2009-11-10	19170	10.3	0.0658	0.0275	18.5	2.42	10.0	1.83	0.2920
SSM000022	2009-03-10	15847	0.295	0.0091	0.0100	0.477	0.067	0.282	0.050	0.0050
SSM000022	2009-05-26	15948	0.645	0.0058	0.0100	1.11	0.146	0.608	0.115	0.0090
SSM000022	2009-08-25	19042	0.322	0.0082	0.0100	0.515	0.073	0.294	0.050	0.0068
SSM000022	2009-11-09	19171	0.280	0.0110	0.0100	0.445	0.062	0.274	0.051	0.0069
SSM000030	2009-03-12	15850	0.623	0.0296	0.0100	1.16	0.143	0.586	0.102	0.0114
SSM000030	2009-05-28	15952	8.620	0.0909	0.0263	16.7	1.93	7.23	1.30	0.1860
SSM000030	2009-08-27	19046	1.15	0.0460	0.0100	2.14	0.261	1.020	0.188	0.0309
SSM000030	2009-11-10	19172	0.933	0.0296	0.0100	1.81	0.219	0.901	0.157	0.0274
SSM000041	2009-03-10	15846	24.5	0.1350	0.0538	50.4	6.76	26.2	4.63	0.6500
SSM000041	2009-05-26	15949	16.1	0.1100	0.0379	31.5	4.21	17.2	3.03	0.3950
SSM000041	2009-08-25	19043	35.9	0.1920	0.0860	70.8	9.60	36.4	6.38	0.8950
SSM000041	2009-11-12	19174	10.2	0.0761	0.0209	18.6	2.53	10.1	1.69	0.2470
SSM000042	2009-03-10	15848	14.5	0.0844	0.0251	25.0	3.23	12.8	2.04	0.2910
SSM000042	2009-05-26	15950	8.01	0.0656	0.0142	13.5	1.75	7.02	1.22	0.1530
SSM000042	2009-08-25	19044	21.7	0.1400	0.0370	36.6	4.80	18.7	2.98	0.4410
SSM000042	2009-11-12	19175	5.24	0.0394	0.0100	8.36	1.13	4.67	0.798	0.1160
SSM000228	2009-03-12	15851	13.5	0.0709	0.0100	25.4	3.03	12.6	1.96	0.3520
SSM000228	2009-05-28	15953	16.5	0.0879	0.0100	30.1	3.61	15.2	2.52	0.4030
SSM000228	2009-08-27	19047	16.4	0.1000	0.0100	29.1	3.48	14.8	2.42	0.4150
SSM000228	2009-11-10	19173	15.6	0.0975	0.0100	29.1	3.50	15.0	2.43	0.4050
SSM000240	2009-03-12	15852	0.277	0.0333	0.0100	0.503	0.071	0.339	0.071	0.0050
SSM000240	2009-06-02	15954	0.292	0.0407	0.0100	0.560	0.085	0.380	0.096	0.0050
SSM000240	2009-09-01	19048	0.249	0.0436	0.0100	0.472	0.066	0.321	0.076	0.0120
SSM000240	2009-11-18	19176	0.295	0.0347	0.0100	0.592	0.085	0.392	0.087	0.0162
SSM000241	2009-04-16	15853	0.106	0.1060	0.1000	0.140	0.050	0.087	0.050	0.0500
SSM000241	2009-06-03	15955	0.946	0.1170	0.1000	0.976	0.108	0.418	0.079	0.0500
SSM000241	2009-09-02	19049	0.520	0.1230	0.1000	0.423	0.062	0.201	0.050	0.0500

