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Oskarshamn site investigation

Monitoring of precipitation water chemistry 2008

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December 2009

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Abstract

Sampling and analysis of precipitation was performed from January to December 2008 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" (Section 4.2). Water from six of the weekly periods (point samples) was sent for full analysis (anions and common cations (Section 4.1), alkalinity, pH, conductivity and isotopes) to different laboratories. Water from the rest of the periods were analysed for anions, alkalinity, pH and conductivity if precipitation had occurred. As an addition analysis of heavy metals and trace elements was performed on one of the point samples. General samples composed of water from each week in each quarter of a year was analysed for isotopes.

Calculations of ion balances showed a great imbalance in three of the point samples (more than 10% relative error). This imbalance was so large that there might be an error either in the analysis or in the handling of the samples. Another 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 two national monitoring stations 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 stations in south east Sweden.

The hydrogen isotope ratio of $\delta^2\text{H}$ (deuterium) varied with a small tendency of lowest ratio in winter. With one exception these ratios correlated well with the ratios of $\delta^{18}\text{O}$. The ratios of ^3H (tritium) varied with a small tendency for lower values in the autumn and winter.

Four nonconformities occurred. The analysis of HCO₃ was not performed on every occasion, due to very low pH. The results from two of the sampling periods were incorrect and error marked in Sicada. The analysis of Cl, SO₄, Br and F was not performed on one of the point samples due to a mistake when ordering the analysis. Due to a mistake when sending samples to the analysing laboratory no ICP-analysis were performed on one of the samples.

Sammanfattning

Provtagning och analys av nederbörd från Äspö har utförts från januari till december 2008. Syftet med undersökningarna var att monitera nederbördens kemiska sammansättning inom området för platsundersökningen i Oskarshamn.

Nederbörden samlades in i behållare som slumpmässigt placerats inom ett område med en diameter på cirka 25 m. Behållarna tömdes, den totala volymen mättes regelbundet varje vecka 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, konduktivitet samt isotoper). Vatten från övriga veckor analyserades på anjoner, vanliga katjoner, alkalinitet, pH och konduktivitet om det fanns vatten tillräckligt för analys. Som ett tillägg genomfördes också analyser av tungmetaller och spårelement på ett av punktproven. 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 tre av punktproverna. Skillnaderna var så stora att ett fel kan föreligga, antingen vid analyserna eller vid hanteringen av proverna. En annan 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 stationer i sydöstra Sverige som ingår i det nationella nederbördskemiska 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 $\text{SO}_4\text{-S}$ (som utesluter svavel som härrör från havet) var också mer likt resultaten från de andra stationerna i sydöstra Sverige.

Väteisotopen $\delta^2\text{H}$ (deuterium) varierade mellan provtagningsstillfällena med en tendens till lägst kvoter under vintern. Kvoterna av $\delta^2\text{H}$ var med ett undantag väl korrelerade med kvoterna av $\delta^{18}\text{O}$ (syre-18). Även kvoterna av ^3H (tritium) varierade mellan provtagningsstillfällena med en svag tendens till lägre värden under hösten och vintern.

Fyra avvikelser från vad som planerats har förekommit under året. HCO_3 analyserades inte vid flera tillfällen på grund av för låga pH-värden. Resultaten från två provtagningsperioder var felaktiga och felmarkerades i Sicada. Analysen av Cl, SO_4 , Br och F utfördes inte på ett av punktproven på grund av ett misstag när analysen beställdes. På grund av ett misstag vid skickande av prover till laboratorium för analys utfördes inte ICP-analys på ett av proverna.

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1 Introduction

This document reports the results gained by the sampling and analysis of precipitation during 2008, 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 400-08-003. 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
Nederbördsprovtagning och analyser 2008 (monitoring)	AP PS 400-08-003	1.0
Method descriptions	Number	Version
Metodbeskrivning för provtagning och analys av nederbörd	SKB MD 423.003	2.0

