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Oskarshamn site investigation

Monitoring of shallow ground water chemistry, 2007

Ulf Ericsson, Medins Biologi AB

December 2008

Svensk Kärnbränslehantering AB

Swedish Nuclear Fuel
and Waste Management Co

Box 250, SE-101 24 Stockholm
Phone +46 8 459 84 00



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Abstract

In 2007 sampling of shallow ground water in water wells in soil has been performed at 12 sites within the site investigation area at Oskarshamn. The purpose of the activity is to monitor 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 program, 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 2007.

One nonconformity has occurred. Analysis of environmental metals, lanthanides and trace elements were not performed on the samples from December 2007. The reason was a mistake at the laboratory ALS. Later it was decided not to perform analysis from the archive samples.

The results showed a quite large variation between the different wells. The ion concentrations and conductivity ranged from what can be termed as low to high or very high values. The concentration of HCO_3 varied extensively throughout the investigation area with high concentrations in most wells. This result indicates a good ground water quality with respect to acidification at the investigated sites.

As with the ions measurements on environmental metals and trace elements varied quite much between the wells. High concentration of lead in some of the wells indicated pollution but since the concentration of lead in the wells had a similar relation to aluminium as most other elements it was argued that the high concentration of lead probably can be explained by the natural composition of minerals within the site investigation area.

The average ratios of boron ($^{10}\text{B}/^{11}\text{B}$) were similar in most wells and there seems to be low variation in the investigated area. With the exception of one site (SSM000241) the ratio of $\delta^{18}\text{O}$ showed a good relationship with the conductivity (Figure 6-8). This result might indicate occurrence of relict seawater at the site.

The average hydrogen stable isotope ratios ($\delta^2\text{H}$) and tritium (^3H) had similar values in most wells. However two wells differed with a markedly lower ratio for ^3H . The $\delta^2\text{H}$ ratio correlates well with the $\delta^{18}\text{O}$ ratio but the linear relation differ markedly from the "Global Meteoric Line" ($\delta^2\text{H}=8\times\delta^{18}\text{O}+10$) which is based on precipitation data.

The concentration of nitrate varied with considerable higher concentration in one of the well (SSM000263). The concentration in this well can be termed as moderately high according to Swedish environmental quality criteria. This result might indicate leakage from the surrounding farmland areas. 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 results between 5 and 13 mg/l in most wells. Again the well SSM000241 differed markedly with a value of 88.2 mg/l.

Sammanfattning

Provtagning av ytligt grundvatten i jordrör har under 2007 skett vid 21 platser inom platsundersökningsområdet i Oskarshamn. Målsättningen med aktiviteten är att monitera 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 2007.

En avvikelse har identifierats. Analyser av miljömetaller, lantanoider och spårelement skedde inte på prover från december 2007. Anledningen var ett misstag på laboratoriet (ALS). Senare bestämdes det att inte utföra analyser på vatten från arkivprover.

Resultaten av undersökningarna visade på en stor variation mellan de olika grundvattenrören i området. Koncentrationen av joner och konduktivitet varierade mellan vad som kan betecknas som låga till väldigt höga värden. Likadant varierade koncentrationen av HCO_3 mycket med höga koncentrationer vid de flesta provplatserna. Detta resultat visar på en god vattenkvalitet med avseende på försurning vid de undersökta platserna.

Liksom för jonerna varierade värdena för miljömetaller och spårelement ganska mycket mellan de olika provplatserna. En hög koncentration av bly vid några av platserna indikerade någon sorts förorening. Men eftersom relationen mellan koncentrationen av bly och aluminium liknade den som flertalet andra metaller och spårelement hade med aluminium drogs slutsatsen att resultatet med höga blyhalter kan förklaras med mineralets naturliga sammansättning i området.

Isotopkvoterna av bor ($^{10}\text{B}/^{11}\text{B}$) var liknande vid de flesta provplatserna och det verkar vara en liten variation inom undersökningsområdet. Med undantag av ett jordrör, SSM000241, visade isotopen av $\delta^{18}\text{O}$ en god relation med konduktiviteten i vattnet. Detta resultat kan indikera förekomst av relik havsvatten vid provplatsen.

Medelvärdena av väteisotoperna deuterium ($\delta^2\text{H}$) och tritium (^3H) var liknande i de flesta grundvattenrören. Resultatet från två av rören skiljde sig dock med en märkbart lägre kvot för ^3H . Kvoterna av $\delta^2\text{H}$ var väl korrelerade till kvoterna av $\delta^{18}\text{O}$ men den linjära relationen skiljde sig märkbart från "the Global Meteoric Line" vilken baseras på data från nederbörd.

Koncentrationen av nitrat varierade med betydligt högre värden i ett av grundvattenrören. Detta värde kan klassas som måttligt högt enligt Naturvårdsverkets kriterier. Koncentrationen av $\text{NH}_4\text{-N}$ och $\text{PO}_4\text{-P}$ varierade med märkbart högre halter i några av jordrören. Resultaten från jordröret SSM000241 visade på vad som kan klassas som extremt höga halter på $\text{NH}_4\text{-N}$ och $\text{PO}_4\text{-P}$. Koncentrationen av kol (TOC and DOC) varierade med värden mellan 5 och 13 mg/l i de flesta jordrören. Jordröret SSM000241 hade ännu högre halt med ett värde på 88,2 mg/l.

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1 Introduction

This document reports the data gained by sampling of shallow ground water 2007, which is one of the activities performed within the site investigation at Oskarshamn. The work was carried out in accordance with activity plan AP PS 400-07-020. In Table 1-1 controlling documents for performing this activity are listed. The activity plan is an SKB's internal controlling document.

Within the site investigation area water has been sampled from shallow ground water wells in soil. During 2007 sampling was performed at 12 sites at four occasions (Figure 1-1). The water was analysed for a large number of parameters. 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).

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

Activity plan	Number	Version
Hydrokemisk jordrörsmonitoring 2007	AP PS 400-07-020	1.0

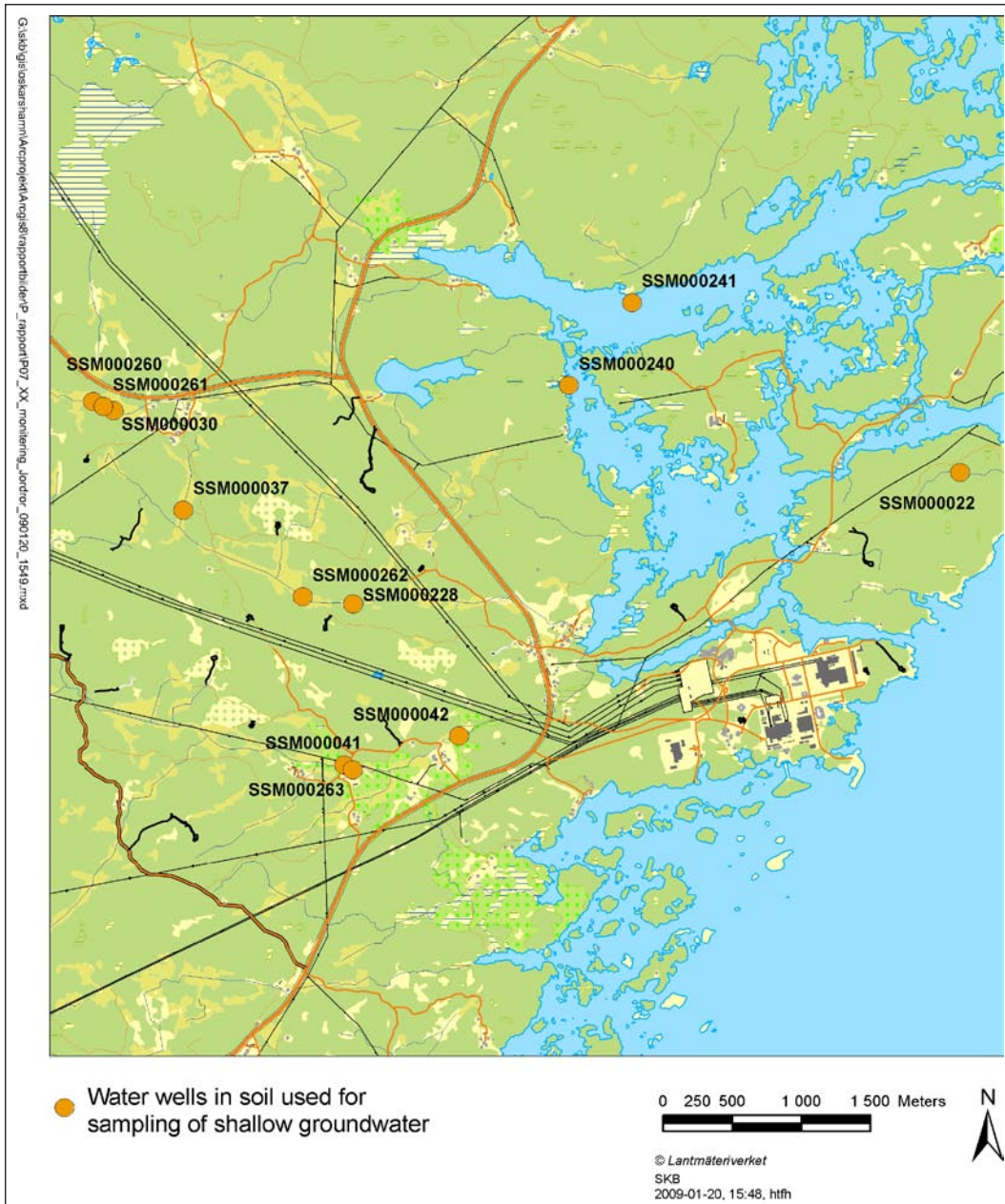


Figure 1-1. The site investigation area and the location of the water wells in soil used for sampling of shallow ground water in 2007.

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 12 different ground water wells, at one or more occasions during 2007. One of these water wells are situated in the Ävrö, Hålö and Simpevarp peninsula area, and 11 in the Laxemar area.

Some physical and chemical parameters were measured in the field. Water samples were then taken for analysis of further parameters. The samples were later sent to different 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 2007 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 2007.

Table 2-1. Analysed components and priority order when sampling ground water wells 2007.

Chemical programme class 5 – reduced 2007			
Components	Priority	Optional components	Priority
Alkalinity, pH, Conductivity	2	Deuterium, $\delta^{18}\text{O}$	4
Anions (F^- , Cl^- , Br^- , SO_4^{2-})	3	Tritium	5
Standard elements	1	Fe^{2+} , Fe-tot	6
B-10	1	HS^-	7
Environmental metals	1	NH_4 , NO_3 , NO_2 , NO_2+NO_3 , PO_4	8
Lantanoides	1	Tot-N and Tot-P	9
Trace elements	1	DOC	10
Archive (acid rinsed)	13	TOC	11
Archive	13	POP, PON and POC	12

3 Equipment

3.1 Equipment used in the field

Under water pump (type 12 V Avimex) and 12 V vacuum pump. Used in the field for pumping up water from the ground water wells.

Two litres plastic cans, used in field as collecting vessels for archive samples. Acid rinsed 500 ml plastic vessels were used when sampling for analysis of Fe (II) + Fe (tot), standard elements, trace elements, lantanoides, and environmental 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 μm .

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

Field notes.

3.2 Equipment used at the laboratory

Tube pump. Used in the laboratory to filter sampled water.

0.45 μm filter (PALL). Capsule filter used together with the tube pump.

