

Oskarshamn site investigation

Monitoring of precipitation water chemistry 2009

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August 2010

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Abstract

Sampling and analysis of precipitation was performed from January to December 2009 in a small forest clearing at Äspö. The purpose of this activity was to monitor chemical compounds in the precipitation within the site investigation area at Oskarshamn.

The precipitation was collected in samplers placed two to ten meters apart in an area with a diameter of approximately 25 meter. The samplers were emptied weekly, the total water volume was measured and if enough water it was stored in one “general sample” and one “point sample” (Chapter 4.2). Water from six of the weekly periods (point samples) was sent for full analysis (anions and major cations (Chapter 4.1), alkalinity, pH, electric conductivity, isotopes, heavy metals, trace elements and lanthanides) to different laboratories. Water from the rest of the periods were analysed for anions, alkalinity, pH and electric conductivity if precipitation had occurred. General samples composed of water from each week in each quarter of a year were analysed for isotopes.

Calculations of ion balances showed a relatively great imbalance in four of the point samples (more than 10% relative error). One explanation might be that the concentrations of many of the ions were close to or below the detection limits which could cause calculation errors.

The weighted average concentration of some of the ions and of pH was compared to results from a national monitoring station for depositions in south east Sweden. The comparison shows that the concentrations of ions were generally higher at Äspö. The average of pH was similar though. The main reason for higher concentration of ions is probably that the Äspö station is situated very close to the sea with a greater influx of sea salt. A corrected average of SO₄-S (which excludes the part of sulphur that originates from sea salt) at Äspö was more similar to the other station in south east Sweden.

The hydrogen isotope ratio of $\delta^2\text{H}$ (deuterium) varied with a small tendency of highest ratio in the autumn. The ratios of $\delta^2\text{H}$ did not correlate well with the ratios of $\delta^{18}\text{O}$ and the reason for this is difficult to interpret. The values of ^3H (tritium) varied with a small tendency for lower values in the autumn and winter.

Some nonconformities occurred. The analysis of HCO₃ (alkalinity) was not performed on every occasion, due to very low pH. The results from two of the weekly sampling periods were incorrect and error marked in Sicada. Some analysis could not be performed due to lack of water in three point samples; (Cl, SO₄, Br and F), (heavy metals, trace elements and lanthanides) and ^3H (tritium).

Sammanfattning

Provtagning och analys av nederbörd från Äspö har utförts från januari till december 2009. Syftet med undersökningarna var att återkommande analysera nederbördens kemiska sammansättning inom området för platsundersökningen i Oskarshamn.

Nederbörden samlades in i behållare som slumpmässigt placerats inom ett område med en diameter på ca 25 m. Behållarna tömdes regelbundet varje vecka, den totala volymen mättes och om det gav tillräckligt med vatten sparades det i ett "samlingsprov" och ett "punktprov" (kapitel 4.2). Vatten från sex av veckoperioderna (punktprover) skickades för analys av samtliga parametrar (anjoner och vanliga katjoner, alkalinitet, pH, elektrisk konduktivitet, isotoper samt tungmetaller, spårelement och lantanoider). Vatten från övriga veckor analyserades på anjoner, alkalinitet, pH och elektrisk konduktivitet om det fanns vatten tillräckligt för analys. Kvartalsvisa samlingsprover med vatten från varje vecka analyserades också på isotoper.

Beräkningar av jonbalanserna visade på relativt stora avvikelser (mer än 10 % relativt fel) i fyra av punktproverna. En förklaring kan vara att koncentrationen av många av jonerna var under eller nära detektionsgränsen vilket kan orsaka fel i beräkningarna.

Viktade medelvärden av några av de undersökta jonerna samt av pH jämfördes med resultat från en station i sydöstra Sverige som ingår i det nationella nederbörds-kemiska nätet. Jämförelsen visar att halten av joner generellt var högre vid Äspö. Medelvärdena av pH var dock relativt lika. Den huvudsakliga orsaken till skillnaden i jonkoncentration är sannolikt närheten till havet. Ett beräknat korrigerat värde för SO₄-S (som utesluter svavel som härrör från havet) var också mer likt resultatet från stationen i sydöstra Sverige.

Väteisotopen $\delta^2\text{H}$ (deuterium) varierade mellan provtagningstillfällena med en tendens till högst kvoter under hösten. Kvoterna av $\delta^2\text{H}$ var dock relativt dåligt korrelerade med kvoterna av $\delta^{18}\text{O}$ (syre-18). Orsaken till det är svårt att ange. Även värdena för ^3H (tritium) varierade mellan provtillfällena med en svag tendens till lägre värden under hösten och vintern.

Några avvikelser från vad som planerats har förekommit under året. HCO₃ (alkalinitet) analyserades inte vid flera tillfällen på grund av för låga pH-värden. Resultaten från två provtagningsperioder var felaktiga och felmarkerades i Sicada. Några analyser kunde inte genomföras på grund av för lite vatten i tre av punktproven; (Cl, SO₄, Br och F), (tungmetaller, spårelement och lantanoider) samt ^3H (tritium).

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1 Introduction

This document reports the results gained by the sampling and analysis of precipitation during 2009, 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 400-09-001. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

The aim of the activity was to measure chemical substances in the precipitation (rain and snow). These data will be a part of the data needed to describe the circulation of water and water transported substances in the investigation area. The sampling was performed at the site PSM001516 at Äspö (Figure 1-1). All data generated was stored in the SKB database Sicada. The data is traceable by the activity plan number.

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

Activity plan	Number	Version
Hydrokemisk monitoring av nederbörd 2009	AP PS 400-09-001	1.0
Method descriptions	Number	Version
Metodbeskrivning för provtagning och analys av nederbörd	SKB MD 423.003	2.0

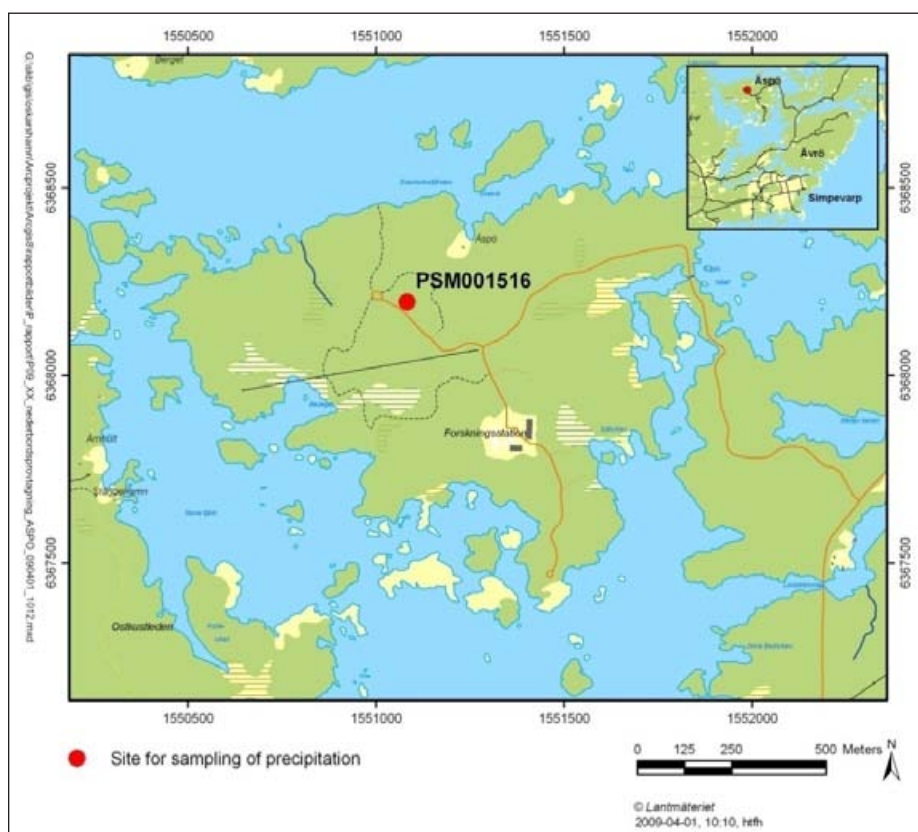


Figure 1-1. Site for sampling of precipitation (PSM001516) at the island of Äspö. Coordinates for the site is N 6368196; E 1551083 (RT90/RHB70).