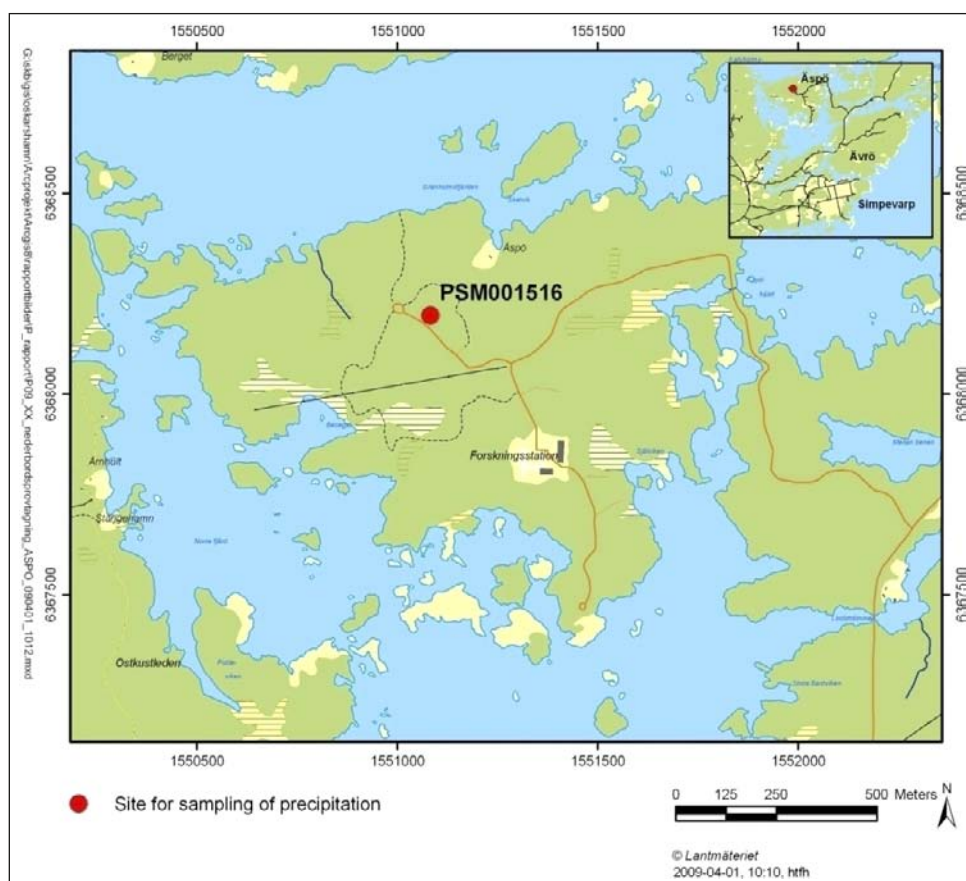


Figure 1-1. Site for sampling of precipitation (PSM001516) at the island of Äspö. Coordinates for the site is N 6368196; E 1551083 (RT90/RHB70).

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 3-2). 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 3-1). In winter the “NILU Particulate Fallout Collector”, essentially a bucket, with a diameter of 20 cm were used (Figure 3-2). 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 common cations (Section 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 (m)	Easting (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 summer at the site for sampling of precipitation at the island of Äspö.



Figure 3-2. The sampler used in winter 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 it was stored in one “general sample” and one “point sample” (Section 4.2). Six point samples were sent for full analysis (anions and common cations (Na, K, Ca, Mg, Fe, Mn, Li, Si, Sr), alkalinity, pH, conductivity and isotopes) to different laboratories. As an addition analysis of heavy metals and trace elements was performed on one of the point samples. Due to a mistake full analysis were not performed on one of these samples (see Section 4.5). An additional problem was that the results from another sample were error marked (see Section 4.5). Water from the rest of the weekly periods were analysed for anions, alkalinity, pH and conductivity if enough precipitation had occurred. 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”. 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 2008.

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. 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 a SKB number. Bottles for “quick analysis” (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 (Table 4-6), 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 one to three times depending on the amount of water available.

If the “point sample” was larger than 2.2 litres then 2×250 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 common cations (Section 4.1) and $\delta^2\text{H}$, ^3H and $\delta^{18}\text{O}$. During the year six “point samples”, denominated as complete samples, were analysed. All 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 Tables 4-2, 4-3, 4-4 and 4-5. See Tables 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 (the point samples and the general samples sent for analysis are highlighted).