Site number	Date	Sample number	Gd (µg/l)	Tb (µg/l)	Dy (µg/l)	Ho (µg/l)	Er (µg/l)	Tm (µg/l)	Yb (µg/l)	Lu (µg/l)
SSM000014	2009-03-12	15849	3.09	0.3640	2.35	0.4330	1.26	0.1700	1.17	0.1940
SSM000014	2009-05-26	15951	2.77	0.3300	2.08	0.4250	1.19	0.1650	1.11	0.1890
SSM000014	2009-08-27	19045	2.47	0.2890	1.65	0.3390	0.9560	0.1290	0.8700	0.1520
SSM000014	2009-11-10	19170	1.55	0.1820	1.01	0.2100	0.6170	0.0851	0.5920	0.1040
SSM000022	2009-03-10	15847	0.0516	0.0065	0.0450	0.0100	0.0322	0.0043	0.0286	0.0056
SSM000022	2009-05-26	15948	0.0829	0.0110	0.0745	0.0157	0.0560	0.0069	0.0467	0.0077
SSM000022	2009-08-25	19042	0.0564	0.0075	0.0455	0.0113	0.0318	0.0047	0.0320	0.0065
SSM000022	2009-11-09	19171	0.0521	0.0069	0.0435	0.0100	0.0323	0.0043	0.0286	0.0063
SSM000030	2009-03-12	15850	0.0944	0.0125	0.0893	0.0192	0.0626	0.0095	0.0711	0.0130
SSM000030	2009-05-28	15952	0.9010	0.1200	0.7930	0.1570	0.4470	0.0597	0.4080	0.0626
SSM000030	2009-08-27	19046	0.1620	0.0224	0.1410	0.0297	0.0921	0.0121	0.1000	0.0190
SSM000030	2009-11-10	19172	0.1430	0.0211	0.1280	0.0287	0.0909	0.0134	0.0998	0.0189
SSM000041	2009-03-10	15846	3.28	0.3820	2.44	0.4430	1.26	0.1740	1.19	0.1900
SSM000041	2009-05-26	15949	2.06	0.2390	1.51	0.3070	0.8900	0.1170	0.8350	0.1320
SSM000041	2009-08-25	19043	4.87	0.5750	3.14	0.6170	1.73	0.2290	1.61	0.2700
SSM000041	2009-11-12	19174	1.36	0.1580	0.8780	0.1760	0.5220	0.0690	0.5040	0.0859
SSM000042	2009-03-10	15848	1.58	0.1870	1.19	0.2190	0.6140	0.0800	0.5140	0.0829
SSM000042	2009-05-26	15950	0.8950	0.1070	0.6490	0.1330	0.3840	0.0479	0.3240	0.0549
SSM000042	2009-08-25	19044	2.48	0.2920	1.61	0.3190	0.8680	0.1090	0.7200	0.1170
SSM000042	2009-11-12	19175	0.7560	0.0820	0.4590	0.1010	0.2870	0.0358	0.2560	0.0451
SSM000228	2009-03-12	15851	1.76	0.1920	1.27	0.2590	0.7520	0.1010	0.6860	0.1200
SSM000228	2009-05-28	15953	2.07	0.2240	1.45	0.3200	0.9400	0.1180	0.8110	0.1420
SSM000228	2009-08-27	19047	2.31	0.2550	1.44	0.3220	0.9250	0.1170	0.8060	0.1510
SSM000228	2009-11-10	19173	2.26	0.2610	1.44	0.3240	0.9340	0.1270	0.8410	0.1530
SSM000240	2009-03-12	15852	0.0920	0.0127	0.0976	0.0235	0.0857	0.0126	0.0994	0.0199
SSM000240	2009-06-02	15954	0.1130	0.0150	0.1080	0.0277	0.1010	0.0142	0.1160	0.0229
SSM000240	2009-09-01	19048	0.1030	0.0134	0.0933	0.0260	0.0899	0.0136	0.1000	0.0228
SSM000240	2009-11-18	19176	0.1160	0.0152	0.1090	0.0289	0.1010	0.0144	0.1080	0.0253
SSM000241	2009-04-16	15853	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
SSM000241	2009-06-03	15955	0.0558	0.0500	0.0704	0.0500	0.0601	0.0500	0.0552	0.0500
SSM000241	2009-09-02	19049	0.0500	0.0500	0.0500	0.0500	0.2930	0.0500	0.0500	0.0500