2 Objective and scope

The purpose of this activity was to measure the bulk deposition, i.e. chemical compounds in the precipitation, within the site investigation area at Oskarshamn (the parameters measured in the samples are presented in Table 4-1). The method used is designed to measure precipitation in an open field and in undisturbed conditions. Samples for analysis were to be taken once every week provided enough water was present. After the sampling of water the samplers were completely emptied.

The measurements and analysis performed aimed to give results of high quality from an undisturbed site. According to the method description (Table 1-1) the relative error in the ion balance should be less than 10%.

3 Equipment

Five samplers were placed in a forest clearing approximately two meter above the ground (Figure 3-1). Exact location with coordinates for the different samplers is given in Table 3-1. The samplers were placed two to ten meters apart in an area with a diameter of approximately 25 meter. The total volume caught in the samplers in each sampling period was treated as one sample to ensure that enough water was caught for all analysis planned. The number of functional samplers at the site was five.

In the summer season the “NILU Precipitation Collector” was used. This is essentially a can with a funnel with a diameter of 20 cm (Figure 3-2). In winter the “NILU Particulate Fallout Collector”, essentially a bucket, with a diameter of 20 cm was used (Figure 3-1). The can and the bucket could hold a maximum volume of 2.5 litres and 12.5 litres respectively. The samplers were emptied weekly into one or two five litres plastic container that was used to transport the mixed sample to the laboratory. At the laboratory a graduated glass was used to measure the total volumes of water in the sample. Later the sample was divided into smaller bottles before delivery to the different analysing laboratories. When the sample was divided into smaller bottles the water for analysis of major cations (Chapter 4.1) were filtrated with a membrane filter (0.45 μm).

Table 3-1. Location of PSM001516 with coordinates for the individual samplers (RT90/RHB70).

ID-code	Northing X (m)	Easting Y (m)
1	6368197.483	1551079.054
2	6368194.742	1551080.070
3	6368195.975	1551082.957
4	6368192.689	1551081.771
5	6368192.513	1551087.517



Figure 3-1. The sampler used in winter at the site for sampling of precipitation at the island of Äspö.



Figure 3-2. The sampler used in summer at the site for sampling of precipitation at the island of Äspö.

4 Execution

4.1 General

The precipitation was collected in samplers placed two to ten meters apart in an area with a diameter of approximately 25 meter. The samplers were emptied weekly, the total water volume was measured and if enough water was present it was stored in one “general sample” and one “point sample” (Chapter 4.2). Six point samples were sent for full analysis (anions and major cations (Na, K, Ca, Mg, Fe, Mn, Li, Si, Sr), alkalinity, pH, electric conductivity and isotopes) to different laboratories. As an addition analysis of heavy metals, trace elements and lanthanides were performed. However, due to lack of water full analysis were not performed on two of the point samples (see Chapter 4.5). Water from the rest of the weekly periods were analysed for anions, alkalinity, pH and electric conductivity if enough precipitation had occurred. For two of these point samples all the results were error marked in the Sicada database (see Chapter 4.5). The work was performed in accordance to the SKB MD 423.003 (Table 1-1).

4.2 Execution of field work

The precipitation was collected in samplers placed in a small forest clearing at Äspö (Figure 1-1, 3-1 and 3-2). The sampler were emptied regularly each week and if the precipitation had been large enough water was stored in one “general sample” and one “point sample” (see below). The total volume gathered from the samplers was measured with a graduated glass. If the samplers contained snow or ice the volume was measured at the laboratory with a graduated glass after melting. Notes on the handling of the samples were kept in a diary. In total precipitation was measured in 49 weekly periods during 2009.

Approximately 20% of the sample from each week was assembled to a so called “general sample”. The general sample was stored in a refrigerator and samples from each week were added for three months (one quarter of a year) before the sample was sent for analysis (Table 4-1). Care was taken to minimize the volume of air in the storage container by using a succession of larger containers as the sample volume grew.

In each week the rest of the sample was saved as a so called “point sample”. If the volume of the “point sample” was larger than 250 ml, but smaller than 2.2 litres the sample was marked with SKB number. Bottles for “quick analysis” (electric conductivity, pH, Cl, SO₄, Br, and F) were immediately delivered to the Äspö laboratory. The rest of the sample was, according to the priority order (Chapter 4.3), filled into smaller bottles and stored in a refrigerator marked with date, week and volume until a decision was made on which analysis to perform or if analysis should be performed at all (Table 4-1). When the bottle for analysis of tritium was filled it was overflowed one to three times depending on the amount of water available.

If the “point sample” was larger than 2.2 litres then 2x250 ml of the sample was marked with an SKB-number and delivered to the Äspö laboratory for “quick analysis”. The rest of the sample was, according to the priority order (Table 4-2, 4-3, 4-4 and 4-5), filled into smaller bottles and stored in a refrigerator marked with date, week and volume until a decision was made on which analysis to perform or if analysis should be performed at all. When the bottle for analysis of tritium was filled it was overflowed three times.

If the volume of the “point sample” was smaller than 250 ml litre the sample was discarded.

When decisions had been made on which “point samples” to analyse the bottles were sent to the laboratories for analysis of major cations, heavy metals, trace elements, lanthanides (Chapter 4.1) and isotopes ($\delta^2\text{H}$ (deuterium), ^3H (tritium) and $\delta^{18}\text{O}$ (oxygen-18)). During the year six “point samples”, denominated as complete samples, were analysed. Four of these contained more than 2.7 litres. Analysis of $\delta^2\text{H}$, ^3H and $\delta^{18}\text{O}$ was also performed on four general samples. Volumes from different weeks in the general sample are presented in Table 4-2, 4-3, 4-4 and 4-5. See Table 4-1, 4-2, 4-3, 4-4, 4-5 and 5-1 for information on analysis, volumes and SKB-numbers in different kind of samples.

Table 4-1. Explanations of the different kind of samples and sample numbers. Point samples are here denominated as complete samples (the complete samples and the general samples sent for analysis are highlighted).