0.45 μm membrane filter. Used together with the tube pump.

4 Execution

4.1 Sites and sampling frequency

The total number of sampled sites was 12 (Appendix 1). During 2007, sampling was performed at 11 sites situated in the Laxemar area and at one site (SSM000022) in the Ävrö, Hälö, and Simpevarp peninsula area (Figure 1).

The sampling frequency of the ground water wells sampled in 2007 is presented in Appendix 2. During the sampling period in March four extra water wells were sampled (SSM000260, SSM000261, SSM000262 and SSM000263).

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 $\text{NH}_4\text{-N}$, $\text{NO}_2\text{-N}$, $\text{NO}_3\text{-N}$, $\text{NO}_2/\text{NO}_3\text{-N}$, $\text{PO}_4\text{-P}$ and DOC were filtered 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 (II) + Fe (tot), standard elements, trace elements, lantanoides, and environmental 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.

Four extra water wells were sampled in March (SSM000260, SSM000261, SSM000262 and SSM000263). Most of the parameters analysed were the same as in the regular ground water wells but some parameters differed. Analysis of $\delta^2\text{H}$, $\delta^{18}\text{O}$, ^3H , POP, PON and POC were not performed in these samples. In addition analysis of arsenic and iodine were performed.

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.

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 ⁻ , Cl ⁻ , Br ⁻ , SO ₄ ²⁻)	Fill up	–
500 ml acid rinsed PEH bottle	1	red	Fe (II) + Fe (tot)	Fill up	Filter with membrane filter, add 5 ml concentrated HCl
Winkler bottle	2		S ₂ ⁻	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 ₃
Test tubes	4	green	NO ₃ ⁻ , NO ₂ ⁻ , (NO ₂ ⁻ +NO ₃ ⁻), PO ₄ ³⁻	Fill 80%	Filter with disposable filter, 0.45 µm in field, heat 60° for 1 hour
100 ml	1	green	Tot-N and Tot-P	Fill up	–
1,000 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	Deuterium, δ ¹⁸ O	Fill 80%	–
500 ml dried	1	green	Tritium	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 ₃

Table 4-2. Treatments of samples when storing and delivering to analysing laboratories.

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 ⁻ , Cl ⁻ , Br ⁻ , SO ₄ ²⁻)	Refrigerator	Äspö laboratory	Directly
500 ml acid rinsed PEH bottle	1	red	Fe (II) + Fe (tot)	Refrigerator	Äspö laboratory	Directly
Winkler bottle	2		S ₂ ⁻	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 ₃ ⁻ , NO ₂ ⁻ , (NO ₂ ⁻ +NO ₃ ⁻), PO ₄ ³⁻	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	Deuterium, δ ¹⁸ O	Refrigerator	IFE, Norway	Parcel post
1,000 ml dried	1	green	Tritium	Refrigerator	Waterloo	Parcel post
250 ml	2	green	Archive	Freezer	–	–
100 ml	2	red	Archive	Freezer	–	–

5 Nonconformities

Analysis of environmental metals, lantanoides and trace elements were not performed on the samples from December 2007. The reason was a mistake at the laboratory ALS. Later it was decided not to perform analysis from the archive samples.

6 Results

6.1 Primary results

All primary results from the laboratory analysis and from the field measurements are presented in Appendix 4 and 5.

6.2 Dissolved ions and conductivity

The concentrations of ions and the conductivity varied quite much between the sites (Table 6-1). Most of 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 was an exception with comparably high concentrations of ions.

Table 6-1. Average concentration of major ions and conductivity in shallow ground water wells 2007. Figures in italic indicate that some or all individual values in the calculation were below the detection limit of the analysis.

Site number	Fe (II) (mg/l)	Fe (tot) (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Li (mg/l)
SSM000022	0.097	0.109	204	5.42	20.5	6.23	<i>0.029</i>
SSM000030	1.77	1.92	28.1	2.43	65.7	7.88	0.008
SSM000037	3.78	3.92	35.6	3.56	50.3	7.25	0.013
SSM000041	5.40	5.68	8.68	4.26	42.8	7.42	0.007
SSM000042	3.13	3.31	66.6	4.12	56.4	11.7	0.005
SSM000228	5.49	5.63	16.0	2.02	38.0	5.72	0.010
SSM000240	0.504	0.552	371	15.6	101	50.8	0.020
SSM000241	0.936	0.976	2,617	125	319	427	0.146
SSM000260	1.13	1.30	20.5	3.55	68.9	11.1	0.010
SSM000261	3.79	3.85	27.5	5.66	63.3	13.7	0.017
SSM000262	1.18	2.85	34.6	3.81	43.0	7.96	0.009
SSM000263	0.407	0.523	138	19.8	96.0	14.3	0.016
Site number	HCO ₃ (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	SO ₄ -S (mg/l)	F (mg/l)	Sr (mg/l)	Conductivity (mS/m)
SSM000022	235	126	130	52.9	3.42	0.253	111
SSM000030	249	12.2	34.4	12.1	2.38	0.259	50.4
SSM000037	179	26.1	48.2	16.3	2.00	0.196	48.4
SSM000041	74.8	32.8	40.4	14.1	0.883	0.124	33.9
SSM000042	187	93.8	103	32.0	1.90	0.144	82.6
SSM000228	110	15.7	39.0	13.7	2.28	0.088	33.1
SSM000240	275	724	64.4	23.8	1.42	0.702	277
SSM000241	5,200	4,910	15.0	13.9	0.860	4.97	1,977
SSM000260	239	11.9	52.0	18.6	1.80	0.253	52.6
SSM000261	249	12.6	44.4	11.9	2.50	0.268	52.9
SSM000262	152	40.5	36.3	13.0	1.69	0.224	47.5
SSM000263	135	331	58.4	20.8	1.15	0.480	143

According to the Swedish Environmental Quality Criteria /Swedish Environment Protection Agency 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 one 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. The samples with high positive deviation in charge balance had a comparatively low conductivity though (Figure 6-1). This might be an indication of an occurrence of ions not included in the calculation of charge balance instead of analytical errors. One possible example is organic anions which has not been included in the calculations. In some cases (Table 6-2) there was a negative deviation of more than ten percent. Likewise this could indicate an analytical problem or a significant concentration of a positive ion not included in the calculation.

Table 6-2. Samples with a charge balance which deviates more than 10 percent. Sampling in shallow ground water wells 2007.

Site number	Sampling date	Sample number	Charge balance (%)
SSM000022	2007-03-28	11797	-14.18
SSM000022	2007-05-22	11847	16.92
SSM000042	2007-05-22	11849	-22.03
SSM000241	2007-04-04	11806	-14.70
SSM000241	2007-05-31	11904	-13.53
SSM000241	2007-09-13	15108	-16.17

Charge balance (%)

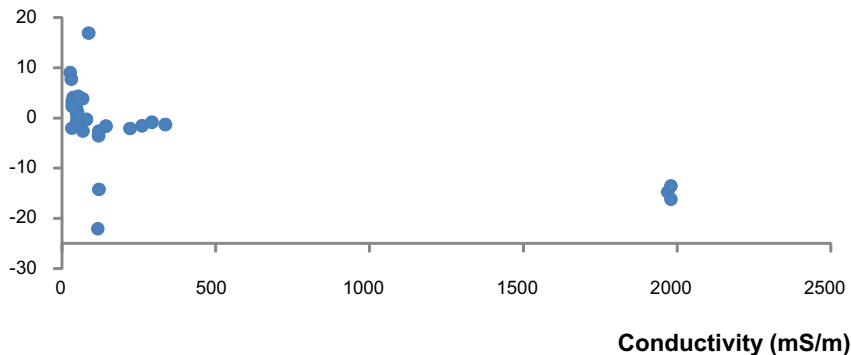


Figure 6 1. Relation of charge balance and conductivity in samples from all ground water wells 2007.

6.3 Acidification

As with other ions the concentration of HCO_3 varied extensively throughout the investigation areas (Table 6-3). In all wells the average concentration of 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 /Swedish Environment Protection Agency 1999/. These results indicate a good ground water quality with respect to acidification at the investigated sites.

The field measurements of pH were in most cases higher than the laboratory measurements (Table 6-3 and Figure 6-2). In most ground waters the opposite is normal due to a shift in the carbonate system when the gas pressure in the water is equalised prior to the analysis in the laboratory. An explanation to the observed results might be high contents of inorganic manganese and iron which is oxidised when the water is aerated prior to the analysis.

Table 6-3. Average concentration of HCO_3 , calculated alkalinity (HCO_3) and pH in shallow ground water wells 2007.

Site number	HCO_3 (mg/l)	Alkalinity (meq/l)	pH-lab	pH-field
SSM000022	235	3.85	7.68	7.45
SSM000030	249	4.07	7.10	7.11
SSM000037	179	2.94	6.72	7.16
SSM000041	74.8	1.23	6.33	6.83
SSM000042	187	3.06	7.09	7.03
SSM000228	110	1.80	6.46	7.08
SSM000240	275	4.50	7.35	7.24
SSM000241	5,200	85.2	6.94	6.93
SSM000260	239	3.92	7.25	7.60
SSM000261	249	4.08	6.97	8.00
SSM000262	152	2.49	7.05	7.50
SSM000263	135	2.21	7.17	7.30

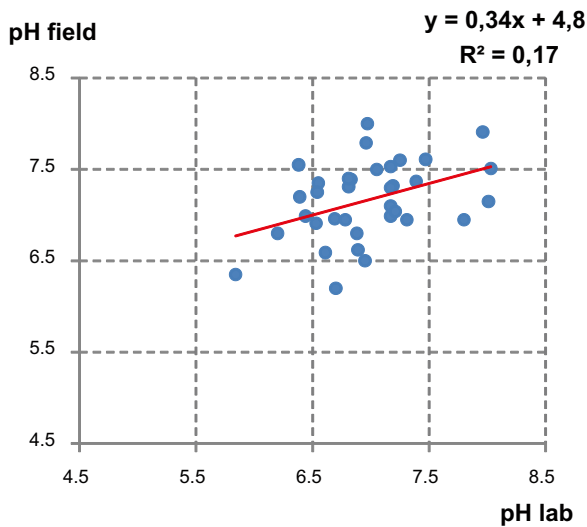


Figure 6-2. Relation of pH measured in the laboratory and in the field in ground water wells 2007.

6.4 Environmental metals and trace elements

The results of measurements on environmental metals and trace elements are presented as average concentrations in Tables 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 6-3. This indicates a good quality of the analysis performed. However, in some cases apparent out layers exists indicating pollution, contamination or analytical errors. Two examples are Zn (SSM00041 and SSM00241, sample numbers 15104 and 11806 respectively) and Cu (SSM00263, sample number 11796) (Figure 6-4). Similar out layers exist for some elements at site SSM00241 (Figure 6-5). This ground water well seems to have a different type of water though and therefore the poor relation with aluminium is probably not an indication of pollution, contamination or analytical errors.

Table 6-4a. Average concentration of environmental metals in shallow ground water wells 2007. Figures in italic indicate that some or all individual values in the calculation were below the detection limit of the analysis.