Site number	Date	Sample number	$\delta^2\text{H}$ (‰ VSMOW)	$\delta^{18}\text{O}$ (‰ VSMOW)	$^3\text{H}$ (TU)	$\delta^{37}\text{Cl}$ (‰ SMOC)
SSM000014	2009-03-12	15849	-68.8	-10.0	10.6	-
SSM000014	2009-05-26	15951	-71.5	-10.6	12.2	-
SSM000014	2009-08-27	19045	-76.2	-10.5	12.4	-
SSM000014	2009-11-10	19170	-59.3	-8.90	8.60	-
SSM000022	2009-03-10	15847	-73.0	-10.4	1.60	-
SSM000022	2009-05-26	15948	-75.0	-10.9	-0.80	-
SSM000022	2009-08-25	19042	-73.3	-10.7	1.10	-
SSM000022	2009-11-09	19171	-72.6	-10.2	1.30	-
SSM000030	2009-03-12	15850	-74.3	-10.8	7.80	-
SSM000030	2009-05-28	15952	-75.6	-11.3	10.7	-
SSM000030	2009-08-27	19046	-79.8	-10.7	9.30	-
SSM000030	2009-11-10	19172	-69.6	-10.9	7.50	-
SSM000041	2009-03-10	15846	-72.2	-10.5	9.20	-
SSM000041	2009-05-26	15949	-74.8	-10.9	9.80	-
SSM000041	2009-08-25	19043	-74.5	-10.8	8.80	-
SSM000041	2009-11-12	19174	-70.2	-10.6	9.50	-
SSM000042	2009-03-10	15848	-72.3	-10.6	7.70	-
SSM000042	2009-05-26	15950	-75.0	-11.2	7.20	-
SSM000042	2009-08-25	19044	-75.7	-11.0	7.30	-
SSM000042	2009-11-12	19175	-69.0	-10.7	6.60	-
SSM000228	2009-03-12	15851	-71.3	-10.4	12.1	-
SSM000228	2009-05-28	15953	-74.9	-11.0	10.1	-
SSM000228	2009-08-27	19047	-77.1	-10.5	11.8	-
SSM000228	2009-11-10	19173	-69.0	-10.8	8.90	-
SSM000240	2009-03-12	15852	-69.8	-10.3	8.00	-
SSM000240	2009-06-02	15954	-74.2	-10.8	8.90	-
SSM000240	2009-09-01	19048	-72.4	-10.0	8.70	-
SSM000240	2009-11-18	19176	-69.7	-10.4	9.40	-
SSM000241	2009-04-16	15853	-60.4	-8.90	0.90	-0.10
SSM000241	2009-06-03	15955	-62.7	-8.80	1.60	-0.18
SSM000241	2009-09-02	19049	-64.0	-9.10	1.40	-0.78

Site number	Date	Sample number	NH <sub>4</sub> -N (mg/l)	NO <sub>2</sub> -N (mg/l)	NO <sub>2</sub> /NO <sub>3</sub> -N (mg/l)	NO <sub>3</sub> -N (mg/l)	N-tot (mg/l)	P-tot (mg/l)
SSM000014	2009-03-12	15849	0.055	0.0005	0.0374	0.0369	0.480	0.1690
SSM000014	2009-05-26	15951	0.081	0.0004	0.0593	0.0589	0.449	0.1860
SSM000014	2009-08-27	19045	0.086	0.0006	0.0061	0.0055	0.451	0.4490
SSM000014	2009-11-10	19170	0.048	0.0003	0.0097	0.0093	0.353	0.1620
SSM000022	2009-03-10	15847	0.698	0.0011	0.0022	0.0012	0.814	0.0136
SSM000022	2009-05-26	15948	0.681	0.0020	0.0069	0.0048	0.782	0.0173
SSM000022	2009-08-25	19042	0.711	0.0002	0.0012	0.0012	0.808	0.0147
SSM000022	2009-11-09	19171	0.714	0.0002	0.0044	0.0042	0.829	0.0149
SSM000030	2009-03-12	15850	1.50	0.0002	0.0011	0.0009	1.74	0.1490
SSM000030	2009-05-28	15952	1.64	0.0010	0.0179	0.0169	1.91	0.2600
SSM000030	2009-08-27	19046	1.56	0.0013	0.0373	0.0361	1.83	0.1660
SSM000030	2009-11-10	19172	1.54	0.0003	0.0041	0.0039	1.67	0.1510
SSM000041	2009-03-10	15846	0.104	0.0006	0.118	0.117	0.770	0.4880
SSM000041	2009-05-26	15949	0.164	0.0002	0.0075	0.0075	0.583	0.2210
SSM000041	2009-08-25	19043	0.117	0.0003	0.0087	0.0084	0.896	0.9410
SSM000041	2009-11-12	19174	0.149	0.0006	0.0243	0.0237	0.677	0.1980
SSM000042	2009-03-10	15848	0.250	0.0002	0.0008	0.0007	0.642	0.4670
SSM000042	2009-05-26	15950	0.260	0.0027	0.0034	0.0007	0.531	0.0358
SSM000042	2009-08-25	19044	0.328	0.0002	0.0020	0.0020	0.614	0.0355
SSM000042	2009-11-12	19175	0.168	0.0291	0.851	0.822	0.631	0.0372
SSM000228	2009-03-12	15851	0.102	0.0007	0.0032	0.0025	0.466	0.0162
SSM000228	2009-05-28	15953	0.103	0.0004	0.0040	0.0036	0.472	0.0167
SSM000228	2009-08-27	19047	0.113	0.0002	0.0003	0.0003	0.484	0.0147
SSM000228	2009-11-10	19173	0.124	0.0005	0.0012	0.0008	0.467	0.0161
SSM000240	2009-03-12	15852	1.39	0.0002	0.0003	0.0003	1.71	0.0745
SSM000240	2009-06-02	15954	2.73	0.0094	0.0334	0.0240	4.49	4.33
SSM000240	2009-09-01	19048	4.85	0.0002	0.0003	0.0003	3.92	2.960
SSM000240	2009-11-18	19176	2.11	0.0009	0.0008	0.0003	2.17	0.4000
SSM000241	2009-04-16	15853	633	0.0002	0.0003	0.0003	613	28.6
SSM000241	2009-06-03	15955	608	0.0007	0.0056	0.0049	633	33.8
SSM000241	2009-09-02	19049	620	0.0002	0.0008	0.0008	635	41.4