Sample period Start	Sample period Stop	Sample number	Type of sample and analyses
2008-01-23	2008-01-30	15333	Point sample. Anions, pH, conductivity and HCO₃⁻, δ²H, ³H and δ¹⁸O
2008-02-05	2008-02-14	15335	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-02-27	2008-03-05	15390	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-03-12	2008-03-19	15391	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-03-19	2008-03-26	15488	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-04-09	2008-04-16	15495	Point sample. Anions, pH, conductivity, HCO₃⁻, common cations, δ²H, ³H and δ¹⁸O
2008-04-16	2008-04-24	15537	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-04-24	2008-04-30	15538	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-04-30	2008-05-07	15539	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-01-09	2008-04-30	15540	General sample. δ²H, ³H and δ¹⁸O
2008-05-14	2008-05-21	15576	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-06-12	2008-06-18	15598	Point sample. No data, sample errormarked in Sicada
2008-06-18	2008-06-25	15613	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-06-25	2008-07-02	15614	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-04-30	2008-07-02	15615	General sample. δ²H, ³H and δ¹⁸O
2008-07-02	2008-07-09	15617	Point sample. Anions, pH, conductivity, HCO₃⁻, common cations, δ²H, ³H and δ¹⁸O
2008-07-09	2008-07-16	15619	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-07-16	2008-07-23	15634	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-07-30	2008-08-06	15635	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-08-06	2008-08-12	15636	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-07-16	2008-07-23	15659	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-07-30	2008-08-06	15660	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-08-27	2008-09-01	15661	Point sample. No data, sample errormarked in Sicada
2008-09-01	2008-09-10	15662	Point sample. Anions, pH, conductivity, HCO₃⁻, common cations, δ²H, ³H and δ¹⁸O
2008-09-10	2008-09-17	15677	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-09-17	2008-09-24	15678	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-07-02	2008-09-29	15679	General sample. δ²H, ³H and δ¹⁸O
2008-09-29	2008-10-07	15681	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-10-13	2008-10-20	15761	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-10-20	2008-10-27	15762	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-10-27	2008-11-04	15763	Point sample. Anions, pH, conductivity, HCO₃⁻, common cations, δ²H, ³H and δ¹⁸O
2008-11-04	2008-11-11	15772	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-11-11	2008-11-18	15787	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-11-18	2008-11-24	15788	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-11-24	2008-12-02	15789	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-12-02	2008-12-08	15790	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-12-08	2008-12-15	15805	Point sample. Anions, pH, conductivity and HCO ₃ ⁻
2008-09-29	2008-12-15	15825	General sample. δ²H, ³H and δ¹⁸O

Table 4-2. Volumes from different point samples/sampling weeks in the general sample, SKB-nr 15540.

Sample date	Sample number	Volume (ml)	Volume (%)	Comments
2008-01-16	–	0	0	No point sample for analysis
2008-01-23	–	0	0	No point sample for analysis
2008-01-30	15333	442	22.8	
2008-02-05	–	0	0	No point sample for analysis
2008-02-14	15335	50	2.6	
2008-02-18	–	0	0	No point sample for analysis
2008-02-27	–	0	0	No point sample for analysis
2008-03-05	15390	225	11.6	
2008-03-12	–	0	0	No point sample for analysis
2008-03-19	15391	225	11.6	
2008-03-26	15488	130	6.7	
2008-04-02	–	0	0	No point sample for analysis
2008-04-09	–	0	0	No point sample for analysis
2008-04-16	15495	684	35.3	
2008-04-24	15537	95	4.9	
2008-04-30	15538	88	4.5	

Table 4-3. Volumes from different point samples/sampling weeks in the general sample, SKB-nr 15615.

Sample date	Sample number	Volume (ml)	Volume (%)	Comments
2008-05-07	15539	219	15.1	
2008-05-14	–	0	0	No point sample for analysis
2008-05-21	15576	109	7.5	
2008-05-28	–	0	0	No point sample for analysis
2008-06-04	–	0	0	No point sample for analysis
2008-06-12	–	0	0	No point sample for analysis
2008-06-18	15598	576	39.7	
2008-06-25	15613	114	7.9	
2008-07-02	15614	434	29.9	

Table 4-4. Volumes from different point samples/sampling weeks in the general sample, SKB-nr 15679.

Sample date	Sample number	Volume (ml)	Volume (%)	Comments
2008-07-09	15617	1,088	14.0	
2008-07-16	15619	456	5.9	
2008-07-23	15634	330	4.3	
2008-07-30	–	0	0	No point sample for analysis
2008-08-06	15635	1,470	18.9	
2008-08-12	15636	904	11.6	
2008-08-20	15659	1,012	13.0	
2008-08-27	15660	930	12.0	
2008-09-01	15661	190	2.4	
2008-09-10	15662	564	7.3	
2008-09-17	15677	398	5.1	
2008-09-24	15678	418	5.4	
2008-09-29	–	0	0	No point sample for analysis

Table 4-5. Volumes from different point samples/sampling weeks in the general sample, SKB-nr 15825.