Site number	Al (µg/l)	As (µg/l)	Ba (µg/l)	Cd (µg/l)	Cr (µg/l)	Cu (µg/l)	Co (µg/l)
SSM000022	29.9		28.7	<i>0.0023</i>	0.132	0.251	0.053
SSM000030	57.6		32.7	0.0065	0.445	0.216	0.063
SSM000037	170		35.3	<i>0.0066</i>	0.576	0.439	0.139
SSM000041	1,418		37.3	0.0686	3.30	4.54	2.15
SSM000042	192		84.3	0.0104	1.14	1.47	0.353
SSM000228	364		27.0	0.0039	1.37	0.485	0.659
SSM000240	39.7		103	0.0053	0.703	0.179	0.070
SSM000241	13.4		731	<i>0.0500</i>	6.63	<i>0.875</i>	5.01
SSM000260	201	0.169	31.9	0.0024	0.379	0.511	0.216
SSM000261	3,290	2.750	70.8	0.0977	5.68	7.47	2.37
SSM000262	76.0	0.527	27.6	0.0073	1.69	2.22	0.195
SSM000263	530	0.946	65.4	0.0122	1.02	9.00	0.576

Table 6-4b. Average concentration of environmental metals in shallow ground water wells 2007. Figures in italic indicate that some or all individual values in the calculation were below the detection limit of the analysis.

Site number	Hg (µg/l)	Mo (µg/l)	Ni (µg/l)	Pb (µg/l)	V (µg/l)	Zn (µg/l)	Zr (µg/l)
SSM000022	<i>0.0020</i>	12.0	0.493	0.092	0.851	0.927	0.977
SSM000030	<i>0.0020</i>	0.669	1.09	0.117	3.77	2.68	2.10
SSM000037	<i>0.0020</i>	1.40	0.758	0.188	1.98	2.38	1.16
SSM000041	<i>0.0020</i>	0.481	6.04	1.72	5.16	17.4	3.60
SSM000042	<i>0.0020</i>	1.51	1.18	0.367	2.63	3.58	1.56
SSM000228	<i>0.0020</i>	0.599	0.980	0.377	8.13	3.06	2.97
SSM000240	<i>0.0034</i>	0.417	0.320	0.179	4.42	1.84	2.37
SSM000241	<i>0.0020</i>	<i>0.500</i>	2.36	0.770	15.1	10.8	15.5
SSM000260	<i>0.0020</i>	0.576	0.729	0.929	2.47	3.12	1.43
SSM000261	<i>0.0020</i>	0.480	5.84	7.63	12.3	24.7	6.58
SSM000262	<i>0.0020</i>	0.803	3.17	0.338	5.53	12.3	1.67
SSM000263	<i>0.0020</i>	2.71	2.43	1.09	2.63	3.92	2.32

Table 6-5a. Average concentration of trace elements in shallow ground water wells 2007. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	U (µg/l)	Th (µg/l)	Sc (µg/l)	Rb (µg/l)	Y (µg/l)	Sb (µg/l)	Cs (µg/l)	La (µg/l)
SSM000022	2.63	0.056	<i>0.0500</i>	2.07	0.467	0.028	<i>0.031</i>	0.353
SSM000030	0.107	0.077	<i>0.0500</i>	4.73	0.569	0.021	0.343	0.448
SSM000037	0.739	0.130	<i>0.0513</i>	3.32	1.64	0.034	0.087	2.46
SSM000041	0.523	1.12	0.538	8.05	6.12	0.049	0.392	10.5
SSM000042	0.996	0.364	0.142	4.34	3.08	0.022	0.206	4.78
SSM000228	1.21	0.410	0.409	2.09	9.03	0.058	0.065	11.0
SSM000240	0.370	0.060	<i>0.0500</i>	9.63	0.880	0.163	0.624	0.354
SSM000241	0.200	<i>0.200</i>	<i>0.0500</i>	59.9	0.274	0.811	2.10	0.138
SSM000260	0.227	0.329	0.0694	3.31	1.16	0.075	0.234	1.76
SSM000261	4.80	1.60	0.618	8.90	8.93	0.163	0.470	14.3
SSM000262	1.37	0.167	0.117	2.29	1.04	2.21	0.199	0.659
SSM000263	1.59	0.620	0.176	11.3	1.72	0.114	0.145	2.72

Table 6-5b. Average concentration of trace elements in shallow ground water wells 2007. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	Hf (µg/l)	Tl (µg/l)	Ce (µg/l)	Pr (µg/l)	Nd (µg/l)	Sm (µg/l)	Eu (µg/l)	Gd (µg/l)
SSM000022	<i>0.044</i>	<i>0.0050</i>	0.581	0.082	0.349	0.058	0.0083	0.061
SSM000030	0.104	<i>0.0050</i>	0.845	0.106	0.445	0.083	0.0155	0.087
SSM000037	0.059	<i>0.0059</i>	4.11	0.504	2.06	0.343	0.0519	0.331
SSM000041	0.114	0.037	20.0	2.70	10.76	1.83	0.2633	1.47
SSM000042	0.044	0.0066	7.01	0.981	4.06	0.667	0.0998	0.624
SSM000228	0.101	<i>0.0056</i>	20.7	2.54	11.03	1.78	0.3117	1.76
SSM000240	0.043	<i>0.0050</i>	0.639	0.088	0.410	0.088	0.0141	0.102
SSM000241	0.114	<i>0.020</i>	0.161	<i>0.050</i>	0.102	<i>0.050</i>	<i>0.0500</i>	<i>0.050</i>
SSM000260	0.033	<i>0.0050</i>	3.29	0.379	1.57	0.229	0.0356	0.221
SSM000261	0.191	0.046	34.2	3.42	13.0	2.33	0.3260	1.93
SSM000262	0.033	0.0085	1.21	0.166	0.652	0.126	0.0197	0.136
SSM000263	0.078	0.011	5.26	0.616	2.51	0.434	0.0555	0.404

Table 6-5c. Average concentration of trace elements in shallow ground water wells 2007. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	Tb (µg/l)	Dy (µg/l)	Ho (µg/l)	Er (µg/l)	Tm (µg/l)	Yb (µg/l)	Lu (µg/l)
SSM000022	0.008	0.050	0.011	0.036	<i>0.005</i>	0.034	0.006
SSM000030	0.011	0.074	0.017	0.059	0.009	0.068	0.016
SSM000037	0.038	0.215	0.044	0.131	0.017	0.114	0.021
SSM000041	0.172	0.963	0.185	0.543	0.075	0.528	0.085
SSM000042	0.069	0.401	0.082	0.241	0.032	0.210	0.038
SSM000228	0.196	1.13	0.244	0.743	0.099	0.680	0.116
SSM000240	0.014	0.096	0.024	0.083	0.013	0.100	0.019
SSM000241	<i>0.050</i>	<i>0.050</i>	<i>0.050</i>	0.084	<i>0.050</i>	<i>0.050</i>	<i>0.050</i>
SSM000260	0.027	0.158	0.031	0.094	0.013	0.084	0.014
SSM000261	0.278	1.55	0.290	0.789	0.111	0.719	0.099
SSM000262	0.018	0.115	0.024	0.092	0.012	0.100	0.018
SSM000263	0.048	0.282	0.052	0.156	0.021	0.142	0.022

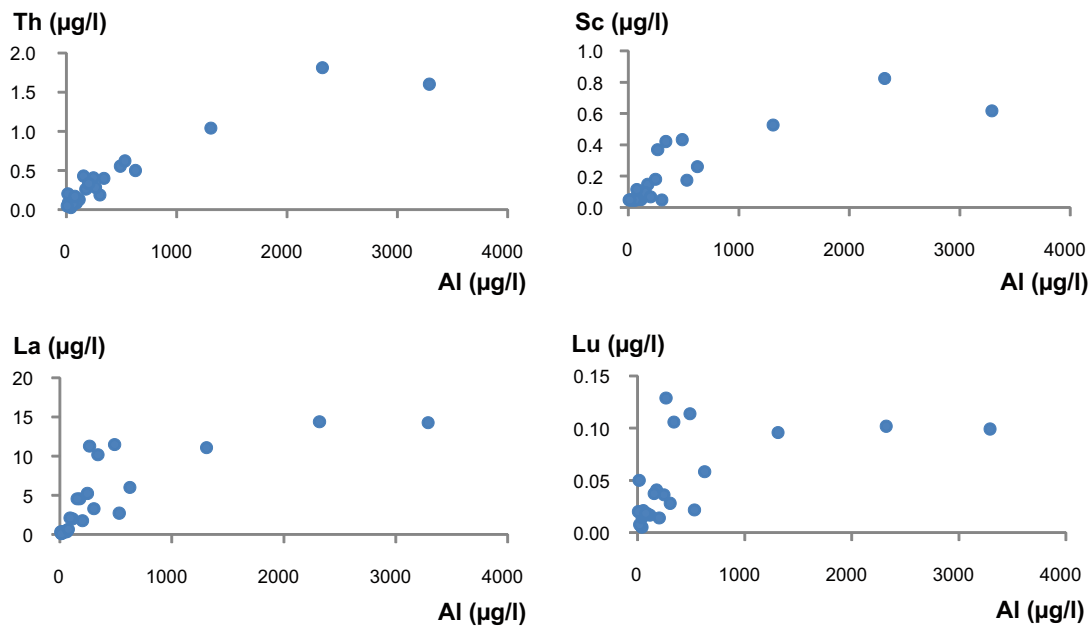


Figure 6-3. Relations between concentrations of Al and some other elements in ground water wells 2007.

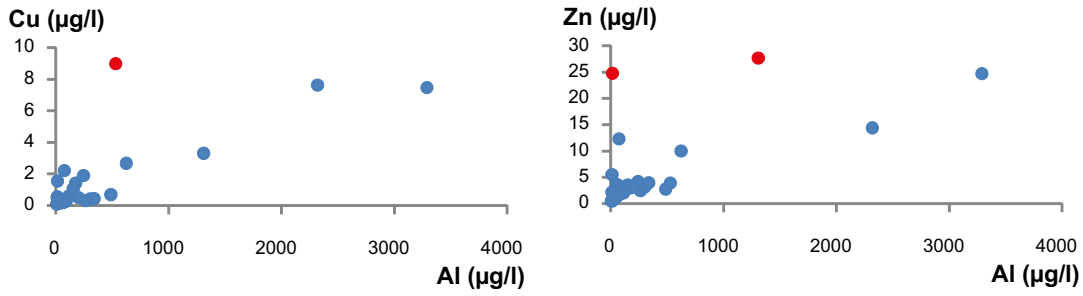


Figure 6-4. Relations between concentrations of Al and Cu and Al and Zn in ground water wells 2007. Apparent out layers are marked red.

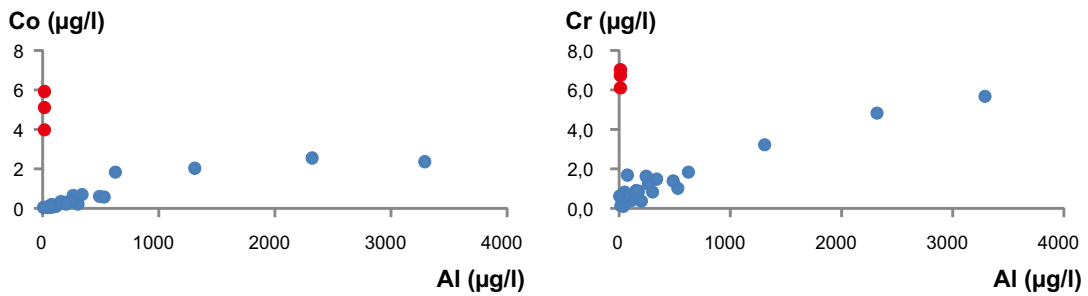


Figure 6-5. Relations between concentrations of Al and Co and Al and Cr in ground water wells 2007. Results from SSM00241 are marked red.