Sample period Start	Sample period Stop	Sample number	Type of sample and analyses
2009-01-13	2009-01-20	15823	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-01-20	2009-01-29	15824	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-02-04	2009-02-10	15827	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-02-10	2009-02-18	15843	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-02-18	2009-02-24	15844	Complete sample. Anions, pH, electric conductivity, HCO₃⁻, major cations, heavy metals, trace elements, lanthanides, δ²H and δ¹⁸O
2009-02-24	2009-03-03	15845	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-03-03	2009-03-11	15855	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-03-11	2009-03-18	15870	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-03-18	2009-03-25	15871	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-03-25	2009-03-31	15872	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-01-13	2009-03-31	15873	General sample. δ²H, ³H and δ¹⁸O
2009-04-29	2009-05-06	15945	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-05-06	2009-05-13	15946	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-05-13	2009-05-20	15947	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-05-20	2009-05-27	15983	No data, sample error marked in Sicada
2009-05-27	2009-06-02	15984	No data, sample error marked in Sicada
2009-06-02	2009-06-10	15998	Complete sample. Anions, pH, electric conductivity, HCO₃⁻, major cations, heavy metals, trace elements, lanthanides, δ²H, ³H and δ¹⁸O
2009-06-10	2009-06-17	15999	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-06-17	2009-06-24	19020	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-03-31	2009-06-24	19021	General sample. δ²H, ³H and δ¹⁸O
2009-07-01	2009-07-08	19023	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-07-08	2009-07-15	19024	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-07-15	2009-07-22	19038	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-07-22	2009-07-29	19039	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-08-05	2009-08-12	19040	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-08-12	2009-08-19	19041	Complete sample. Anions, pH, electric conductivity, HCO₃⁻, major cations, heavy metals, trace elements, lanthanides, δ²H, ³H and δ¹⁸O
2009-08-19	2009-08-25	19050	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-08-25	2009-09-02	19065	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-09-02	2009-09-08	19066	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-09-22	2009-09-30	19081	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-07-01	2009-09-30	19082	General sample. δ²H, ³H and δ¹⁸O
2009-09-30	2009-10-06	19084	Complete sample. Anions, pH, electric conductivity, HCO₃⁻, major cations, heavy metals, trace elements, lanthanides, δ²H, ³H and δ¹⁸O
2009-10-06	2009-10-15	19146	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-10-15	2009-10-21	19168	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-10-21	2009-10-28	19169	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-11-03	2009-11-10	19178	Complete sample. Anions, pH, electric conductivity, HCO₃⁻, δ²H, ³H and δ¹⁸O
2009-11-10	2009-11-18	19192	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-11-18	2009-11-25	19193	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-11-25	2009-11-30	19194	Anions, pH, electric conductivity and HCO ₃ ⁻
2009-11-30	2009-12-07	19195	pH, electric conductivity and HCO ₃ ⁻
2009-12-07	2009-12-15	19196	Complete sample. Anions, pH, electric conductivity, HCO₃⁻, major cations, heavy metals, trace elements, lanthanides, δ²H, ³H and δ¹⁸O
2009-09-30	2009-12-15	19197	General sample. δ²H, ³H and δ¹⁸O

Table 4-2. Volumes from different point samples/ sampling weeks in the general sample, SKB-nr 15873.

Sample date	Sample number	Volume (ml)	Volume (%)	Comments
2009-01-20	15823	64	3.0	
2009-01-29	15824	101	4.7	
2009-02-10	15827	230	10.7	
2009-02-18	15843	434	20.2	
2009-02-24	15844	382	17.8	
2009-03-03	15845	216	10.1	
2009-03-11	15855	216	10.1	
2009-03-18	15870	125	5.8	
2009-03-25	15871	120	5.6	
2009-03-31	15872	256	11.9	

Table 4-3. Volumes from different point samples/ sampling weeks in the general sample, SKB-nr 19021.

Sample date	Sample number	Volume (ml)	Volume (%)	Comments
2009-05-06	15945	195	4.0	
2009-05-13	15946	1,170	24.1	
2009-05-20	15947	312	6.4	
2009-05-27	15983	881	18.2	
2009-06-02	15984	340	7.0	
2009-06-10	15998	1,465	30.2	
2009-06-17	15999	353	7.3	
2009-06-24	19020	135	2.8	

Table 4-4. Volumes from different point samples/ sampling weeks in the general sample, SKB-nr 19082.

Sample date	Sample number	Volume (ml)	Volume (%)	Comments
2009-07-08	19023	919	16.0	
2009-07-15	19024	208	3.6	
2009-07-22	19038	1,376	24.0	
2009-07-29	19039	352	6.1	
2009-08-05	–	24	0.4	no point sample for analysis
2009-08-12	19040	104	1.8	
2009-08-19	19041	1,070	18.7	
2009-08-25	19050	495	8.6	
2009-09-02	19065	628	11.0	
2009-09-08	19066	365	6.4	
2009-09-15	–	44	0.8	no point sample for analysis
2009-09-30	19081	142	2.5	

Table 4-5. Volumes from different point samples/ sampling weeks in the general sample, SKB-nr 19197.

Sample date	Sample number	Volume (ml)	Volume (%)	Comments
2009-10-06	19084	922	24.5	
2009-10-15	19146	344	9.1	
2009-10-21	19168	250	6.6	
2009-10-28	19169	221	5.9	
2009-11-10	19178	443	11.8	
2009-11-18	19192	420	11.2	
2009-11-25	19193	332	8.8	
2009-11-30	19194	165	4.4	
2009-12-07	19195	68	1.8	
2009-12-15	19196	600	15.9	

4.3 Handling of samples before analysis

Basically the analysis performed followed chemistry class 3 except for five of the six point samples which were analysed according to chemistry class 5 (heavy metals, trace elements, lanthanides). The method used is described in detail in SKB MD 423.003 (Table 1-1).

The handling of the samples prior to analysis with priority order, type of bottles, filtration, acidification, filling instructions and the laboratories used are shown in Table 4-6. In addition two archive samples of 250 ml were stored by SKB. The 250 ml archive samples were filtrated in a Pall filter (0.45 µm) prior to storage.

Two different ways of delivery to the laboratories were used. The samples for Äspö laboratory were delivered directly. To ALS, IFE and EIL the samples were sent by postal service (Table 4-6).

Table 4-6. Analysed components, priority, treatments of samples and analysing laboratory.

Components	Priority	Bottle/volume	Preparation of sample	Laboratory
pH, electric conductivity, HCO ₃	1	250 ml	–	Äspö laboratory
Cl, Br, SO ₄ , F	1	250 ml	filtration-Pallfilter (in connection with analysis)	Äspö laboratory
Ca, Fe, K, Mg, Na, S, Si, Li, Mn, Sr, trace elements, heavy metals, lanthanides, Se, I	4	100 ml, acid rinsed	filtration membrane filter/ acidification 1% HNO ₃	ALS Scandinavia AB
³ H	3	500 ml	dried bottle, flow over at least once	Environmental Isotope Lab at the University of Waterloo, Canada
δ ² H, δ ¹⁸ O	2	100 ml	–	Institute for Energy Technology, Norway
Archive samples	5	2 x 250 ml	filtration with pallfilter	–

4.4 Data handling and calculations

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

The precipitation (P (mm)) during the sampling periods was calculated from the collected average volume (V (ml)) and the area of the samplers (A (cm²)) by the equation $P = 10 \times V / A$.

The concentration in mg/l of SO₄-S in the precipitation was calculated as the atomic proportion of SO₄ ($[SO_4-S] = [SO_4]/96 \times 32$).

A part of the SO₄-S originates from sea salt which makes it difficult to compare the concentrations of SO₄-S from different sites at different distances from the sea. A corrected value which excludes the part that originate from sea salt was calculated from the concentration of Na ($[SO_4-S_{corr}] = [SO_4-S] - 0.0837 \times [Na]$) (concentrations in mg/l).

To compare with results from other sites in south east Sweden weighted averages were calculated on some of the ions and pH. The weighted averages were calculated as $X_m = \sum(c_i \times m_i) / \sum(m_i)$ where c_i is the concentration during a period and m_i is the precipitation during the same period.

4.5 Nonconformities

The analysis of HCO₃ (alkalinity) was not performed on every occasion, due to very low pH.

The results from two of the point samples were incorrect and error marked in Sicada (SKB-number 15983 and 15984 (Table 4-1)). These results are not included in this report.

Due to lack of water ³H (tritium) was not analysed in point sample 15844.

Due to lack of water major cations, heavy metals, trace elements and lanthanides were not analysed in point sample 19178.

Due to lack of water anions were not analysed in sample 19195.

5 Results and discussion

All data gained were stored in the SKB primary data base Sicada. The data is traceable in Sicada by the Activity Plan number (Table 1-1). Only data in Sicada are accepted for further interpretation and modelling.

The average volume collected per sampler during 2009 was 359 ml (Table 5-1). The mean calculated precipitation per sampling period was 11.4 mm. The total measured precipitation from January to December was 525.1 mm. This is probably an underestimation of the true total precipitation during this period due to evaporation from the samplers.