Sample date	Sample number	Volume (ml)	Volume (%)	Comments
2008-10-07	15681	590	12.2	
2008-10-13	–	15	0.3	No point sample for analysis
2008-10-20	15761	497	10.3	
2008-10-27	15762	248	5.1	
2008-11-04	15763	1,260	26.1	
2008-11-11	15772	453	9.4	
2008-11-18	15787	116	2.4	
2008-11-24	15788	150	3.1	
2008-12-02	15789	422	8.7	
2008-12-08	15790	342	7.1	
2008-12-15	15805	742	15.3	

4.3 Handling of samples before analysis

The analysis performed follow chemistry class 3 except for one point sample (SKB-nr 15763) that was analysed according to chemistry class 5. 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 was 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, Conductivity, HCO ₃	1	250 ml	–	Äspö laboratory.
Cl, Br, SO ₄ , F	1	250 ml	Filtration (in connection with analysis).	Äspö laboratory.
Ca, Fe, K, Mg, Na, S, Si, Li, Mn, Sr	4	100 ml, acid rinsed	Filtration membrane filter/ acidification 1% HNO ₃ .	ALS.
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	–	Institutute for Energy Technology, Norway
Archive samples	5	2×250 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 $P = 10 \cdot V / A$.

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

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 ($[SO_4-S_{corr}] = [SO_4-S] - 0.0837 \cdot [Na]$) (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 $X_m = \sum(c_i \cdot m_i) / \sum(m_i)$ 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 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 15598 and 15661 (Table 4-1)). These results are not included in this report.

The analysis of Cl, SO₄, Br and F was not performed on the point sample 15538 (Table 4-1) due to a mistake when ordering the analysis.

Due to a mistake when sending samples to the analysing laboratory no ICP-analysis were performed on the sample 15333 (Table 4-1).

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 2008 was 327 ml (Table 5-1). The mean calculated precipitation per sampling period was 10.4 mm. The total measured precipitation from January to December was 510.4 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 results from the four occasions when full analysis were performed are also presented in Table 5-2, 5-5, and 5-6. The concentrations of different ions varied much between the different measuring periods (Table 5-2 and Appendix). On two occasions the concentrations of anions far exceeded the concentrations of the cations and on one occasion the concentration of cations far exceeded the concentration of anions. In these cases the imbalance was large indicating an 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 for this report (Table 5-3). These calculations show rather great imbalances (more than 10% relative error) in three of the 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 municipality of Vimmerby) the average concentrations of $\text{NO}_3\text{-N}$ and $\text{NH}_4\text{-N}$ was 0.27 mg/l and 0.17 mg/l in 2008 (www.ivl.se). 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 conductivity varied between the different measuring periods (Table 5-4 and Appendix). Some periods differ with markedly higher conductivity. Influx of sea water spray might be an explanation but there was no corresponding increase of the concentrations of chloride or sulphate in these periods (Figure 5-1 and Appendix).

To compare some of 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 Section 4.4). Two stations situated in the counties of Kalmar and Kronoberg were chosen and the results as weighted averages from 2004, 2005, 2006, 2007 and 2008 were taken from the Swedish environmental program for air and precipitation financed by SEPA (Swedish Environmental Protection Board) (data can be obtained from www.ivl.se). The results was also compared to the data obtained at the Äspö site during 2002 to 2007 /Ericsson 2004, 2005, 2009, Ericsson and Engdahl 2007, 2008/. The comparison shows that the concentration of ions is generally higher at Äspö (Table 5-5). The average of pH has varied at the Äspö site with slightly higher values than the other sites in south east Sweden. 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 $\text{SO}_4\text{-S}_{\text{korr}}$ (which excludes the part of sulphate that originates from sea salt) at Äspö has also previous years been more similar to the other stations in south east Sweden (Table 5-5). The reason for the different results from 2008 can be explained as a calculating error caused by higher reporting limits for SO_4 from the laboratory in two of the samples (sample number 15617 and 15662, see Table 5-2). If the calculation for these two samples instead is done on the results obtained by the measurements of $\text{SO}_4\text{-S}$ the value of $\text{SO}_4\text{-S}_{\text{korr}}$ is 0.32 mg/l. This value corresponds well with the values obtained previous years.