Some of the environmental metals can be classified according to the Swedish Environmental Quality Criteria's /Swedish Environment Protection Agency 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 concentration of Pb were high ($> 3\mu\text{g/l}$) in one of the wells (SSM00261) (Table 6-4b and Figure 6-6). 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.

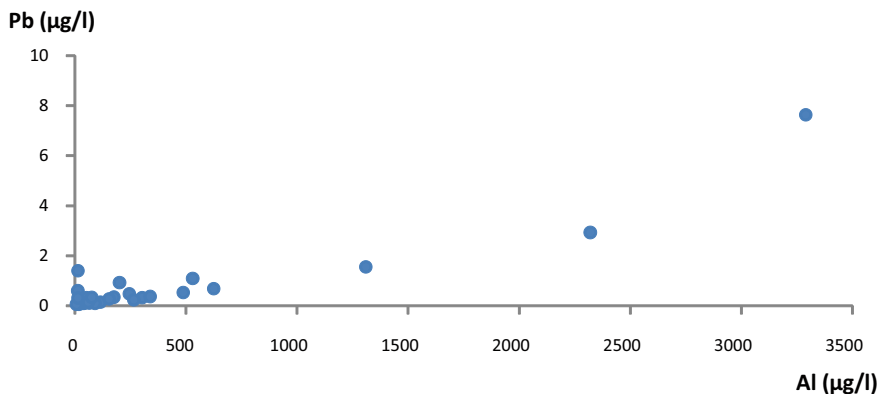


Figure 6-6. Relations between concentrations of Al and Pb in ground water wells 2007.

6.5 Isotopes

The results of the measurements of isotopes are presented in Table 6-6. The average ratios of boron ($^{10}\text{B}/^{11}\text{B}$) were similar in most wells and there seems to be low variation in the investigated area. With the exception of one site (SSM000241) the ratio of $\delta^{18}\text{O}$ showed a good relationship with the conductivity (Figure 6-7). This result might indicate occurrence of relict seawater at the site SSM000241.

The average hydrogen isotope ratios of $\delta^2\text{H}$ and ^3H had similar values in most wells. However the wells SSM000022 and SSM000241 differed with a markedly lower ratio for ^3H . The $\delta^2\text{H}$ ratio correlates well with the $\delta^{18}\text{O}$ ratio but the linear relation differs markedly from the “Global Meteoric Line” ($\delta^2\text{H}=8\times\delta^{18}\text{O}+10$) which is based on precipitation data (Figure 6-8).

Table 6-6. Average ratio of isotopes in shallow ground water wells 2007. Measurements not performed is marked with –.

Site number	$\delta^2\text{H}$ (‰ VSMOW)	^3H (TU)	$\delta^{18}\text{O}$ (‰ VSMOW)	$^{10}\text{B}/^{11}\text{B}$ (atomic)
SSM000022	-77.5	1.62	-10.58	0.2332
SSM000030	-78.2	8.38	-10.90	0.2348
SSM000037	-78.3	6.98	-10.93	0.2344
SSM000041	-78.5	9.32	-10.95	0.2360
SSM000042	-77.6	7.93	-10.78	0.2332
SSM000228	-78.7	9.11	-10.80	0.2333
SSM000240	-75.1	9.01	-10.25	0.2347
SSM000241	-64.9	1.03	-8.63	0.2347
SSM000260	–	–	–	0.2403
SSM000261	–	–	–	0.2406
SSM000262	–	–	–	0.2408
SSM000263	–	–	–	0.2375

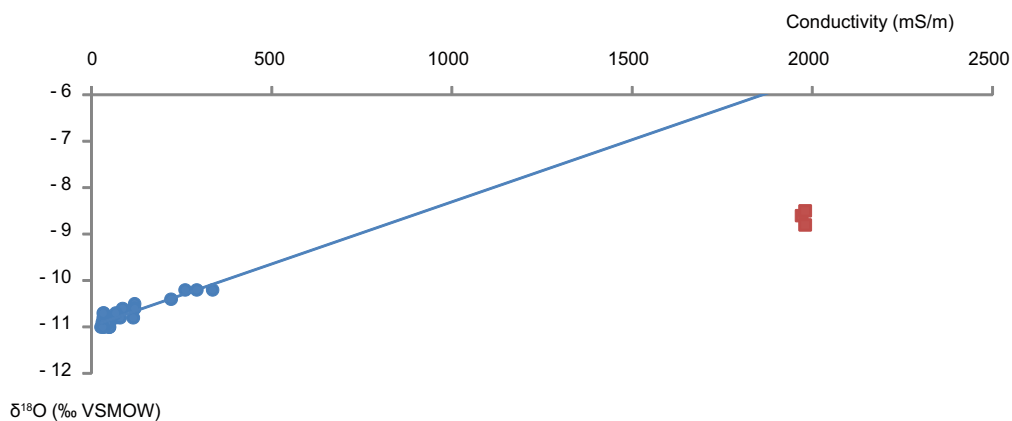


Figure 6-7. The relationship between the conductivity and the ratio of $\delta^{18}\text{O}$ in ground water wells 2007. Red dots show the site SSM000241 which had a different relationship between the conductivity and the ratio of $\delta^{18}\text{O}$.

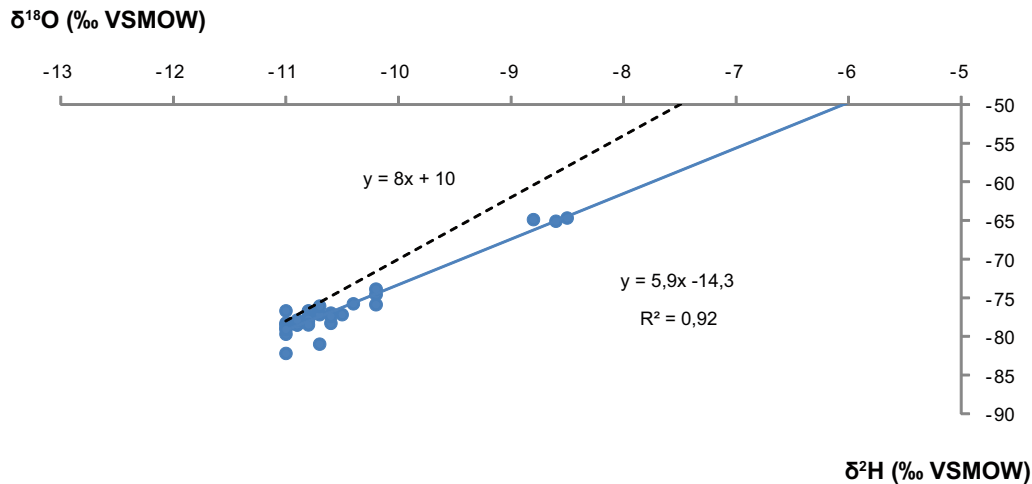


Figure 6-8. The local relationship between the ratios of δ^2H and $\delta^{18}O$ in ground water wells 2007. The dotted line shows Global Meteoric Line” ($\delta^2H=8\times\delta^{18}O+10$).

6.6 Nutrients and carbon

The concentration of nitrate varied with considerable higher concentration in one of the well (Table 6-7). According to the Swedish Environmental Quality Criteria /Swedish Environment Protection Agency 1999/ the concentration of nitrate was moderately high (1–5 $\mu\text{g/l}$) in SSM000263. This result might indicate leakage from the surrounding farmland areas. 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 results between 5 and 13 mg/l in most wells (Table 6-7). Again the well SSM000241 differed markedly with a value of 88.2 mg/l .

Table 6-7. Average concentration of nitrogen and phosphorus compounds, and carbon in shallow ground water wells 2007. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis. Measurements not performed is marked with –.

Site number	$\text{NO}_2\text{-N}$ (mg/l)	$\text{NO}_3\text{-N}$ (mg/l)	$\text{NO}_2/\text{NO}_3\text{-N}$ (mg/l)	$\text{NH}_4\text{-N}$ (mg/l)	N-tot (mg/l)	PON (mg/l)
SSM000022	0.0067	0.0368	0.0435	0.671	0.856	0.0135
SSM000030	0.0009	0.0108	0.0117	1.66	1.86	0.0436
SSM000037	0.0013	0.0718	0.0730	0.950	0.796	0.0777
SSM000041	0.0005	0.0043	0.0047	0.183	0.533	0.0859
SSM000042	0.0005	0.0014	0.0019	0.284	0.569	0.0652
SSM000228	0.0004	0.0014	0.0017	0.125	0.438	0.0112
SSM000240	0.0004	0.0003	0.0005	1.91	2.19	0.0185
SSM000241	0.0047	0.0014	0.0060	626	639	0.169
SSM000260	0.0278	0.392	0.420	0.873	1.90	–
SSM000261	0.0009	0.0017	0.0026	12.6	5.40	–
SSM000262	0.371	0.271	0.642	1.80	2.18	–
SSM000263	0.0071	2.320	2.33	0.174	3.01	–

Site number	PO ₄ -P (mg/l)	P-tot (mg/l)	POP (mg/l)	TOC (mg/l)	DOC (mg/l)	POC (mg/l)
SSM000022	0.0131	0.0163	0.0014	5.18	5.33	0.107
SSM000030	0.0664	0.169	0.0105	8.88	8.65	0.414
SSM000037	0.0354	0.0369	0.0128	6.85	7.40	0.623
SSM000041	0.0106	0.134	0.0793	9.83	9.65	1.20
SSM000042	0.0012	0.0548	0.0331	5.98	6.38	1.33
SSM000228	0.0085	0.0114	0.0021	12.5	13.4	0.114
SSM000240	0.625	0.565	0.0025	10.1	10.3	0.125
SSM000241	24.9	25.5	0.0245	88.2	85.4	1.14
SSM000260	0.0609	0.204	–	8.70	9.50	–
SSM000261	0.472	0.992	–	13.1	11.5	–
SSM000262	0.059	0.168	–	12.6	12.6	–
SSM000263	0.168	0.255	–	8.60	8.80	–

References

Swedish Environment Protection Agency, 1999. Bedömningsgrunder för miljö kvalitet. grundvatten. Naturvårdsverket. rapport 4915.