The complete results from the analysis are presented in the Appendix at the end of this report. The concentrations of different ions varied much between the measuring periods (Table 5-2 and Appendix). In all analysed point samples, the concentration of cations exceeded the concentration of anions and in four of them the imbalances were relatively large, indicating a possible error either in the analysis or in the handling of the samples. To test the quality of the samples the relative error in the ion balance was calculated (Table 5-3). These calculations show rather great imbalances (more than 10% relative error) in four samples. The reason for this is difficult to interpret. It cannot be explained by the lack of analysis of two major ions: NO_3 and NH_4 . In a nearby station for measurement of precipitation (Norra Kivill in the county of Kalmar) the average concentrations of $\text{NO}_3\text{-N}$ and $\text{NH}_4\text{-N}$ was 0.28 mg/l and 0.18 mg/l in 2009 /IVL 2009/. If the relation between NO_3 and NH_4 is similar at the Äspö site the imbalance would be unaltered. There might be another explanation though, the concentration of many of the ions was close to or below the detection limits which could have caused calculation errors.

Also pH and electric conductivity varied between the different measuring periods (Table 5-4 and Appendix). Some periods differ with markedly higher electric conductivity. Influx of sea water spray might be an explanation but there was no corresponding increase of the concentrations of chloride or sulphate in some of these periods (Figure 5-1 and Appendix).

To compare the results with those from national stations for monitoring deposition in south east Sweden, weighted averages was calculated on some of the ions and on pH (see Chapter 4.4). The station situated in the county of Kalmar (Norra Kivill) was chosen and the results as weighted averages from 2004, 2005, 2006, 2007, 2008 and 2009 were taken from the Swedish environmental program for air and precipitation financed by SEPA (Swedish Environmental Protection Board) (data can be obtained from /IVL 2009/. The results was also compared to the data obtained at the Äspö site during 2002 to 2008 /Ericsson 2004, 2005, 2009a, b, Ericsson and Engdahl 2007, 2008/. The comparison shows that the concentration of ions is generally higher at Äspö (Table 5-5) and the average of pH has varied with slightly higher values. The main reason for higher concentration of ions at the Äspö site is probably because the site is situated very close to the sea with a greater influx of sea salt. The average of $\text{SO}_4\text{-S}_{\text{korrr}}$ (which excludes the part of sulphate that originates from sea salt) at Äspö has previous years been similar to the station Norra Kivill in county of Kalmar (Table 5-5).

Table 5-1. Sampling periods and measured volumes of water in the samplers and calculated precipitation during the periods when measurements were performed.

Sample period Start	Sample period Stop	Sample number	Total volume (ml)	Average volume per sampler (ml)	Sampler diameter (cm)	Sampler area (cm ²)	Precipitation (mm)
2009-01-13	2009-01-20	15823	320	64	20	314.2	2.0
2009-01-20	2009-01-29	15824	509	102	20	314.2	3.2
2009-02-04	2009-02-10	15827	1,150	230	20	314.2	7.3
2009-02-10	2009-02-18	15843	2,170	434	20	314.2	13.8
2009-02-18	2009-02-24	15844	1,910	382	20	314.2	12.2
2009-02-24	2009-03-03	15845	1,080	216	20	314.2	6.9
2009-03-03	2009-03-11	15855	1,080	216	20	314.2	6.9
2009-03-11	2009-03-18	15870	625	125	20	314.2	4.0
2009-03-18	2009-03-25	15871	600	120	20	314.2	3.8
2009-03-25	2009-03-31	15872	1,280	256	20	314.2	8.1
2009-03-31	2009-04-07	–	0	0	20	314.2	0.0
2009-04-07	2009-04-14	–	0	0	20	314.2	0.0
2009-04-14	2009-04-22	–	0	0	20	314.2	0.0
2009-04-22	2009-04-29	–	0	0	20	314.2	0.0
2009-04-29	2009-05-06	15945	976	195	20	314.2	6.2
2009-05-06	2009-05-13	15946	5,850	1,170	20	314.2	37.2
2009-05-13	2009-05-20	15947	1,560	312	20	314.2	9.9
2009-05-20	2009-05-27	15983	4,405	881	20	314.2	28.0
2009-05-27	2009-06-02	15984	1,700	340	20	314.2	10.8
2009-06-02	2009-06-10	15998	7,326	1,465	20	314.2	46.6
2009-06-10	2009-06-17	15999	1,766	353	20	314.2	11.2
2009-06-17	2009-06-24	19020	676	135	20	314.2	4.3
2009-07-01	2009-07-08	19023	4,595	919	20	314.2	29.3
2009-07-08	2009-07-15	19024	1,040	208	20	314.2	6.6
2009-07-15	2009-07-22	19038	6,880	1,376	20	314.2	43.8
2009-07-22	2009-07-29	19039	1,760	352	20	314.2	11.2
2009-07-29	2009-08-05	–	120	24	20	314.2	0.8
2009-08-05	2009-08-12	19040	520	104	20	314.2	3.3
2009-08-12	2009-08-19	19041	5,353	1,071	20	314.2	34.1
2009-08-19	2009-08-25	19050	2,478	496	20	314.2	15.8
2009-08-25	2009-09-02	19065	3,143	629	20	314.2	20.0
2009-09-02	2009-09-08	19066	1,822	364	20	314.2	11.6
2009-09-08	2009-08-15	–	220	44	20	314.2	1.4
2009-08-15	2009-09-22	–	21	4	20	314.2	0.1
2009-09-22	2009-09-30	19081	710	142	20	314.2	4.5
2009-09-30	2009-10-06	19084	4,612	922	20	314.2	29.4
2009-10-06	2009-10-15	19146	1,720	344	20	314.2	10.9
2009-10-15	2009-10-21	19168	1,250	250	20	314.2	8.0
2009-10-21	2009-10-28	19169	1,106	221	20	314.2	7.0
2009-10-28	2009-11-03	–	0	0	20	314.2	0.0
2009-11-03	2009-11-10	19178	2,218	444	20	314.2	14.1
2009-11-10	2009-11-18	19192	2,102	420	20	314.2	13.4
2009-11-18	2009-11-25	19193	1,660	332	20	314.2	10.6
2009-11-25	2009-11-30	19194	823	165	20	314.2	5.2
2009-11-30	2009-12-07	19195	344	69	20	314.2	2.2
2009-12-07	2009-12-15	19196	3,000	600	20	314.2	19
Average				359			11.4
Standard deviation				370			11.8

Table 5-2. Measured concentrations of ions and some other components for point samples sent for analyses. (There is one measured and one calculated SO₄-S value for the samples, the calculated SO₄-S was calculated from SO₄, see Chapter 4.4).