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)
2008-01-09	2008-01-16		250	50	20	314.2	1.6
2008-01-16	2008-01-23		0	0	20	314.2	0.0
2008-01-23	2008-01-30	15333	2,210	442	20	314.2	14.1
2008-01-30	2008-02-05		0	0	20	314.2	0.0
2008-02-05	2008-02-14	15335	244	49	20	314.2	1.6
2008-02-14	2008-02-18		0	0	20	314.2	0.0
2008-02-18	2008-02-27		0	0	20	314.2	0.0
2008-02-27	2008-03-05	15390	1,125	225	20	314.2	7.2
2008-03-05	2008-03-12		0	0	20	314.2	0.0
2008-03-12	2008-03-19	15391	1,125	225	20	314.2	7.2
2008-03-19	2008-03-26	15488	650	130	20	314.2	4.1
2008-03-26	2008-04-02		0	0	20	314.2	0.0
2008-04-02	2008-04-09		0	0	20	314.2	0.0
2008-04-09	2008-04-16	15495	3,420	684	20	314.2	21.8
2008-04-16	2008-04-24	15537	475	95	20	314.2	3.0
2008-04-24	2008-04-30	15538	440	88	20	314.2	2.8
2008-04-30	2008-05-07	15539	1,095	219	20	314.2	7.0
2008-05-07	2008-05-14		0	0	20	314.2	0.0
2008-05-14	2008-05-21	15576	543	109	20	314.2	3.5
2008-05-21	2008-05-28		0	0	20	314.2	0.0
2008-05-28	2008-06-04		0	0	20	314.2	0.0
2008-06-04	2008-06-12		0	0	20	314.2	0.0
2008-06-12	2008-06-18	15598	2,880	576	20	314.2	18.3
2008-06-18	2008-06-25	15613	570	114	20	314.2	3.6
2008-06-25	2008-07-02	15614	2,170	434	20	314.2	13.8
2008-07-02	2008-07-09	15617	5,440	1,088	20	314.2	34.6
2008-07-09	2008-07-16	15619	2,280	456	20	314.2	14.5
2008-07-16	2008-07-23	15634	1,650	330	20	314.2	10.5
2008-07-23	2008-07-30		0	0	20	314.2	0.0
2008-07-30	2008-08-06	15635	7,350	1,470	20	314.2	46.8
2008-08-06	2008-08-12	15636	4,520	904	20	314.2	28.8
2008-08-12	2008-08-20	15659	5,060	1,012	20	314.2	32.2
2008-08-20	2008-08-27	15660	4,650	930	20	314.2	29.6
2008-08-27	2008-09-01	15661	950	190	20	314.2	6.0
2008-09-01	2008-09-10	15662	2,820	564	20	314.2	18.0
2008-09-10	2008-09-17	15677	1,990	398	20	314.2	12.7
2008-09-17	2008-09-24	15678	2,090	418	20	314.2	13.3
2008-09-24	2008-09-29		0	0	20	314.2	0.0
2008-09-29	2008-10-07	15679	2,950	590	20	314.2	18.8
2008-10-07	2008-10-13		75	15	20	314.2	0.5
2008-10-13	2008-10-20	15761	2,485	497	20	314.2	16
2008-10-20	2008-10-27	15762	1,240	248	20	314.2	7.9
2008-10-27	2008-11-04	15763	6,300	1,260	20	314.2	40.1
2008-11-04	2008-11-11	15772	2,265	453	20	314.2	14.4
2008-11-11	2008-11-18	15787	580	116	20	314.2	3.7
2008-11-18	2008-11-24	15788	750	150	20	314.2	4.8
2008-11-24	2008-12-02	15789	2,110	422	20	314.2	13.4
2008-12-02	2008-12-08	15790	1,710	342	20	314.2	10.9
2008-12-08	2008-12-15	15805	3,710	742	20	314.2	23.6
Average				327			10.4
Standard deviation				369			11.7

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 Section 4.4).