Sites – co-ordinates and sampling depths

Sites. sample depths and location co-ordinates 2007			
ID-code	Co-ordinate (X)	Co-ordinate (Y)	Sampling depth (m)
SSM000022	6367458	1553120	5–7
SSM000030	6367908	1546986	4–5
SSM000037	6367186	1547490	3–4
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
SSM000260	6367974	1546833	7.45–9.45
SSM000261	6367941	1546910	9.2–10.2
SSM000262	6366555	1548354	11.7–14.7
SSM000263	6365296	1548715	6.3–8.3

Schedule – Sampling of shallow ground water 2007

Sampling occasions 2007				
ID-code	February/March Week number 12–14	May/June Week number 21–22	September Week number 36–37	December Week number 49–51
SSM000022	x	x	x	x
SSM000030	x	x	x	x
SSM000037	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
SSM000260	x			
SSM000261	x			
SSM000262	x			
SSM000263	x			

Primary results – laboratory analysis

(Figures in *italic* indicate that the results were below the detection limit of the analysis)

Site number	Date	Sample number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	HCO ₃ (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	SO ₄ -S (mg/l)
SSM000022	2007-03-28	11797	180	5.30	18.0	5.30	260	145	138	61.0
SSM000022	2007-05-22	11847	208	5.60	20.2	6.35	157	76.8	91.6	45.3
SSM000022	2007-09-06	15106	213	5.24	22.1	6.65	262	140	145	54.4
SSM000022	2007-12-06	15223	215	5.54	21.7	6.61	260	144	147	50.9
SSM000030	2007-03-20	11777	28.0	2.44	64.8	7.82	246	12.7	37.9	12.9
SSM000030	2007-05-24	11888	28.8	2.45	65.6	7.99	249	12.6	35.4	12.2
SSM000030	2007-09-04	15101	27.0	2.23	67.4	7.90	249	12.1	33.4	12.6
SSM000030	2007-12-04	15218	28.5	2.60	64.8	7.79	250	11.4	31.0	10.8
SSM000037	2007-03-20	11778	37.5	3.57	52.5	7.19	181	33.0	46.0	15.3
SSM000037	2007-05-27	11889	35.2	3.25	50.4	7.31	173	28.8	53.0	17.9
SSM000037	2007-09-04	15103	35.5	3.84	46.8	7.04	174	21.2	46.6	16.1
SSM000037	2007-12-04	15219	34.2	3.57	51.4	7.45	189	21.5	47.1	15.9
SSM000041	2007-03-22	11793	8.20	4.18	33.8	6.25	53.8	26.7	28.5	10.6
SSM000041	2007-05-22	11848	8.80	4.21	44.4	7.61	62.0	36.0	55.4	18.0
SSM000041	2007-09-06	15104	7.80	4.14	38.2	7.15	55.5	31.5	40.4	14.8
SSM000041	2007-12-06	15221	9.90	4.50	54.6	8.67	128	37.0	37.2	12.9
SSM000042	2007-03-28	11798	69.2	4.23	56.3	11.7	154	67.2	87.8	31.7
SSM000042	2007-05-22	11849	57.9	3.85	57.1	11.6	263	136	142	30.4
SSM000042	2007-09-06	15105	82.3	4.43	58.6	12.1	172	98.9	92.8	35.6
SSM000042	2007-12-06	15222	57.0	3.98	53.4	11.4	158	73.0	87.9	30.2
SSM000228	2007-03-22	11794	12.6	1.97	34.9	5.44	96.0	12.3	47.0	16.0
SSM000228	2007-05-24	11890	14.7	1.96	37.6	5.78	103	16.1	39.4	13.2
SSM000228	2007-09-04	15102	22.6	2.02	39.1	5.77	120	17.9	36.6	13.8
SSM000228	2007-12-04	15220	13.9	2.11	40.3	5.89	119	16.3	33.1	11.6
SSM000240	2007-04-03	11805	292	13.2	81.4	39.9	261	561	51.6	17.5
SSM000240	2007-05-30	11903	345	15.0	89.7	47.9	273	663	58.9	21.1
SSM000240	2007-09-12	15107	394	15.9	108	54.7	276	769	69.6	26.1
SSM000240	2007-12-19	15224	453	18.2	123	60.8	289	902	77.5	30.5
SSM000241	2007-04-04	11806	2,670	126	305	432	5,230	4,970	16.0	15.4
SSM000241	2007-05-31	11904	2,650	129	323	419	5,170	4,770	23.6	13.6
SSM000241	2007-09-13	15108	2,530	120	329	430	5,200	4,990	5.3	12.8
SSM000260	2007-03-20	11779	20.5	3.55	68.9	11.1	239	11.9	52.0	18.6
SSM000261	2007-03-20	11780	27.5	5.66	63.3	13.7	249	12.6	44.4	11.9
SSM000262	2007-03-22	11795	34.6	3.81	43.0	7.96	152	40.5	36.3	13.0
SSM000263	2007-03-22	11796	138	19.8	96.0	14.3	135	331	58.4	20.8

Site number	Date	Sample number	Br (mg/l)	F (mg/l)	Si (mg/l)	Fe (mg/l)	Fe-tot (mg/l)	Fe (II) (mg/l)	Mn (mg/l)	Li (mg/l)
SSM000022	2007-03-28	11797	0.425	4.16	4.30	0.110	0.101	0.090	0.0630	0.0500
SSM000022	2007-05-22	11847	0.530	1.00	5.06	0.143	0.120	0.107	0.0708	0.0216
SSM000022	2007-09-06	15106	0.509	4.36	5.45	0.121	0.112	0.098	0.0763	0.0214
SSM000022	2007-12-06	15223	0.200	4.15	5.16	0.118	0.103	0.092	0.0752	0.0233
SSM000030	2007-03-20	11777	0.200	2.37	8.66	1.90	1.86	1.72	0.5630	0.0078
SSM000030	2007-05-24	11888	0.200	2.34	8.31	2.01	1.93	1.77	0.5700	0.0079
SSM000030	2007-09-04	15101	0.200	2.44	8.69	2.17	1.95	1.70	0.5840	0.0079
SSM000030	2007-12-04	15218	0.200	2.37	8.65	2.25	1.92	1.89	0.5680	0.0079
SSM000037	2007-03-20	11778	0.200	1.90	10.4	3.89	3.24	3.24	0.6090	0.0129
SSM000037	2007-05-27	11889	0.200	2.05	10.1	4.21	4.14	3.87	0.5990	0.0128
SSM000037	2007-09-04	15103	0.200	2.12	11.5	5.55	4.99	4.85	0.5960	0.0137
SSM000037	2007-12-04	15219	0.200	1.94	11.8	4.14	3.31	3.16	0.5850	0.0136
SSM000041	2007-03-22	11793	0.200	0.92	14.9	7.18	3.63	3.59	0.4270	0.0076
SSM000041	2007-05-22	11848	0.210	0.80	12.7	9.14	3.30	3.38	0.5630	0.0070
SSM000041	2007-09-06	15104	0.200	0.86	15.6	10.4	8.38	7.64	0.4620	0.0063
SSM000041	2007-12-06	15221	0.200	0.95	13.4	8.75	7.42	6.98	0.6490	0.0067
SSM000042	2007-03-28	11798	0.440	1.00	9.76	8.24	1.62	1.60	0.7520	0.0059
SSM000042	2007-05-22	11849	0.520	4.20	9.70	8.67	3.49	3.14	0.7700	0.0044
SSM000042	2007-09-06	15105	0.630	1.26	10.6	7.34	6.58	6.24	0.7700	0.0069
SSM000042	2007-12-06	15222	0.290	1.13	10.5	8.01	1.53	1.52	0.6980	0.0042
SSM000228	2007-03-22	11794	0.200	2.25	11.4	6.24	3.42	3.06	0.5050	0.0097
SSM000228	2007-05-24	11890	0.047	2.18	10.1	6.75	6.35	6.34	0.5440	0.0102
SSM000228	2007-09-04	15102	0.200	2.43	10.4	6.46	6.43	6.09	0.5430	0.0107
SSM000228	2007-12-04	15220	0.200	2.25	10.4	7.25	6.33	6.47	0.5670	0.0097
SSM000240	2007-04-03	11805	2.610	1.35	9.62	0.542	0.286	0.237	0.6600	0.0184
SSM000240	2007-05-30	11903	3.110	1.36	9.74	0.660	0.476	0.345	0.6800	0.0208
SSM000240	2007-09-12	15107	3.230	1.48	10.0	0.485	0.600	0.602	0.8470	0.0198
SSM000240	2007-12-19	15224	3.950	1.48	9.49	0.853	0.845	0.833	0.9670	0.0221
SSM000241	2007-04-04	11806	164	0.74	22.2	0.172	0.138	0.068	0.6220	0.1520
SSM000241	2007-05-31	11904	171	1.10	22.7	2.34	1.03	1.01	0.9390	0.1450
SSM000241	2007-09-13	15108	158	0.740	21.4	1.76	1.76	1.73	0.6530	0.1410
SSM000260	2007-03-20	11779	0.200	1.80	10.8	1.34	1.30	1.13	0.3750	0.0098
SSM000261	2007-03-20	11780	0.200	2.50	16.3	8.18	3.85	3.79	0.6400	0.0167
SSM000262	2007-03-22	11795	0.220	1.69	11.0	3.63	2.85	1.18	0.4750	0.0087
SSM000263	2007-03-22	11796	1.42	1.15	9.49	0.903	0.523	0.407	0.5060	0.0158

Site number	Date	Sample number	Sr (mg/l)	pH	Conductivity (mS/m)	S ₂ ⁻ (mg/l)	I (mg/l)	P (mg/l)	Charge balance (%)
SSM000022	2007-03-28	11797	0.230	7.96	120	0.053	–	–	–14.18
SSM000022	2007-05-22	11847	0.257	6.96	86.6	0.074	–	0.0300	16.92
SSM000022	2007-09-06	15106	0.258	7.80	119	0.067	–	0.0164	–3.55
SSM000022	2007-12-06	15223	0.268	8.01	120	0.060	–	–	–2.57
SSM000030	2007-03-20	11777	0.262	7.17	51.0	0.023	–	–	–0.71
SSM000030	2007-05-24	11888	0.268	7.17	51.2	0.034	–	0.1580	0.14
SSM000030	2007-09-04	15101	0.248	6.88	49.7	0.025	–	0.1330	–0.05
SSM000030	2007-12-04	15218	0.257	7.17	49.7	0.028	–	–	0.54
SSM000037	2007-03-20	11778	0.205	6.83	50.1	0.006	–	–	1.24
SSM000037	2007-05-27	11889	0.195	6.81	49.4	0.009	–	0.0255	0.23
SSM000037	2007-09-04	15103	0.182	6.44	45.9	0.084	–	0.1110	2.04
SSM000037	2007-12-04	15219	0.200	6.78	48.0	0.019	–	–	1.01
SSM000041	2007-03-22	11793	0.102	6.39	26.7	0.006	–	–	9.06
SSM000041	2007-05-22	11848	0.135	6.38	36.3	0.068	–	0.0828	4.13
SSM000041	2007-09-06	15104	0.110	5.84	30.1	0.096	–	0.1040	7.75
SSM000041	2007-12-06	15221	0.149	6.70	42.3	0.041	–	–	3.19
SSM000042	2007-03-28	11798	0.145	6.81	67.0	0.059	–	–	3.87
SSM000042	2007-05-22	11849	0.146	8.03	116	0.016	–	0.0286	–22.03
SSM000042	2007-09-06	15105	0.146	6.61	79.6	0.017	–	0.0123	–0.25
SSM000042	2007-12-06	15222	0.140	6.89	67.6	0.026	–	–	–2.58
SSM000228	2007-03-22	11794	0.083	6.55	31.8	0.012	–	–	–2.01
SSM000228	2007-05-24	11890	0.090	6.54	32.8	0.011	–	0.0201	3.28
SSM000228	2007-09-04	15102	0.087	6.20	34.6	0.008	–	0.0106	3.35
SSM000228	2007-12-04	15220	0.090	6.53	33.0	0.012	–	–	2.35
SSM000240	2007-04-03	11805	0.568	7.39	221	0.099	–	–	–2.08
SSM000240	2007-05-30	11903	0.659	7.47	260	0.356	–	1.2300	–1.54
SSM000240	2007-09-12	15107	0.723	7.21	292	0.499	–	0.1250	–0.83
SSM000240	2007-12-19	15224	0.858	7.31	336	0.252	–	–	–1.28
SSM000241	2007-04-04	11806	4.91	7.19	1,970	0.053	–	26.1	–14.70
SSM000241	2007-05-31	11904	5.12	6.69	1,980	0.286	–	58.5	–13.53
SSM000241	2007-09-13	15108	4.87	6.95	1,980	3.66	–	23.8	–16.17
SSM000260	2007-03-20	11779	0.253	7.25	52.6	0.061	0.0124	0.1660	–1.06
SSM000261	2007-03-20	11780	0.268	6.97	52.9	0.006	0.0821	1.21	4.34
SSM000262	2007-03-22	11795	0.224	7.05	47.5	0.020	0.0175	0.1260	–0.77
SSM000263	2007-03-22	11796	0.480	7.17	143	0.039	0.0228	0.2380	–1.59