Sample period Start	Sample period Stop	Sample number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)
2009-02-18	2009-02-24	15844	0.6	<0.4	0.6	<0.09
2009-06-02	2009-06-10	15998	0.4	<0.4	0.2	0.10
2009-08-12	2009-08-19	19041	0.4	<0.4	0.1	<0.09
2009-09-30	2009-10-06	19084	0.7	<0.4	0.2	<0.09
2009-12-07	2009-12-15	19196	0.3	<0.4	0.1	<0.09

Sample period Start	Sample period Stop	Sample number	Fe (mg/l)	Mn (mg/l)	Li (mg/l)	Si (mg/l)
2009-02-18	2009-02-24	15844	0.0214	0.00	0.000	<0.03
2009-06-02	2009-06-10	15998	0.0039	0.01	0.0982	<0.03
2009-08-12	2009-08-19	19041	0.0050	0.00	0.0326	<0.03
2009-09-30	2009-10-06	19084	0.0041	0.00	<0.004	<0.03
2009-12-07	2009-12-15	19196	0.0104	0.00	<0.004	<0.03

Sample period Start	Sample period Stop	Sample number	Sr (mg/l)	Cl (mg/l)	Br (mg/l)	F (mg/l)
2009-02-18	2009-02-24	15844	0.01	0.70	<0.2	<0.2
2009-06-02	2009-06-10	15998	0.00	0.40	<0.2	<0.2
2009-08-12	2009-08-19	19041	0.00	0.30	<0.2	<0.2
2009-09-30	2009-10-06	19084	<0.002	1.30	<0.2	<0.2
2009-12-07	2009-12-15	19196	<0.002	0.50	<0.2	<0.2

Sample period Start	Sample period Stop	Sample number	SO ₄ -S measured (mg/l)	SO ₄ (mg/l)	SO ₄ -S calculated (mg/l)	SO ₄ -S _{korr} calculated (mg/l)
2009-02-18	2009-02-24	15844	0.86	2.43	0.81	0.76
2009-06-02	2009-06-10	15998	0.31	0.65	0.22	0.18
2009-08-12	2009-08-19	19041	<0.2	0.44	0.15	0.11
2009-09-30	2009-10-06	19084	0.18	0.44	0.15	0.09
2009-12-07	2009-12-15	19196	0.43	1.28	0.43	0.40

Table 5-3. Calculated relative errors of the ion balance in the point samples sent for analyses.

Sample period Start	Sample period Stop	Sample number	Ion balance relative error (%)
2009-02-18	2009-02-24	15844	14.1
2009-06-02	2009-06-10	15998	13.7
2009-08-12	2009-08-19	19041	18.2
2009-09-30	2009-10-06	19084	1.7
2009-12-07	2009-12-15	19196	12.8

Table 5-4. Measured values of pH and electric conductivity for all point samples and general samples.

Sample period Start	Sample period Stop	Sample number	pH	Electric conductivity (mS/m)
2009-01-20	2009-01-20	15823	4.16	6.5
2009-01-29	2009-01-29	15824	4.12	5.4
2009-02-10	2009-02-10	15827	4.03	6.7
2009-02-18	2009-02-18	15843	4.47	2.6
2009-02-24	2009-02-24	15844	4.43	4.5
2009-03-03	2009-03-03	15845	4.56	2.3
2009-03-11	2009-03-11	15855	4.43	4.0
2009-03-18	2009-03-18	15870	4.77	1.5
2009-03-25	2009-03-25	15871	4.85	1.7
2009-03-31	2009-03-31	15872	4.48	3.0
2009-05-06	2009-05-06	15945	5.77	2.6
2009-05-13	2009-05-13	15946	5.46	1.1
2009-05-20	2009-05-20	15947	5.74	1.6
2009-06-10	2009-06-10	15998	5.39	0.6
2009-06-17	2009-06-17	15999	5.18	0.9
2009-06-24	2009-06-24	19020	5.23	1.0
2009-07-08	2009-07-08	19023	4.79	1.6
2009-07-15	2009-07-15	19024	4.79	1.7
2009-07-22	2009-07-22	19038	5.01	1.4
2009-07-29	2009-07-29	19039	5.72	1.1
2009-08-12	2009-08-12	19040	4.90	1.4
2009-08-19	2009-08-19	19041	5.37	0.5
2009-08-25	2009-08-25	19050	5.10	1.4
2009-09-02	2009-09-02	19065	5.13	1.3
2009-09-08	2009-09-08	19066	4.65	1.4
2009-09-30	2009-09-30	19081	5.70	2.0
2009-10-06	2009-10-06	19084	5.55	2.2
2009-10-15	2009-10-15	19146	4.83	2.1
2009-10-21	2009-10-21	19168	4.84	1.3
2009-10-28	2009-10-28	19169	4.29	2.6
2009-11-10	2009-11-10	19178	4.46	2.9
2009-11-18	2009-11-18	19192	4.38	3.1
2009-11-25	2009-11-25	19193	4.86	5.0
2009-11-30	2009-11-30	19194	5.00	2.3
2009-12-07	2009-12-07	19195	3.78	12.2
2009-12-15	2009-12-15	19196	4.47	2.6
Average			4.85	2.7
Standard deviation			0.52	2.2

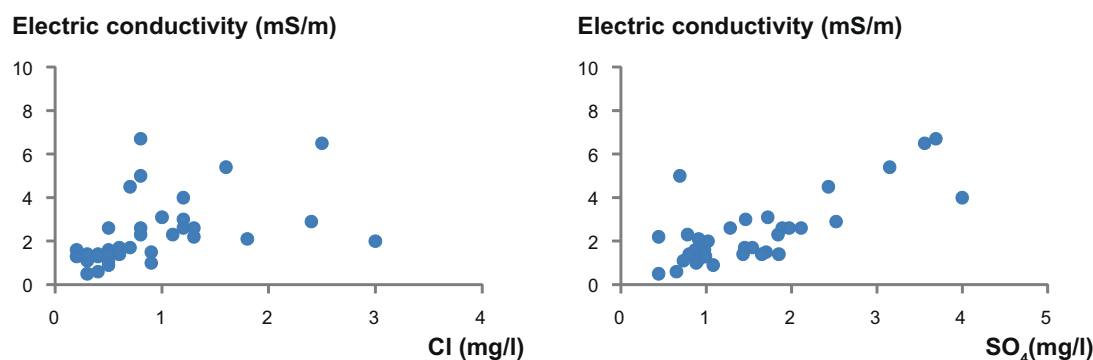


Figure 5-1. The relationships between Chloride and electric conductivity and sulphate and electric conductivity.

Table 5-5. Volume weighted averages of some major ions and pH in Äspö and in N Kvill, a station in the county of Kalmar 2004–2009.

Station	Cl (mg/l)	SO ₄ -S _{korrr} (mg/l)	Na (mg/l)	Ca (mg/l)	K (mg/l)	Mg (mg/l)	pH (mg/l)
Äspö 2009	0.62	0.20	0.49	0.21	0.40	0.09	5.33
Äspö 2008	2.74	0.94	0.87	0.26	0.40	0.19	5.37
Äspö 2007	0.57	0.27	1.10	0.47	0.58	0.37	4.77
Äspö 2006	0.66	0.36	1.33	0.38	0.88	0.27	4.97
Äspö 2005	0.99	0.41	0.74	0.37	0.59	0.15	4.66
Äspö 2004	1.50	0.25	2.13	0.78	0.51	0.12	4.75
Äspö 2002 to 2003	1.64	0.50	2.05	0.74	0.78	0.16	5.09
N Kvill 2009	0.42	0.27	0.26	0.12	0.17	0.05	4.75
N Kvill 2008	0.46	0.23	0.35	0.15	0.07	0.06	4.83
N Kvill 2007	0.50	0.26	0.32	0.15	0.07	0.06	4.89
N Kvill 2006	0.42	0.32	0.27	0.19	0.21	0.07	4.88
N Kvill 2005	0.50	0.26	0.33	0.15	0.09	0.05	4.77
N Kvill 2004	0.36	0.26	0.28	0.11	0.10	0.05	4.89

The hydrogen isotope ratio of $\delta^2\text{H}$ (deuterium) varied with an indication of higher ratios in early autumn (Table 5-6 and Appendix). Data from previous years has also indicated lower ratios in winter /Ericsson 2009b/. However, ratios of $\delta^2\text{H}$ did not correlate well with the ratios of $\delta^{18}\text{O}$ (oxygen-18) (Figure 5-2). Previous years the correlation has always been evident. The reason for this is difficult to interpret, but likely the mismatch depends of some problem at the analysing laboratory, since the handling of samples in the field has been unchanged between the years. In Figure 5-3 sample number 15998 has been omitted with a slightly better linear correlation as a result. Consequently the linear relation in Figure 5-3 does not correspond well with the “Global Meteoric Water Line” ($\delta^2\text{H} = 8 \times \delta^{18}\text{O} + 10$) which is based on precipitation data from locations around the globe /Craig 1961/. This relation has also corresponded well previous years. The ratios of ^3H varied with a small tendency for lower values in the autumn and winter.