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)
2008-04-09	2008-04-16	15495	1.0	<0.4	0.6	0.44	<0.02	<0.003
2008-07-02	2008-07-09	15617	0.2	<0.4	0.1	<0.09	<0.02	<0.003
2008-09-01	2008-09-10	15662	0.4	<0.4	0.3	0.10	<0.02	0.00611
2008-10-27	2008-11-04	15763	1.6	<0.4	0.2	0.17	0.0096	0.00389
Sample period Start	Sample period Stop	Sample number	Li (mg/l)	Si (mg/l)	Sr (mg/l)	SO ₄ -S meas. (mg/l)	Cl (mg/l)	
2008-04-09	2008-04-16	15495	<0.004	<0.03	0.005	0.78	1.6	
2008-07-02	2008-07-09	15617	<0.004	<0.03	<0.002	0.25	4.4	
2008-09-01	2008-09-10	15662	<0.004	<0.03	0.003	0.42	<1	
2008-10-27	2008-11-04	15763	<0.004	<0.03	0.003	0.29	2.7	
Sample period Start	Sample period Stop	Sample number	SO ₄ (mg/l)	SO ₄ -S calc. (mg/l)	SO ₄ -S _{korrr} calc. (mg/l)	Br (mg/l)	F (mg/l)	
2008-04-09	2008-04-16	15495	1.98	0.66	0.58	<0.2	<0.2	
2008-07-02	2008-07-09	15617	<5	<1.67	<1.65	<0.5	0.22	
2008-09-01	2008-09-10	15662	<5	<1.67	<1.63	<0.5	<0.2	
2008-10-27	2008-11-04	15763	1.07	0.36	0.22	<0.2	<0.2	

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 (%)
2008-04-09	2008-04-16	15495	23.0
2008-07-02	2008-07-09	15617	-71.2
2008-09-01	2008-09-10	15662	-38.0
2008-10-27	2008-11-04	15763	-3.4

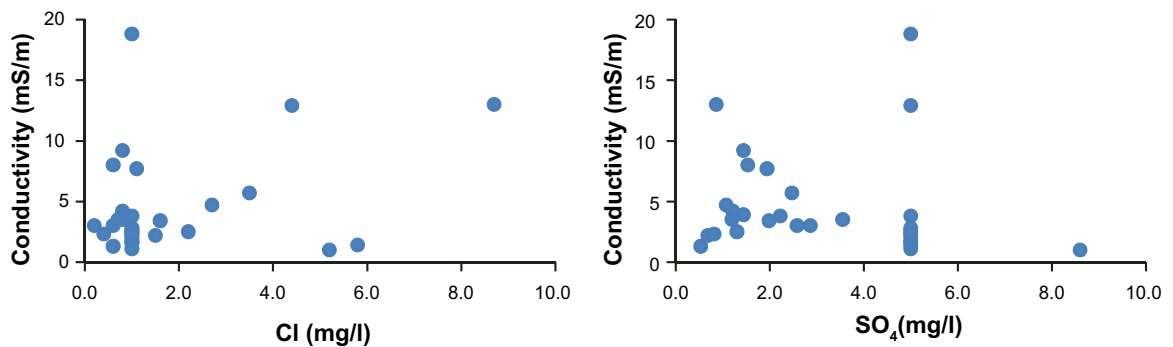


Figure 5-1. The relationships between chloride and conductivity and sulphate and conductivity.

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

Sample period Start	Sample period Stop	Sample number	pH	Conductivity (mS/m)
2008-01-23	2008-01-30	15333	4.96	1.3
2008-02-05	2008-02-14	15335	4.16	5.7
2008-02-27	2008-03-05	15390	4.80	2.2
2008-03-12	2008-03-19	15391	4.64	3.9
2008-03-19	2008-03-26	15488	4.52	7.7
2008-04-09	2008-04-16	15495	4.41	3.4
2008-04-16	2008-04-24	15537	3.90	3.5
2008-04-24	2008-04-30	15538	4.97	5.3
2008-04-30	2008-05-07	15539	6.41	3.0
2008-05-14	2008-05-21	15576	5.15	3.0
2008-06-18	2008-06-25	15613	5.17	1.6
2008-06-25	2008-07-02	15614	4.84	2.6
2008-07-02	2008-07-09	15617	5.00	12.9
2008-07-09	2008-07-16	15619	4.71	2.4
2008-07-16	2008-07-23	15634	5.00	18.8
2008-07-30	2008-08-06	15635	4.83	3.8
2008-08-06	2008-08-12	15636	5.14	1.1
2008-07-16	2008-07-23	15659	5.53	1.0
2008-07-30	2008-08-06	15660	5.14	1.4
2008-09-01	2008-09-10	15662	4.79	1.7
2008-09-10	2008-09-17	15677	4.52	2.8
2008-09-17	2008-09-24	15678	5.12	2.0
2008-09-29	2008-10-07	15681	5.29	2.3
2008-10-13	2008-10-20	15761	4.91	9.2
2008-10-20	2008-10-27	15762	5.39	4.2
2008-10-27	2008-11-04	15763	6.47	4.7
2008-11-04	2008-11-11	15772	4.58	8.0
2008-11-11	2008-11-18	15787	5.10	2.5
2008-11-18	2008-11-24	15788	5.08	13.0
2008-11-24	2008-12-02	15789	4.38	3.8
2008-12-02	2008-12-08	15790	4.20	3.5
2008-12-08	2008-12-15	15805	4.48	2.3
Average			4.92	4.5
Standard deviation			0.54	4.0

Table 5-5. Volume weighted averages of some major ions and pH in Äspö and in some other stations in south east Sweden 2004, 2005, 2006, 2007 and 2008.