Site number	Date	Sample number	Al (ug/l)	As (ug/l)	Ba (ug/l)	Cd (ug/l)	Cr (ug/l)	Cu (ug/l)	Co (ug/l)
SSM000022	2007-03-28	11797	31.6	–	29.3	0.0020	0.140	0.334	0.0648
SSM000022	2007-05-22	11847	39.9	–	29.3	0.0030	0.115	0.304	0.0468
SSM000022	2007-09-06	15106	18.2	–	27.5	0.0020	0.140	0.114	0.0478
SSM000022	2007-12-06	15223	–	–	–	–	–	–	–
SSM000030	2007-03-20	11777	41.3	–	35.0	0.0109	0.416	0.189	0.0501
SSM000030	2007-05-24	11888	66.9	–	34.2	0.0021	0.473	0.254	0.0744
SSM000030	2007-09-04	15101	64.6	–	29.0	0.0065	0.447	0.206	0.0630
SSM000030	2007-12-04	15218	–	–	–	–	–	–	–
SSM000037	2007-03-20	11778	115	–	36.4	0.0051	0.420	0.614	0.1150
SSM000037	2007-05-27	11889	90.6	–	34.8	0.0020	0.468	0.277	0.0848
SSM000037	2007-09-04	15103	303	–	34.7	0.0126	0.839	0.425	0.2180
SSM000037	2007-12-04	15219	–	–	–	–	–	–	–
SSM000041	2007-03-22	11793	2320	–	39.9	0.0392	4.830	7.63	2.56
SSM000041	2007-05-22	11848	625	–	34.7	0.0286	1.840	2.68	1.84
SSM000041	2007-09-06	15104	1310	–	37.2	0.138	3.220	3.31	2.04
SSM000041	2007-12-06	15221	–	–	–	–	–	–	–
SSM000042	2007-03-28	11798	176	–	85.1	0.0108	0.876	1.43	0.3320
SSM000042	2007-05-22	11849	245	–	79.3	0.0106	1.63	1.90	0.3900
SSM000042	2007-09-06	15105	154	–	88.6	0.0098	0.917	1.07	0.3380
SSM000042	2007-12-06	15222	–	–	–	–	–	–	–
SSM000228	2007-03-22	11794	488	–	26.2	0.0065	1.39	0.697	0.6210
SSM000228	2007-05-24	11890	339	–	28.1	0.0023	1.49	0.445	0.7140
SSM000228	2007-09-04	15102	265	–	26.7	0.0030	1.24	0.313	0.6430
SSM000228	2007-12-04	15220	–	–	–	–	–	–	–
SSM000240	2007-04-03	11805	51.9	–	89.5	0.0080	0.824	0.239	0.0971
SSM000240	2007-05-30	11903	60.4	–	98.7	0.0045	0.665	0.197	0.0600
SSM000240	2007-09-12	15107	6.79	–	121	0.0034	0.620	0.101	0.0514
SSM000240	2007-12-19	15224	–	–	–	–	–	–	–
SSM000241	2007-04-04	11806	13.7	–	674	0.0500	7.04	1.56	5.12
SSM000241	2007-05-31	11904	13.1	–	683	0.0500	6.74	0.564	5.92
SSM000241	2007-09-13	15108	13.4	–	837	0.0500	6.12	0.500	3.99
SSM000260	2007-03-20	11779	201	0.169	31.9	0.0024	0.379	0.511	0.2160
SSM000261	2007-03-20	11780	3,290	2.75	70.8	0.0977	5.68	7.47	2.37
SSM000262	2007-03-22	11795	76.0	0.527	27.6	0.0073	1.69	2.22	0.1950
SSM000263	2007-03-22	11796	530	0.946	65.4	0.0122	1.02	9.00	0.5760

Site number	Date	Sample number	Hg (ug/l)	Mo (ug/l)	Ni (ug/l)	Pb (ug/l)	V (ug/l)	Zn (ug/l)	Zr (ug/l)
SSM000022	2007-03-28	11797	0.0020	12.8	0.659	0.115	0.887	1.14	1.66
SSM000022	2007-05-22	11847	0.0020	11.7	0.627	0.103	0.860	1.12	0.416
SSM000022	2007-09-06	15106	0.0020	11.5	0.194	0.059	0.807	0.520	0.856
SSM000022	2007-12-06	15223	–	–	–	–	–	–	–
SSM000030	2007-03-20	11777	0.0020	0.724	2.12	0.104	3.93	2.03	3.48
SSM000030	2007-05-24	11888	0.0020	0.722	0.693	0.142	3.72	2.43	1.47
SSM000030	2007-09-04	15101	0.0020	0.562	0.459	0.105	3.65	3.58	1.34
SSM000030	2007-12-04	15218	–	–	–	–	–	–	–
SSM000037	2007-03-20	11778	0.0020	1.37	0.941	0.144	1.69	2.02	1.73
SSM000037	2007-05-27	11889	0.0020	1.50	0.531	0.092	1.64	1.94	0.713
SSM000037	2007-09-04	15103	0.0020	1.33	0.802	0.329	2.60	3.17	1.05
SSM000037	2007-12-04	15219	–	–	–	–	–	–	–
SSM000041	2007-03-22	11793	0.0020	0.441	6.05	2.93	7.52	14.4	6.49
SSM000041	2007-05-22	11848	0.0020	0.638	4.88	0.680	3.12	9.99	2.00
SSM000041	2007-09-06	15104	0.0020	0.364	7.20	1.55	4.85	27.7	2.31
SSM000041	2007-12-06	15221	–	–	–	–	–	–	–
SSM000042	2007-03-28	11798	0.0020	1.53	1.670	0.345	2.63	3.00	2.10
SSM000042	2007-05-22	11849	0.0020	1.43	0.889	0.482	2.95	4.18	1.35
SSM000042	2007-09-06	15105	0.0020	1.58	0.979	0.274	2.32	3.57	1.23
SSM000042	2007-12-06	15222	–	–	–	–	–	–	–
SSM000228	2007-03-22	11794	0.0020	0.446	1.02	0.528	8.05	2.76	4.80
SSM000228	2007-05-24	11890	0.0020	0.593	1.14	0.369	8.35	3.99	2.02
SSM000228	2007-09-04	15102	0.0020	0.759	0.781	0.235	7.99	2.43	2.10
SSM000228	2007-12-04	15220	–	–	–	–	–	–	–
SSM000240	2007-04-03	11805	0.0060	0.453	0.625	0.328	4.72	3.62	3.75
SSM000240	2007-05-30	11903	0.0020	0.396	0.224	0.148	4.52	1.40	1.70
SSM000240	2007-09-12	15107	0.0023	0.403	0.112	0.062	4.02	0.501	1.67
SSM000240	2007-12-19	15224	–	–	–	–	–	–	–
SSM000241	2007-04-04	11806	0.0020	0.500	2.09	1.40	16.3	24.8	20.0
SSM000241	2007-05-31	11904	0.0020	0.500	3.37	0.600	16.5	5.52	12.5
SSM000241	2007-09-13	15108	0.0020	0.500	1.63	0.311	12.4	2.17	14.1
SSM000260	2007-03-20	11779	0.0020	0.576	0.729	0.929	2.47	3.12	1.43
SSM000261	2007-03-20	11780	0.0020	0.480	5.84	7.63	12.3	24.7	6.58
SSM000262	2007-03-22	11795	0.0020	0.803	3.17	0.338	5.53	12.3	1.67
SSM000263	2007-03-22	11796	0.0020	2.71	2.43	1.09	2.63	3.92	2.32

Site number	Date	Sample number	U (ug/l)	Th (ug/l)	Sc (ug/l)	Rb (ug/l)	Y (ug/l)	Sb (ug/l)	Cs (ug/l)	La (ug/l)
SSM000022	2007-03-28	11797	2.84	0.056	0.050	2.10	0.492	0.0358	0.0300	0.352
SSM000022	2007-05-22	11847	2.44	0.024	0.050	1.82	0.419	0.0271	0.0300	0.330
SSM000022	2007-09-06	15106	2.61	0.088	0.050	2.30	0.489	0.0218	0.0331	0.376
SSM000022	2007-12-06	15223	–	–	–	–	–	–	–	–
SSM000030	2007-03-20	11777	0.086	0.063	0.050	4.75	0.497	0.0250	0.343	0.297
SSM000030	2007-05-24	11888	0.112	0.101	0.050	4.10	0.575	0.0210	0.321	0.498
SSM000030	2007-09-04	15101	0.123	0.067	0.050	5.33	0.636	0.0174	0.366	0.550
SSM000030	2007-12-04	15218	–	–	–	–	–	–	–	–
SSM000037	2007-03-20	11778	0.830	0.124	0.053	2.71	1.46	0.0303	0.0503	1.99
SSM000037	2007-05-27	11889	0.688	0.083	0.051	2.92	1.57	0.0347	0.0507	2.11
SSM000037	2007-09-04	15103	0.699	0.184	0.050	4.32	1.90	0.0369	0.160	3.29
SSM000037	2007-12-04	15219	–	–	–	–	–	–	–	–
SSM000041	2007-03-22	11793	0.657	1.81	0.824	9.84	7.86	0.0605	0.551	14.40
SSM000041	2007-05-22	11848	0.356	0.498	0.262	5.84	3.98	0.0452	0.215	6.01
SSM000041	2007-09-06	15104	0.557	1.040	0.528	8.46	6.53	0.0423	0.410	11.10
SSM000041	2007-12-06	15221	–	–	–	–	–	–	–	–
SSM000042	2007-03-28	11798	0.928	0.260	0.149	3.82	3.13	0.0198	0.189	4.55
SSM000042	2007-05-22	11849	1.00	0.404	0.181	3.89	3.13	0.0245	0.226	5.24
SSM000042	2007-09-06	15105	1.06	0.427	0.096	5.31	2.98	0.0226	0.202	4.56
SSM000042	2007-12-06	15222	–	–	–	–	–	–	–	–
SSM000228	2007-03-22	11794	0.993	0.552	0.434	2.08	9.50	0.0760	0.0726	11.5
SSM000228	2007-05-24	11890	0.922	0.396	0.422	1.98	8.75	0.0486	0.0622	10.2
SSM000228	2007-09-04	15102	1.70	0.281	0.370	2.21	8.85	0.0507	0.0600	11.3
SSM000228	2007-12-04	15220	–	–	–	–	–	–	–	–
SSM000240	2007-04-03	11805	0.374	0.063	0.050	8.32	0.974	0.159	0.528	0.419
SSM000240	2007-05-30	11903	0.373	0.072	0.050	8.76	0.836	0.108	0.498	0.329
SSM000240	2007-09-12	15107	0.362	0.045	0.050	11.8	0.829	0.221	0.845	0.313
SSM000240	2007-12-19	15224	–	–	–	–	–	–	–	–
SSM000241	2007-04-04	11806	0.040	0.200	0.050	59.3	0.180	–	2.11	0.172
SSM000241	2007-05-31	11904	0.492	0.200	0.050	58.6	0.331	1.19	1.94	0.138
SSM000241	2007-09-13	15108	0.069	0.200	0.050	61.8	0.311	0.431	2.26	0.105
SSM000260	2007-03-20	11779	0.227	0.329	0.069	3.31	1.16	0.0747	0.234	1.76
SSM000261	2007-03-20	11780	4.80	1.60	0.618	8.90	8.93	0.163	0.470	14.3
SSM000262	2007-03-22	11795	1.37	0.167	0.117	2.29	1.04	2.21	0.199	0.659
SSM000263	2007-03-22	11796	1.59	0.620	0.176	11.3	1.72	0.114	0.145	2.72