The results of the measurements of heavy metals, trace elements and lanthanides from five occasions during 2009 and one occasion 2008 are listed in Appendix. Table 5-7 show calculated averages from 2008 and 2009, totally six occasions. The values showed, as expected, low concentrations. Optional, analysis of Se, P and I was also performed.

Table 5-6. Isotope data obtained from both analysed point samples and general samples.

Sample period Start	Sample period Stop	Sample number	^3H (TU)	$\delta^2\text{H}$ (‰ V-SMOW)	$\delta^{18}\text{O}$ (‰ V-SMOW)
2009-02-18	2009-02-24	15844		-76.4	-11.50
2009-06-02	2009-06-10	15998	13.70	-78.3	-13.70
2009-08-12	2009-08-19	19041	12.10	-80.4	-11.00
2009-09-30	2009-10-06	19084	7.50	-67.7	-10.90
2009-11-03	2009-11-10	19178	9.10	-70.6	-10.90
2009-12-07	2009-12-15	19196	11.10	-91.4	-13.90

Sample period Start	Sample period Stop	Sample number	^3H (TU)	$\delta^2\text{H}$ (‰ V-SMOW)	$\delta^{18}\text{O}$ (‰ V-SMOW)
2009-01-13	2009-03-31	15873	10.80	-73.1	-10.80
2009-03-31	2009-06-24	19021	11.30	-77.7	-12.00
2009-07-01	2009-09-30	19082	12.80	-57.2	-8.70
2009-09-30	2009-12-15	19197	8.40	-71.8	-11.10

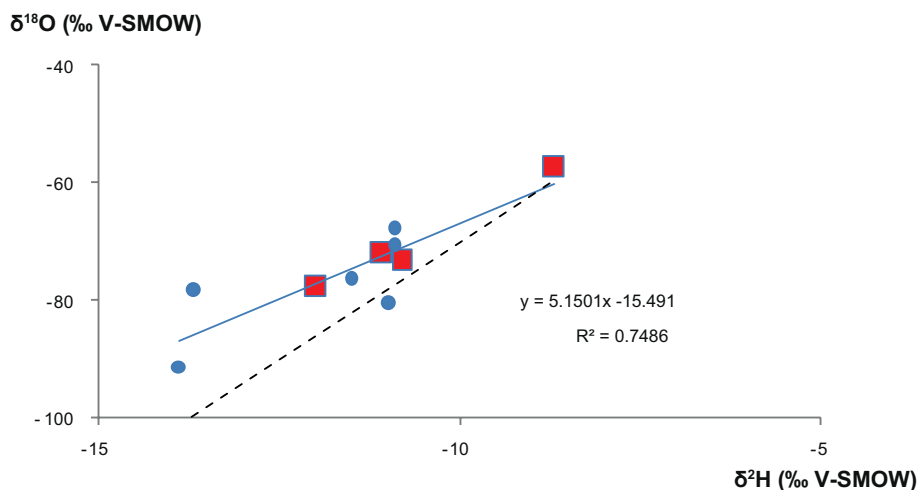


Figure 5-2. The relationship between the ratios of $\delta^2\text{H}$ and $\delta^{18}\text{O}$ at the Äspö site in 2009. The blue dots are data from the point samples and the red squares are data from the general samples. The dotted line represents the Global Meteoric Water Line" ($\delta^2\text{H} = 8 \times \delta^{18}\text{O} + 10$).

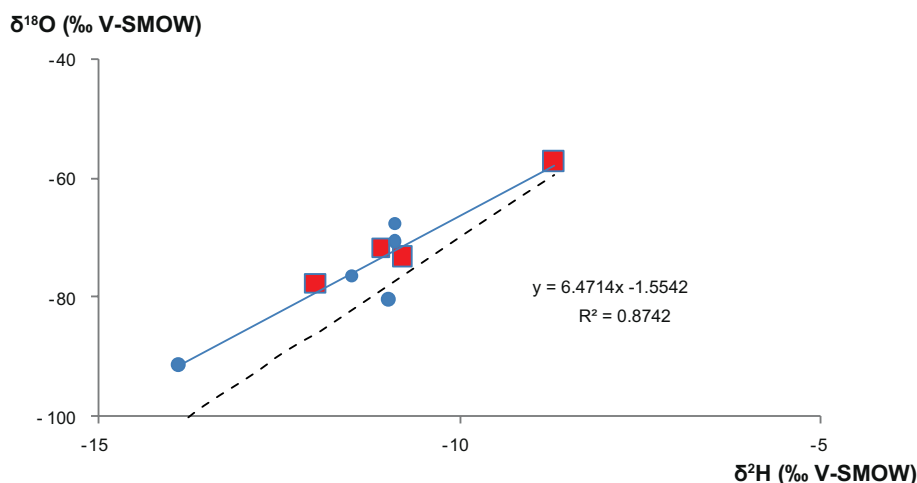


Figure 5-3. The relationship between the ratios of $\delta^2\text{H}$ and $\delta^{18}\text{O}$ at the Äspö site in 2009. The blue dots are data from the point samples and the red squares are data from the general samples (compared to Figure 5-2 sample number 15763 has been omitted for comparison). The dotted line represents the Global Meteoric Water Line" ($\delta^2\text{H} = 8 \times \delta^{18}\text{O} + 10$).

Table 5-7. Average of heavy metals, trace elements and lanthanides from six occasions measured in sample period 2008-10-27 to 2009-12-15 (average of Se, P and I from five occasions during 2009).

Al ($\mu\text{g/l}$)	Ba ($\mu\text{g/l}$)	Cd ($\mu\text{g/l}$)	Cr ($\mu\text{g/l}$)	Cu ($\mu\text{g/l}$)	Co ($\mu\text{g/l}$)	Hg ($\mu\text{g/l}$)	Ni ($\mu\text{g/l}$)	Mo ($\mu\text{g/l}$)	Pb ($\mu\text{g/l}$)	V ($\mu\text{g/l}$)	Zn ($\mu\text{g/l}$)
4.72	0.582	0.049	0.380	1.32	0.0176	<0.002	0.476	<0.0670	0.548	0.248	24.1
U ($\mu\text{g/l}$)	Th ($\mu\text{g/l}$)	Sc ($\mu\text{g/l}$)	Rb ($\mu\text{g/l}$)	Y ($\mu\text{g/l}$)	Zr ($\mu\text{g/l}$)	Sb ($\mu\text{g/l}$)	Cs ($\mu\text{g/l}$)	La ($\mu\text{g/l}$)	Hf ($\mu\text{g/l}$)	Tl ($\mu\text{g/l}$)	Ce ($\mu\text{g/l}$)
0.0028	<0.02	<0.05	0.422	0.0084	<0.03	0.0991	<0.03	0.0166	<0.005	<0.012	0.0278
Pr ($\mu\text{g/l}$)	Nd ($\mu\text{g/l}$)	Sm ($\mu\text{g/l}$)	Eu ($\mu\text{g/l}$)	Gd ($\mu\text{g/l}$)	Tb ($\mu\text{g/l}$)	Dy ($\mu\text{g/l}$)	Ho ($\mu\text{g/l}$)	Er ($\mu\text{g/l}$)	Tm ($\mu\text{g/l}$)	Yb ($\mu\text{g/l}$)	Lu ($\mu\text{g/l}$)
<0.005	0.0121	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.004	<0.005	<0.005
Se ($\mu\text{g/l}$)	P (mg/l)	I (mg/l)									
0.0871	0.0132	<0.0027									