Site number	Date	Sample number	PO <sub>4</sub> -P (mg/l)	PO <sub>4</sub> -P (Hlysis) (mg/l)	POP (mg/l)	PON (mg/l)	POC (mg/l)	TOC (mg/l)	DOC (mg/l)
SSM000014	2009-03-12	15849	0.0042	0.0058	0.0864	0.148	2.42	16.6	16.0
SSM000014	2009-05-26	15951	0.0053	0.0066	0.0854	0.128	1.92	11.6	13.0
SSM000014	2009-08-27	19045	0.0071	0.0095	0.172	0.192	3.06	10.2	9.70
SSM000014	2009-11-10	19170	0.0010	0.0026	0.0722	0.0958	1.52	9.10	8.00
SSM000022	2009-03-10	15847	0.0128	0.0131	0.0010	0.0052	0.0490	4.80	5.10
SSM000022	2009-05-26	15948	0.0124	–	0.0016	0.0150	0.126	5.10	5.70
SSM000022	2009-08-25	19042	0.0129	0.0145	0.0013	0.0038	0.0580	5.00	5.10
SSM000022	2009-11-09	19171	0.0116	0.0116	0.0010	0.0050	0.0540	5.20	5.10
SSM000030	2009-03-12	15850	0.0542	0.1230	0.0021	0.0196	0.179	8.50	8.40
SSM000030	2009-05-28	15952	0.132	0.1390	0.0322	0.157	1.38	8.60	8.60
SSM000030	2009-08-27	19046	0.0553	0.1360	0.0036	0.0308	0.339	8.40	8.10
SSM000030	2009-11-10	19172	0.0512	0.1310	0.0027	0.0288	0.318	8.40	8.50
SSM000041	2009-03-10	15846	0.0073	0.0134	0.3050	0.2520	3.71	13.2	13.3
SSM000041	2009-05-26	15949	0.0152	–	0.0746	0.116	1.38	12.6	11.9
SSM000041	2009-08-25	19043	0.0223	0.0248	0.345	0.516	7.10	11.8	11.6
SSM000041	2009-11-12	19174	0.0131	0.0160	0.0619	0.147	1.29	13.3	11.6
SSM000042	2009-03-10	15848	0.0005	0.0030	0.406	0.195	4.03	7.20	6.90
SSM000042	2009-05-26	15950	0.0021	–	0.0249	0.0381	1.04	7.30	7.20
SSM000042	2009-08-25	19044	0.0008	0.0052	0.0145	0.0266	1.06	6.90	7.10
SSM000042	2009-11-12	19175	0.0006	0.0013	0.0187	0.0443	0.679	8.80	8.30
SSM000228	2009-03-12	15851	0.0046	0.0052	0.0013	0.0101	0.0770	14.7	16.0
SSM000228	2009-05-28	15953	0.0050	0.0056	0.0056	0.0055	0.0500	14.3	15.6
SSM000228	2009-08-27	19047	0.0061	0.0073	0.0008	0.0036	0.0530	15.4	15.2
SSM000228	2009-11-10	19173	0.0061	0.0064	0.0004	0.0021	0.134	15.1	15.3
SSM000240	2009-03-12	15852	0.0547	0.0647	0.0018	0.0089	0.0560	10.6	10.6
SSM000240	2009-06-02	15954	2.39	–	0.0074	0.0142	0.112	10.9	10.1
SSM000240	2009-09-01	19048	4.89	5.06	0.0015	0.0057	0.0320	10.5	10.2
SSM000240	2009-11-18	19176	0.364	0.4330	0.0008	0.0109	0.0560	10.6	10.5
SSM000241	2009-04-16	15853	27.7	–	0.0059	0.0395	0.181	71.2	68.9
SSM000241	2009-06-03	15955	29.9	–	0.0219	0.121	0.890	70.1	70.5
SSM000241	2009-09-02	19049	31.2	32.1	0.0864	0.3500	2.44	74.0	72.0