Site number	Date	Sample number	Hf (ug/l)	Tl (ug/l)	Ce (ug/l)	Pr (ug/l)	Nd (ug/l)	Sm (ug/l)	Eu (ug/l)	Gd (ug/l)
SSM000022	2007-03-28	11797	0.115	0.0050	0.588	0.0885	0.361	0.0583	0.0079	0.0628
SSM000022	2007-05-22	11847	0.0050	0.0050	0.550	0.0739	0.323	0.0513	0.0079	0.0576
SSM000022	2007-09-06	15106	0.0114	0.0050	0.605	0.0837	0.362	0.0639	0.0090	0.0622
SSM000022	2007-12-06	15223	–	–	–	–	–	–	–	–
SSM000030	2007-03-20	11777	0.264	0.0050	0.581	0.0767	0.335	0.0667	0.0131	0.0670
SSM000030	2007-05-24	11888	0.0266	0.0050	0.976	0.117	0.493	0.0920	0.0159	0.0961
SSM000030	2007-09-04	15101	0.0226	0.0050	0.979	0.123	0.506	0.0903	0.0174	0.0964
SSM000030	2007-12-04	15218	–	–	–	–	–	–	–	–
SSM000037	2007-03-20	11778	0.130	0.0057	3.44	0.436	1.82	0.296	0.0452	0.290
SSM000037	2007-05-27	11889	0.0174	0.0050	3.60	0.420	1.78	0.295	0.0429	0.293
SSM000037	2007-09-04	15103	0.0304	0.0070	5.28	0.655	2.59	0.437	0.0677	0.410
SSM000037	2007-12-04	15219	–	–	–	–	–	–	–	–
SSM000041	2007-03-22	11793	0.198	0.0559	28.5	3.67	14.5	2.47	0.354	1.95
SSM000041	2007-05-22	11848	0.0631	0.0154	11.6	1.49	6.27	1.04	0.151	0.886
SSM000041	2007-09-06	15104	0.0811	0.0399	20.0	2.94	11.5	1.97	0.285	1.57
SSM000041	2007-12-06	15221	–	–	–	–	–	–	–	–
SSM000042	2007-03-28	11798	0.0563	0.0066	6.45	0.907	3.85	0.609	0.0929	0.578
SSM000042	2007-05-22	11849	0.0401	0.0065	7.82	1.07	4.42	0.720	0.109	0.673
SSM000042	2007-09-06	15105	0.0355	0.0066	6.77	0.965	3.91	0.673	0.0975	0.620
SSM000042	2007-12-06	15222	–	–	–	–	–	–	–	–
SSM000228	2007-03-22	11794	0.169	0.0068	21.4	2.72	11.5	1.84	0.323	1.79
SSM000228	2007-05-24	11890	0.0642	0.0050	21.2	2.35	10.4	1.67	0.293	1.70
SSM000228	2007-09-04	15102	0.0702	0.0050	19.5	2.54	11.2	1.84	0.319	1.79
SSM000228	2007-12-04	15220	–	–	–	–	–	–	–	–
SSM000240	2007-04-03	11805	0.0675	0.0050	0.740	0.103	0.472	0.0996	0.0156	0.113
SSM000240	2007-05-30	11903	0.0315	0.0050	0.642	0.0850	0.390	0.0891	0.0167	0.0951
SSM000240	2007-09-12	15107	0.0310	0.0050	0.535	0.0749	0.367	0.0759	0.0099	0.0984
SSM000240	2007-12-19	15224	–	–	–	–	–	–	–	–
SSM000241	2007-04-04	11806	0.144	0.0500	0.117	0.0500	0.064	0.0500	0.0500	0.0500
SSM000241	2007-05-31	11904	0.102	0.0050	0.178	0.0500	0.123	0.0500	0.0500	0.0500
SSM000241	2007-09-13	15108	0.0965	0.0050	0.189	0.0500	0.118	0.0500	0.0500	0.0500
SSM000260	2007-03-20	11779	0.0327	0.0050	3.29	0.379	1.57	0.229	0.0356	0.221
SSM000261	2007-03-20	11780	0.191	0.0463	34.2	3.42	13.0	2.33	0.326	1.93
SSM000262	2007-03-22	11795	0.0328	0.0085	1.21	0.166	0.652	0.126	0.0197	0.136
SSM000263	2007-03-22	11796	0.0780	0.0112	5.26	0.616	2.51	0.434	0.0555	0.404

Site number	Date	Sample number	Tb (ug/l)	Dy (ug/l)	Ho (ug/l)	Er (ug/l)	Tm (ug/l)	Yb (ug/l)	Lu (ug/l)
SSM000022	2007-03-28	11797	0.0078	0.0518	0.0113	0.0386	0.0050	0.0350	0.0059
SSM000022	2007-05-22	11847	0.0066	0.0444	0.0103	0.0312	0.0050	0.0313	0.0051
SSM000022	2007-09-06	15106	0.0081	0.0523	0.0121	0.0376	0.0054	0.0351	0.0076
SSM000022	2007-12-06	15223	–	–	–	–	–	–	–
SSM000030	2007-03-20	11777	0.0092	0.0660	0.0151	0.0552	0.0084	0.0637	0.0142
SSM000030	2007-05-24	11888	0.0119	0.0725	0.0172	0.0595	0.0091	0.0656	0.0179
SSM000030	2007-09-04	15101	0.0130	0.0839	0.0198	0.0630	0.0101	0.0753	0.0166
SSM000030	2007-12-04	15218	–	–	–	–	–	–	–
SSM000037	2007-03-20	11778	0.0315	0.186	0.0374	0.113	0.0140	0.0971	0.0166
SSM000037	2007-05-27	11889	0.0322	0.182	0.0379	0.115	0.0148	0.0952	0.0179
SSM000037	2007-09-04	15103	0.0493	0.277	0.0577	0.166	0.0232	0.151	0.0280
SSM000037	2007-12-04	15219	–	–	–	–	–	–	–
SSM000041	2007-03-22	11793	0.229	1.31	0.234	0.705	0.0936	0.663	0.102
SSM000041	2007-05-22	11848	0.099	0.578	0.114	0.338	0.0462	0.341	0.0583
SSM000041	2007-09-06	15104	0.188	1.00	0.2070	0.587	0.0840	0.579	0.0960
SSM000041	2007-12-06	15221	–	–	–	–	–	–	–
SSM000042	2007-03-28	11798	0.0650	0.382	0.0747	0.234	0.0288	0.204	0.0407
SSM000042	2007-05-22	11849	0.0718	0.434	0.0872	0.246	0.0324	0.215	0.0362
SSM000042	2007-09-06	15105	0.0702	0.386	0.0838	0.244	0.0333	0.210	0.0373
SSM000042	2007-12-06	15222	–	–	–	–	–	–	–
SSM000228	2007-03-22	11794	0.195	1.19	0.244	0.751	0.0986	0.694	0.114
SSM000228	2007-05-24	11890	0.179	1.03	0.227	0.696	0.0907	0.632	0.106
SSM000228	2007-09-04	15102	0.213	1.18	0.261	0.781	0.108	0.714	0.129
SSM000228	2007-12-04	15220	–	–	–	–	–	–	–
SSM000240	2007-04-03	11805	0.0150	0.106	0.0250	0.0895	0.0136	0.108	0.0209
SSM000240	2007-05-30	11903	0.0135	0.0917	0.0222	0.0783	0.0121	0.0925	0.0175
SSM000240	2007-09-12	15107	0.0137	0.0905	0.0234	0.0804	0.0127	0.0995	0.0200
SSM000240	2007-12-19	15224	–	–	–	–	–	–	–
SSM000241	2007-04-04	11806	0.0500	0.0500	0.0500	0.121	0.0500	0.0500	0.0500
SSM000241	2007-05-31	11904	0.0500	0.0500	0.0500	0.0629	0.0500	0.0500	0.0500
SSM000241	2007-09-13	15108	0.0500	0.0500	0.0500	0.0681	0.0500	0.0500	0.0500
SSM000260	2007-03-20	11779	0.0274	0.158	0.0313	0.0943	0.0126	0.0838	0.0139
SSM000261	2007-03-20	11780	0.278	1.55	0.290	0.789	0.111	0.719	0.0993
SSM000262	2007-03-22	11795	0.0178	0.115	0.0240	0.0921	0.0118	0.0997	0.0183
SSM000263	2007-03-22	11796	0.0483	0.282	0.0517	0.156	0.0205	0.142	0.0217

Site number	Date	Sample number	$\delta^2\text{H}$ (‰ VSMOW)	^3H (TU)	$\delta^{18}\text{O}$ (‰ VSMOW)	$^{10}\text{B}/^{11}\text{B}$ (atomic)
SSM000022	2007-03-28	11797	-77.2	1.20	-10.50	0.2372
SSM000022	2007-05-22	11847	-77.0	1.90	-10.60	0.2378
SSM000022	2007-09-06	15106	-78.3	1.58	-10.60	0.2217
SSM000022	2007-12-06	15223	-77.4	1.80	-10.60	0.2361
SSM000030	2007-03-20	11777	-76.7	9.00	-10.80	0.2371
SSM000030	2007-05-24	11888	-77.1	8.20	-10.80	0.2390
SSM000030	2007-09-04	15101	-82.2	7.63	-11.00	0.2238
SSM000030	2007-12-04	15218	-76.7	8.70	-11.00	0.2393
SSM000037	2007-03-20	11778	-79.7	6.90	-11.00	0.2368
SSM000037	2007-05-27	11889	-78.3	6.80	-11.00	0.2386
SSM000037	2007-09-04	15103	-78.5	6.63	-10.90	0.2225
SSM000037	2007-12-04	15219	-76.8	7.60	-10.80	0.2395
SSM000041	2007-03-22	11793	-78.5	8.90	-11.00	0.2386
SSM000041	2007-05-22	11848	-78.9	10.30	-11.00	0.2420
SSM000041	2007-09-06	15104	-78.5	9.19	-10.90	0.2239
SSM000041	2007-12-06	15221	-77.9	8.90	-10.90	0.2393
SSM000042	2007-03-28	11798	-78.0	8.20	-10.80	0.2348
SSM000042	2007-05-22	11849	-77.5	8.50	-10.80	0.2390
SSM000042	2007-09-06	15105	-77.8	6.81	-10.80	0.2210
SSM000042	2007-12-06	15222	-77.2	8.20	-10.70	0.2381
SSM000228	2007-03-22	11794	-79.1	8.30	-11.00	0.2354
SSM000228	2007-05-24	11890	-78.5	8.90	-10.80	0.2385
SSM000228	2007-09-04	15102	-81.0	9.62	-10.70	0.2222
SSM000228	2007-12-04	15220	-76.1	9.60	-10.70	0.2369
SSM000240	2007-04-03	11805	-75.8	8.50	-10.40	0.2385
SSM000240	2007-05-30	11903	-74.6	10.10	-10.20	0.2380
SSM000240	2007-09-12	15107	-75.9	9.35	-10.20	0.2239
SSM000240	2007-12-19	15224	-73.9	8.10	-10.20	0.2382
SSM000241	2007-04-04	11806	-65.1	2.00	-8.60	-
SSM000241	2007-05-31	11904	-64.7	1.90	-8.50	0.2408
SSM000241	2007-09-13	15108	-64.9	-0.80	-8.80	0.2285
SSM000260	2007-03-20	11779	-	-	-	0.2403
SSM000261	2007-03-20	11780	-	-	-	0.2406
SSM000262	2007-03-22	11795	-	-	-	0.2408
SSM000263	2007-03-22	11796	-	-	-	0.2375