Station	Cl (mg/l)	SO ₄ -S _{korrr} (mg/l)	Na (mg/l)	Ca (mg/l)	K (mg/l)	Mg (mg/l)	pH
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 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
Aneboda 2008	1.58	0.36	1.06	0.22	0.12	0.13	4.72
Aneboda 2007	2.68	0.39	1.65	0.20	0.11	0.20	4.80
Aneboda 2006	1.00	0.37	0.65	0.13	0.16	0.09	4.71
Aneboda 2005	0.69	0.38	0.44	0.14	0.11	0.06	4.69
Aneboda 2004	1.27	0.35	0.87	0.14	0.09	0.12	4.69

The hydrogen isotope ratio of $\delta^2\text{H}$ varied with an indication of lower ratios in winter (Table 5-6 and Appendix). With one exception these ratios correlated well with the ratios of $\delta^{18}\text{O}$ (Figure 5-2). In Figure 5-3 sample number 15763 has been omitted with a better linear correlation as a result. The linear relation in Figure 5-3 also corresponds well with the “Global Meteoric Water Line” ($\delta^2\text{H} = 8 \cdot \delta^{18}\text{O} + 10$) which is based on precipitation data from locations around the globe /Craig 1961/. 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 and trace elements in one of the sample periods (SKB-number 15763) showed, as expected, low values (Table 5-7).

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)
2008-01-23	2008-01-30	15333	7.50	-95.8	-12.70
2008-04-09	2008-04-16	15495	9.80	-96.8	-13.00
2008-07-02	2008-07-09	15617	16.40	-71.7	-10.20
2008-09-01	2008-09-10	15662	7.80	-55.3	-7.90
2008-10-27	2008-11-04	15763	7.80	-79.7	-12.90
Sample period Start	Sample period Stop	Sample number	^3H (TU)	$\delta^2\text{H}$ (‰ V-SMOW)	$\delta^{18}\text{O}$ (‰ V-SMOW)
2008-01-09	2008-04-30	15540	8.00	-86.3	-11.40
2008-04-30	2008-07-02	15615	14.20	-53.8	-7.60
2008-07-02	2008-09-29	15679	10.70	-67.8	-9.70
2008-09-29	2008-12-15	15825	9.90	-87.9	-11.90

Table 5-7. Heavy metals and trace elements measured in sample period 2008-10-27 to 2008-11-04.

Sample period Start	Sample period Stop	Sample number	Al (ug/l)	Ba (ug/l)	Cd (ug/l)	Cr (ug/l)	Cu (ug/l)	Co (ug/l)
2008-10-27	2008-11-04	15763	4.89	0.705	0.01	0.175	0.787	0.0143
Sample period Start	Sample period Stop	Sample number	Hg (ug/l)	Ni (ug/l)	Mo (ug/l)	Pb (ug/l)	V (ug/l)	Zn (ug/l)
2008-10-27	2008-11-04	15763	<0.002	0.582	<0.05	0.209	0.164	8.19
Sample period Start	Sample period Stop	Sample number	U (ug/l)	Th (ug/l)	Sc (ug/l)	Rb (ug/l)	Y (ug/l)	Zr (ug/l)
2008-10-27	2008-11-04	15763	0.0058	<0.02	<0.05	0.321	0.0071	<0.03
Sample period Start	Sample period Stop	Sample number	Sb (ug/l)	Cs (ug/l)	La (ug/l)	Hf (ug/l)	Tl (ug/l)	Ce (ug/l)
2008-10-27	2008-11-04	15763	0.119	<0.03	0.01	<0.005	<0.01	0.0239
Sample period Start	Sample period Stop	Sample number	Pr (ug/l)	Nd (ug/l)	Sm (ug/l)	Eu (ug/l)	Gd (ug/l)	Tb (ug/l)
2008-10-27	2008-11-04	15763	<0.005	0.0119	<0.005	<0.005	<0.005	<0.005
Sample period Start	Sample period Stop	Sample number	Dy (ug/l)	Ho (ug/l)	Er (ug/l)	Tm (ug/l)	Yb (ug/l)	Lu (ug/l)
2008-10-27	2008-11-04	15763	<0.005	<0.005	<0.005	<0.004	<0.005	<0.005