6 References

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Appendix

Primary results

Sample period start	Sample period stop	Sample number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Fe (mg/l)	Mn (mg/l)	Li (mg/l)	Si (mg/l)	Sr (mg/l)
2009-01-13	2009-01-20	15823									
2009-01-20	2009-01-29	15824									
2009-02-04	2009-02-10	15827									
2009-02-10	2009-02-18	15843									
2009-02-18	2009-02-24	15844	0.6	<0.4	0.6	<0.09	0.0214	0.00240	0.0002	<0.03	0.010
2009-02-24	2009-03-03	15845									
2009-03-03	2009-03-11	15855									
2009-03-11	2009-03-18	15870									
2009-03-18	2009-03-25	15871									
2009-03-25	2009-03-31	15872									
2009-04-29	2009-05-06	15945									
2009-05-06	2009-05-13	15946									
2009-05-13	2009-05-20	15947									
2009-06-02	2009-06-10	15998	0.4	<0.4	0.2	0.10	0.0039	0.00532	0.0982	<0.03	0.002
2009-06-10	2009-06-17	15999									
2009-06-17	2009-06-24	19020									
2009-07-01	2009-07-08	19023									
2009-07-08	2009-07-15	19024									
2009-07-15	2009-07-22	19038									
2009-07-22	2009-07-29	19039									
2009-08-05	2009-08-12	19040									
2009-08-12	2009-08-19	19041	0.4	<0.4	0.1	<0.09	0.0050	0.00267	0.0326	<0.03	0.001
2009-08-19	2009-08-25	19050									
2009-08-25	2009-09-02	19065									
2009-09-02	2009-09-08	19066									
2009-09-22	2009-09-30	19081									
2009-09-30	2009-10-06	19084	0.7	<0.4	0.2	<0.09	0.0041	0.00329	<0.004	<0.03	<0.002
2009-10-06	2009-10-15	19146									
2009-10-15	2009-10-21	19168									
2009-10-21	2009-10-28	19169									
2009-11-03	2009-11-10	19178									
2009-11-10	2009-11-18	19192									
2009-11-18	2009-11-25	19193									
2009-11-25	2009-11-30	19194									
2009-11-30	2009-12-07	19195									
2009-12-07	2009-12-15	19196	0.3	<0.4	0.1	<0.09	0.0104	0.00123	<0.004	<0.03	<0.002

Sample period start	Sample period stop	Sample number	SO ₄ -S measured (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	Br (mg/l)	F (mg/l)	HCO ₃ (mg/l)	pH	Electric conductivity (mS/m)
2009-01-13	2009-01-20	15823		2.5	3.56	<0.2	<0.2		4.16	6.5
2009-01-20	2009-01-29	15824		1.6	3.15	<0.2	0.07		4.12	5.4
2009-02-04	2009-02-10	15827		0.8	3.69	<0.2	0.10		4.03	6.7
2009-02-10	2009-02-18	15843		1.2	1.89	<0.2	<0.2		4.47	2.6
2009-02-18	2009-02-24	15844	0.86	0.7	2.43	<0.2	<0.2		4.43	4.5
2009-02-24	2009-03-03	15845		0.8	1.84	<0.2	<0.2		4.56	2.3
2009-03-03	2009-03-11	15855		1.2	4.00	<0.2	<0.2		4.43	4.0
2009-03-11	2009-03-18	15870		0.9	1.70	<0.2	<0.2		4.77	1.5
2009-03-18	2009-03-25	15871		0.7	1.45	<0.2	<0.2		4.85	1.7
2009-03-25	2009-03-31	15872		1.2	1.46	<0.2	<0.2		4.48	3.0
2009-04-29	2009-05-06	15945		1.3	1.97	<0.2	<0.2	<0.3	5.77	2.6
2009-05-06	2009-05-13	15946		0.3	0.73	<0.2	<0.2		5.46	1.1
2009-05-13	2009-05-20	15947		0.2	0.98	<0.2	<0.2	<0.3	5.74	1.6
2009-06-02	2009-06-10	15998	0.31	0.4	0.65	<0.2	<0.2		5.39	0.6
2009-06-10	2009-06-17	15999		0.5	1.08	<0.2	<0.2		5.18	0.9
2009-06-17	2009-06-24	19020		0.9	0.88	<0.2	<0.2		5.23	1.0
2009-07-01	2009-07-08	19023		0.5	0.87	<0.2	<0.2		4.79	1.6
2009-07-08	2009-07-15	19024		0.6	1.54	<0.2	<0.2		4.79	1.7
2009-07-15	2009-07-22	19038		0.4	1.43	<0.2	<0.2		5.01	1.4
2009-07-22	2009-07-29	19039		0.5	0.90	<0.2	<0.2		5.72	1.1
2009-08-05	2009-08-12	19040		0.6	1.85	<0.2	<0.2		4.90	1.4
2009-08-12	2009-08-19	19041	<0.2	0.3	0.44	<0.2	<0.2		5.37	0.5
2009-08-19	2009-08-25	19050		0.3	1.65	<0.2	<0.2		5.10	1.4
2009-08-25	2009-09-02	19065		<0.2	0.98	<0.2	<0.2		5.13	1.3
2009-09-02	2009-09-08	19066		0.5	0.80	<0.2	<0.2		4.65	1.4
2009-09-22	2009-09-30	19081		3.0	1.02	<0.2	<0.2		5.70	2.0
2009-09-30	2009-10-06	19084	0.18	1.3	0.44	<0.2	<0.2		5.55	2.2
2009-10-06	2009-10-15	19146		1.8	0.91	<0.2	<0.2		4.83	2.1
2009-10-15	2009-10-21	19168		0.4	0.99	<0.2	<0.2	<0.3	4.84	1.3
2009-10-21	2009-10-28	19169		0.8	2.11	<0.2	<0.2		4.29	2.6
2009-11-03	2009-11-10	19178		2.4	2.52	<0.2	<0.2		4.46	2.9
2009-11-10	2009-11-18	19192		1.0	1.72	<0.2	<0.2		4.38	3.1
2009-11-18	2009-11-25	19193		0.8	0.69	<0.2	<0.2		4.86	5.0
2009-11-25	2009-11-30	19194		1.1	0.78	<0.2	<0.2		5.00	2.3
2009-11-30	2009-12-07	19195							3.78	12.2
2009-12-07	2009-12-15	19196	0.43	0.5	1.28	<0.2	<0.2		4.47	2.6

Sample period Start	Sample period Stop	Sample number	^3H (TU)	$\delta^2\text{H}$ (‰ VSMOW)	$\delta^{18}\text{O}$ (‰ VSMOW)
2009-01-13	2009-01-20	15823			
2009-01-20	2009-01-29	15824			
2009-02-04	2009-02-10	15827			
2009-02-10	2009-02-18	15843			
2009-02-18	2009-02-24	15844		-76.4	-11.50
2009-02-24	2009-03-03	15845			
2009-03-03	2009-03-11	15855			
2009-03-11	2009-03-18	15870			
2009-03-18	2009-03-25	15871			
2009-03-25	2009-03-31	15872			
2009-04-29	2009-05-06	15945			
2009-05-06	2009-05-13	15946			
2009-05-13	2009-05-20	15947			
2009-05-20	2009-05-27	15983			
2009-06-02	2009-06-10	15998	13.70	-78.3	-13.70
2009-06-10	2009-06-17	15999			
2009-06-17	2009-06-24	19020			
2009-07-01	2009-07-08	19023			
2009-07-08	2009-07-15	19024			
2009-07-15	2009-07-22	19038			
2009-07-22	2009-07-29	19039			
2009-08-05	2009-08-12	19040			
2009-08-12	2009-08-19	19041	12.10	-80.4	-11.00
2009-08-19	2009-08-25	19050			
2009-08-25	2009-09-02	19065			
2009-09-02	2009-09-08	19066			
2009-09-22	2009-09-30	19081			
2009-09-30	2009-10-06	19084	7.50	-67.7	-10.90
2009-10-06	2009-10-15	19146			
2009-10-15	2009-10-21	19168			
2009-10-21	2009-10-28	19169			
2009-11-03	2009-11-10	19178	9.10	-70.6	-10.90
2009-11-10	2009-11-18	19192			
2009-11-18	2009-11-25	19193			
2009-11-25	2009-11-30	19194			
2009-11-30	2009-12-07	19195			
2009-12-07	2009-12-15	19196	11.10	-91.4	-13.90