Site number	Date	Sample number	NH ₄ -N (mg/l)	NO ₂ -N (mg/l)	NO ₂ /NO ₃ -N (mg/l)	NO ₃ -N (mg/l)	N-tot (mg/l)	P-tot (mg/l)
SSM000022	2007-03-28	11797	0.552	0.0078	0.141	0.133	0.836	0.0157
SSM000022	2007-05-22	11847	0.693	0.0186	0.0315	0.0129	0.876	0.0193
SSM000022	2007-09-06	15106	0.733	0.0002	0.0003	0.0003	0.859	0.0154
SSM000022	2007-12-06	15223	0.707	0.0003	0.0013	0.0011	0.851	0.0148
SSM000030	2007-03-20	11777	1.73	0.0004	0.0018	0.0014	1.91	0.158
SSM000030	2007-05-24	11888	1.71	0.0018	0.0362	0.0344	1.93	0.208
SSM000030	2007-09-04	15101	1.63	0.0011	0.0063	0.0052	1.84	0.155
SSM000030	2007-12-04	15218	1.56	0.0003	0.0024	0.0021	1.77	0.154
SSM000037	2007-03-20	11778	0.191	0.0015	0.0057	0.0042	0.466	0.0141
SSM000037	2007-05-27	11889	0.263	0.0006	0.0006	0.0003	0.554	0.0236
SSM000037	2007-09-04	15103	2.66	0.0007	0.0015	0.0008	1.22	0.0765
SSM000037	2007-12-04	15219	0.685	0.0023	0.2840	0.282	0.943	0.0335
SSM000041	2007-03-22	11793	0.188	0.0006	0.0095	0.0090	0.546	0.173
SSM000041	2007-05-22	11848	0.174	0.0002	0.0029	0.0029	0.573	0.109
SSM000041	2007-09-06	15104	0.163	0.0010	0.0046	0.0036	0.500	0.136
SSM000041	2007-12-06	15221	0.205	0.0002	0.0017	0.0016	0.512	0.118
SSM000042	2007-03-28	11798	0.270	0.0002	0.0038	0.0036	0.666	0.144
SSM000042	2007-05-22	11849	0.274	0.0002	0.0003	0.0003	0.532	0.0180
SSM000042	2007-09-06	15105	0.329	0.0015	0.0024	0.0009	0.552	0.0128
SSM000042	2007-12-06	15222	0.262	0.0002	0.0009	0.0007	0.525	0.0443
SSM000228	2007-03-22	11794	0.124	0.0005	0.0050	0.0045	0.452	0.0148
SSM000228	2007-05-24	11890	0.115	0.0003	0.0006	0.0003	0.440	0.0107
SSM000228	2007-09-04	15102	0.135	0.0005	0.0005	0.0003	0.434	0.0100
SSM000228	2007-12-04	15220	0.125	0.0003	0.0008	0.0005	0.424	0.0100
SSM000240	2007-04-03	11805	1.44	0.0003	0.0004	0.0003	1.59	0.239
SSM000240	2007-05-30	11903	2.85	0.0003	0.0006	0.0004	2.94	1.82
SSM000240	2007-09-12	15107	1.68	0.0002	0.0004	0.0003	2.14	0.129
SSM000240	2007-12-19	15224	1.65	0.0008	0.0007	0.0003	2.09	0.0738
SSM000241	2007-04-04	11806	627	0.0125	0.0128	0.0003	638	15.0
SSM000241	2007-05-31	11904	626	0.0011	0.0027	0.0016	625	31.9
SSM000241	2007-09-13	15108	625	0.0004	0.0026	0.0022	655	29.6
SSM000260	2007-03-20	11779	0.873	0.0278	0.420	0.392	1.90	0.204
SSM000261	2007-03-20	11780	12.6	0.0009	0.0026	0.0017	5.40	0.992
SSM000262	2007-03-22	11795	1.80	0.371	0.642	0.271	2.18	0.168
SSM000263	2007-03-22	11796	0.174	0.0071	2.33	2.32	3.01	0.255

Site number	Date	Sample number	PO ₄ -P (mg/l)	POP (mg/l)	PON (mg/l)	POC (mg/l)	TOC (mg/l)	DOC (mg/l)	SiO ₄ -Si (mg/l)
SSM000022	2007-03-28	11797	0.0100	0.0006	0.0113	0.0760	5.1	5.3	–
SSM000022	2007-05-22	11847	0.0143	0.0040	0.0321	0.207	5.3	5.5	–
SSM000022	2007-09-06	15106	0.0151	0.0004	0.0051	0.0200	5.1	5.2	–
SSM000022	2007-12-06	15223	0.0129	0.0006	0.0054	0.124	5.2	5.3	4.96
SSM000030	2007-03-20	11777	0.0703	0.0229	0.0471	0.432	9.0	8.8	–
SSM000030	2007-05-24	11888	0.0667	0.0103	0.0646	0.568	8.7	8.7	–
SSM000030	2007-09-04	15101	0.0810	0.0032	0.0272	0.279	8.8	8.8	–
SSM000030	2007-12-04	15218	0.0474	0.0056	0.0355	0.375	9.0	8.3	7.56
SSM000037	2007-03-20	11778	0.0035	0.0066	0.0205	0.241	6.4	6.2	–
SSM000037	2007-05-27	11889	0.0040	0.0058	0.0304	0.411	7.0	7.4	–
SSM000037	2007-09-04	15103	0.122	0.0258	0.141	0.965	7.3	9.6	–
SSM000037	2007-12-04	15219	0.0121	0.0129	0.119	0.876	6.7	6.4	9.67
SSM000041	2007-03-22	11793	0.0105	0.0829	0.126	1.46	10.0	9.8	–
SSM000041	2007-05-22	11848	0.0104	0.0788	0.0699	1.22	9.9	9.5	–
SSM000041	2007-09-06	15104	–	0.111	0.103	1.46	10.0	10.0	–
SSM000041	2007-12-06	15221	0.0108	0.0444	0.0448	0.665	9.4	9.3	9.97
SSM000042	2007-03-28	11798	0.0005	0.0608	0.0867	1.51	5.7	5.8	–
SSM000042	2007-05-22	11849	0.0005	0.0250	0.0780	1.40	5.7	6.2	–
SSM000042	2007-09-06	15105	0.0031	0.0149	0.0539	1.31	6.4	6.9	–
SSM000042	2007-12-06	15222	0.0005	0.0316	0.0423	1.11	6.1	6.6	8.50
SSM000228	2007-03-22	11794	0.0039	0.0054	0.0240	0.251	13.9	13.1	–
SSM000228	2007-05-24	11890	0.0035	0.0006	0.0078	0.0720	11.4	13.2	–
SSM000228	2007-09-04	15102	0.0222	0.0016	0.0097	0.0950	12.3	13.4	–
SSM000228	2007-12-04	15220	0.0042	0.0009	0.0031	0.0370	12.2	13.9	9.60
SSM000240	2007-04-03	11805	0.196	0.0078	0.0545	0.419	10.1	10.6	–
SSM000240	2007-05-30	11903	2.15	0.0015	0.0065	0.0550	10.3	10.4	8.44
SSM000240	2007-09-12	15107	0.127	0.0005	0.0093	0.0110	10.2	10.2	–
SSM000240	2007-12-19	15224	0.0267	0.0003	0.0035	0.0150	9.7	9.8	–
SSM000241	2007-04-04	11806	14.3	0.0537	0.310	1.60	79.7	77.8	–
SSM000241	2007-05-31	11904	30.8	0.0142	0.152	1.37	111.0	106.0	22.8
SSM000241	2007-09-13	15108	29.7	0.0055	0.0443	0.4350	73.9	72.3	–
SSM000260	2007-03-20	11779	0.0609	–	–	–	8.7	9.5	9.68
SSM000261	2007-03-20	11780	0.472	–	–	–	13.1	11.5	12.4
SSM000262	2007-03-22	11795	0.0594	–	–	–	12.6	12.6	10.2
SSM000263	2007-03-22	11796	0.168	–	–	–	8.6	8.8	8.26

Primary results – field analysis

Site number	Date	Sample number	Water depth (m)	Water temperature (°C)	pH
SSM000022	2007-03-28	11797	–	6.5	7.91
SSM000022	2007-05-22	11847	0.76	11.0	7.79
SSM000022	2007-09-06	15106	0.88	11.7	6.95
SSM000022	2007-12-06	15223	0.58	7.9	7.15
SSM000030	2007-03-20	11777	–	8.5	7.53
SSM000030	2007-05-24	11888	1.62	11.7	7.10
SSM000030	2007-09-04	15101	1.59	9.8	6.80
SSM000030	2007-12-04	15218	1.39	6.0	6.99
SSM000037	2007-03-20	11778	–	7.9	7.39
SSM000037	2007-05-27	11889	1.54	12.9	7.31
SSM000037	2007-09-04	15103	1.41	12.1	6.99
SSM000037	2007-12-04	15219	1.90	5.3	6.95
SSM000041	2007-03-22	11793	–	5.4	7.20
SSM000041	2007-05-22	11848	1.93	12.1	7.55
SSM000041	2007-09-06	15104	1.93	12.2	6.35
SSM000041	2007-12-06	15221	1.39	7.5	6.20
SSM000042	2007-03-28	11798	–	6.0	7.40
SSM000042	2007-05-22	11849	2.09	12.1	7.51
SSM000042	2007-09-06	15105	2.11	13.1	6.59
SSM000042	2007-12-06	15222	1.36	8.0	6.62
SSM000228	2007-03-22	11794	–	6.4	7.35
SSM000228	2007-05-24	11890	2.87	11.3	7.25
SSM000228	2007-09-04	15102	2.85	9.7	6.80
SSM000228	2007-12-04	15220	2.53	7.0	6.91
SSM000240	2007-04-03	11805	–	8.4	7.37
SSM000240	2007-05-30	11903	1.28	17.5	7.61
SSM000240	2007-09-12	15107	1.19	15.1	7.04
SSM000240	2007-12-19	15224	1.30	6.1	6.95
SSM000241	2007-04-04	11806	–	10.1	7.32
SSM000241	2007-05-31	11904	–	18.3	6.96
SSM000241	2007-09-13	15108	2.15	16.4	6.50
SSM000260	2007-03-20	11779	–	9.1	7.60
SSM000261	2007-03-20	11780	–	7.1	8.00
SSM000262	2007-03-22	11795	–	7.8	7.50
SSM000263	2007-03-22	11796	–	6.9	7.30