## Primary results – Field analysis

Site number	Sampling date	Sample number	Water depth (before purging) from T.O.C. (m)	Water depth (sampling day) from T.O.C. (m)	Water temperature (°C)	pH	Conductivity (mS/m)
SSM000014	2009-03-12	15849	1.33	1.33	4.7	6.94	–
SSM000014	2009-05-28	15951	1.51	1.54	10.7	6.13	–
SSM000014	2009-08-27	19045	1.62	1.63	12.6	6.04	–
SSM000014	2009-11-10	19170	1.57	1.56	10.1	6.20	–
SSM000022	2009-03-10	15847	0.64	0.65	11.6	6.98	–
SSM000022	2009-05-26	15948	0.74	0.76	12.4	7.02	–
SSM000022	2009-08-25	19042	0.98	0.99	10.1	6.75	–
SSM000022	2009-11-10	19171	0.96	0.95	10.2	6.56	–
SSM000030	2009-03-12	15850	1.33	1.35	10.8	6.77	–
SSM000030	2009-05-28	15952	1.45	1.47	10.3	6.51	–
SSM000030	2009-08-27	19046	1.49	1.49	11.3	6.45	–
SSM000030	2009-11-10	19172	1.54	1.55	9.0	6.46	–
SSM000041	2009-03-10	15846	0.86	0.97	5.1	6.99	–
SSM000041	2009-05-26	15949	1.44	1.46	11.7	6.31	–
SSM000041	2009-08-25	19043	1.94	1.93	13.2	6.42	–
SSM000041	2009-11-12	19174	1.91	1.90	11.1	6.12	–
SSM000042	2009-03-10	15848	1.39	1.40	6.6	7.05	–
SSM000042	2009-05-26	15950	1.72	1.69	12.6	6.38	–
SSM000042	2009-08-25	19044	2.14	2.15	12.3	6.38	–
SSM000042	2009-11-12	19175	2.05	2.01	7.4	6.37	–
SSM000228	2009-03-12	15851	2.56	2.60	7.6	7.17	–
SSM000228	2009-05-28	15953	2.74	2.75	9.3	6.94	–
SSM000228	2009-08-27	19047	2.87	2.87	11.7	6.16	–
SSM000228	2009-11-10	19173	2.82	2.83	9.6	6.41	–
SSM000240	2009-03-17	15852	1.57	1.50	8.4	6.85	230.0
SSM000240	2009-06-02	15954	1.47	1.46	16.3	6.69	203.2
SSM000240	2009-09-01	19048	1.48	1.43	17.4	6.60	245.5
SSM000240	2009-11-18	19176	1.61	1.63	7.7	6.00	272.2
SSM000241	2009-04-16	15853	2.44	3.02	6.8	7.15	–
SSM000241	2009-06-03	15955	2.15	2.53	15.5	6.95	–
SSM000241	2009-09-02	19049	2.41	2.52	16.4	6.51	–

Measurements on water depth are made from top of casing (T.O.C.). For length of casing above ground see Table below.

Site number	Measurement from top of casing (T.O.C.) to ground (m)	Site number	Measurement from top of casing (T.O.C.) to ground (m)
SSM000014	0.800	SSM000042	0.800
SSM000022	0.400	SSM000228	1.000
SSM000030	1.200	SSM000240	1.000
SSM000041	0.800	SSM000241	0.500

Site number	Sampling date	Rn <sub>corr</sub> (Bq/l)	Rn <sub>corr</sub> (Std) (Bq/l)
SSM000009	2009-05-26	53.0	2.57
SSM000009	2009-05-26	50.6	2.15
SSM000014	2009-05-27	62.4	3.72
SSM000022	2009-05-25	56.4	4.42
SSM000022	2009-05-25	54.7	4.01
SSM000030	2009-05-27	54.6	4.94
SSM000030	2009-05-27	53.6	1.47
SSM000031	2009-05-27	104.2	5.54
SSM000037	2009-05-26	41.5	2.56
SSM000041	2009-05-25	35.1	1.47
SSM000042	2009-05-25	71.9	2.61
SSM000218	2009-05-26	40.7	1.69
SSM000228	2009-05-27	54.4	3.21
SSM000228	2009-05-27	54.0	4.32
SSM000230	2009-05-25	174.2	7.23
SSM000230	2009-05-25	177.6	6.20
SSM000240	2009-06-01	52.2	1.47
SSM000264	2009-05-27	34.7	3.35
SSM000264	2009-05-27	35.7	2.84
SSM000267	2009-05-25	56.0	2.57