Sample period Start	Sample period Stop	Sample number	^3H (TU)	$\delta^2\text{H}$ (‰ VSMOW)	$\delta^{18}\text{O}$ (‰ VSMOW)
2009-01-20	2009-03-31	15873	10.80	-73.1	-10.80
2009-05-06	2009-06-24	19021	11.30	-77.7	-12.00
2009-07-08	2009-09-30	19082	12.80	-57.2	-8.70
2009-10-06	2009-12-15	19197	8.40	-71.8	-11.10

Sample period Start	Sample period Stop	Sample number	Al (µg/l)	Ba (µg/l)	Cd (µg/l)	Cr (µg/l)	Cu (µg/l)	Co (µg/l)
2008-10-27	2008-11-04	15763	4.89	0.705	0.0135	0.175	0.787	0.0143
2009-02-18	2009-02-24	15844	10.1	1.27	0.0901	0.453	2.70	0.0342
2009-06-02	2009-06-10	15998	3.69	0.354	0.0133	0.177	1.23	0.0136
2009-08-12	2009-08-19	19041	1.86	0.355	0.0077	0.132	1.59	0.0126
2009-09-30	2009-10-06	19084	2.80	0.380	0.02	0.214	0.995	0.0111
2009-12-07	2009-12-15	19196	5.00	0.430	0.154	1.13	0.602	0.020
Average			4.72	0.582	0.049	0.380	1.32	0.0176
Standard dev			2.90	0.362	0.060	0.385	0.76	0.0087

Sample period Start	Sample period Stop	Sample number	Hg (µg/l)	Ni (µg/l)	Mo (µg/l)	Pb (µg/l)	V (µg/l)	Zn (µg/l)
2008-10-27	2008-11-04	15763	<0.002	0.582	<0.05	0.209	0.164	8.19
2009-02-18	2009-02-24	15844	<0.002	0.853	0.0898	2.14	0.668	69.4
2009-06-02	2009-06-10	15998	<0.002	0.246	<0.05	0.180	0.141	17.8
2009-08-12	2009-08-19	19041	<0.002	0.252	<0.05	0.0728	0.122	7.91
2009-09-30	2009-10-06	19084	<0.002	0.399	<0.05	0.0708	0.0964	14.1
2009-12-07	2009-12-15	19196	<0.002	0.522	0.112	0.613	0.299	27.0
Average			<0.002	0.476	<0.0670	0.548	0.248	24.1
Standard dev			0	0.230	0.027	0.805	0.217	23.3

Sample period Start	Sample period Stop	Sample number	U (µg/l)	Th (µg/l)	Sc (µg/l)	Rb (µg/l)	Y (µg/l)	Zr (µg/l)
2008-10-27	2008-11-04	15763	0.0058	<0.02	<0.05	0.321	0.0071	<0.03
2009-02-18	2009-02-24	15844	0.0044	<0.02	<0.05	0.321	0.0127	<0.03
2009-06-02	2009-06-10	15998	0.0016	<0.02	<0.05	1.45	0.0103	<0.03
2009-08-12	2009-08-19	19041	0.0025	<0.02	<0.05	0.119	0.0061	<0.03
2009-09-30	2009-10-06	19084	0.0010	<0.02	<0.05	0.225	0.0052	<0.03
2009-12-07	2009-12-15	19196	0.0012	<0.02	<0.05	0.0975	0.0090	<0.03
Average			0.0028	<0.02	<0.05	0.422	0.0084	<0.03
Standard dev			0.0019	0	0	0.512	0.0028	0

Sample period Start	Sample period Stop	Sample number	Sb (µg/l)	Cs (µg/l)	La (µg/l)	Hf (µg/l)	Tl (µg/l)	Ce (µg/l)
2008-10-27	2008-11-04	15763	0.119	<0.03	0.0136	<0.005	<0.01	0.0239
2009-02-18	2009-02-24	15844	0.233	<0.03	0.0298	<0.005	0.0236	0.0468
2009-06-02	2009-06-10	15998	0.0627	<0.03	0.0160	<0.005	<0.01	0.0268
2009-08-12	2009-08-19	19041	0.0437	<0.03	0.0121	<0.005	<0.01	0.0210
2009-09-30	2009-10-06	19084	0.0409	<0.03	0.0094	<0.005	<0.01	0.0230
2009-12-07	2009-12-15	19196	0.0955	<0.03	0.0187	<0.005	<0.01	0.0254
Average			0.0991	<0.03	0.0166	<0.005	<0.012	0.0278
Standard dev			0.0723	0	0.0072	0	0.006	0.0095

Sample period Start	Sample period Stop	Sample number	Pr (µg/l)	Nd (µg/l)	Sm (µg/l)	Eu (µg/l)	Gd (µg/l)	Tb (µg/l)
2008-10-27	2008-11-04	15763	<0.005	0.0119	<0.005	<0.005	<0.005	<0.005
2009-02-18	2009-02-24	15844	<0.005	0.0204	<0.005	<0.005	<0.005	<0.005
2009-06-02	2009-06-10	15998	<0.005	0.0117	<0.005	<0.005	<0.005	<0.005
2009-08-12	2009-08-19	19041	<0.005	0.0096	<0.005	<0.005	<0.005	<0.005
2009-09-30	2009-10-06	19084	<0.005	0.0067	<0.005	<0.005	<0.005	<0.005
2009-12-07	2009-12-15	19196	<0.005	0.0125	<0.005	<0.005	<0.005	<0.005
Average			<0.005	0.0121	<0.005	<0.005	<0.005	<0.005
Standard dev			0	0.0046	0	0	0	0

Sample period Start	Sample period Stop	Sample number	Dy (µg/l)	Ho (µg/l)	Er (µg/l)	Tm (µg/l)	Yb (µg/l)	Lu (µg/l)
2008-10-27	2008-11-04	15763	<0.005	<0.005	<0.005	<0.004	<0.005	<0.005
2009-02-18	2009-02-24	15844	<0.005	<0.005	<0.005	<0.004	<0.005	<0.005
2009-06-02	2009-06-10	15998	<0.005	<0.005	<0.005	<0.004	<0.005	<0.005
2009-08-12	2009-08-19	19041	<0.005	<0.005	<0.005	<0.004	<0.005	<0.005
2009-09-30	2009-10-06	19084	<0.005	<0.005	<0.005	<0.004	<0.005	<0.005
2009-12-07	2009-12-15	19196	<0.005	<0.005	<0.005	<0.004	<0.005	<0.005
Average			<0.005	<0.005	<0.005	<0.004	<0.005	<0.005
Standard dev			0	0	0	0	0	0

Sample period Start	Sample period Stop	Sample number	Se (µg/l)	P (mg/l)	I (mg/l)
2008-10-27	2008-11-04	15763			
2009-02-18	2009-02-24	15844	0.174	0.0158	<0.002
2009-06-02	2009-06-10	15998	0.125	0.0306	0.004
2009-08-12	2009-08-19	19041	0.0318	0.0084	<0.005
2009-09-30	2009-10-06	19084	0.0346	0.0078	0.0014
2009-12-07	2009-12-15	19196	0.0701	0.0032	0.0009
Average			0.0871	0.0132	<0.0027
Standard dev			0.0614	0.0107	0.0018