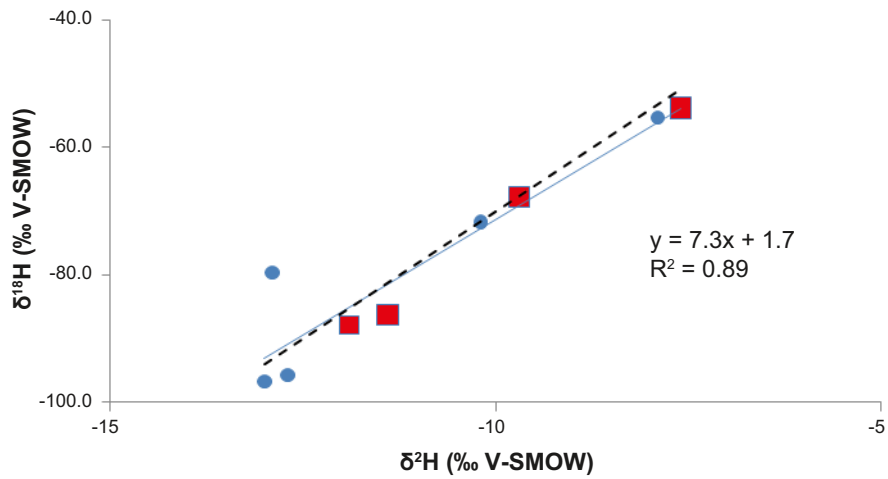


Figure 5-2. The relationship between the ratios of $\delta^2\text{H}$ and $\delta^{18}\text{O}$ at the Äspö site in 2008. The red square is the data from the general samples. The dotted line represents the Global Meteoric Water Line ($\delta^2\text{H} = 8 \cdot \delta^{18}\text{O} + 10$).

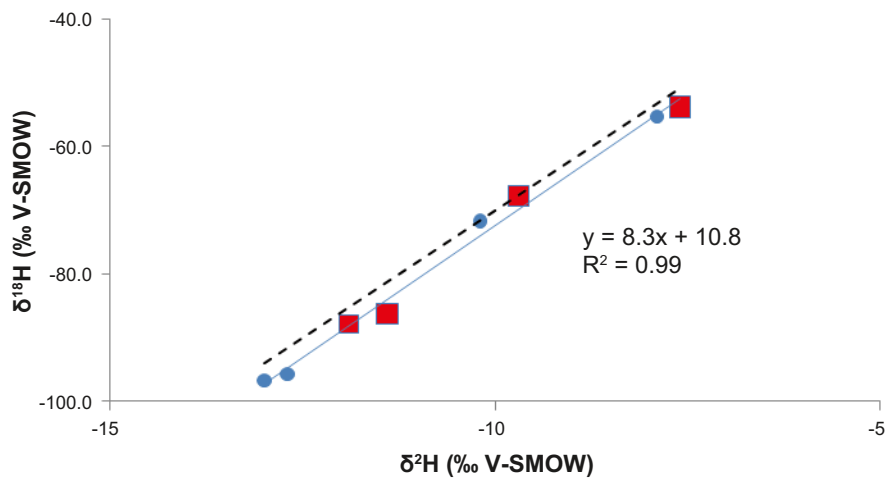


Figure 5-3. The relationship between the ratios of $\delta^2\text{H}$ and $\delta^{18}\text{O}$ at the Äspö site in 2008. The red square is the data from the general samples (compared to Figure 5-1 sample number 15763 has been omitted for comparison). The dotted line represents the Global Meteoric Water Line ($\delta^2\text{H} = 8 \cdot \delta^{18}\text{O} + 10$).

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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)
2008-01-23	2008-01-30	15333									
2008-02-05	2008-02-14	15335									
2008-02-27	2008-03-05	15390									
2008-03-12	2008-03-19	15391									
2008-03-19	2008-03-26	15488									
2008-04-09	2008-04-16	15495	1.0	<0.4	0.6	0.44	<0.02	<0.003	<0.004	<0.03	0.005
2008-04-16	2008-04-24	15537									
2008-04-24	2008-04-30	15538									
2008-04-30	2008-05-07	15539									
2008-05-14	2008-05-21	15576									
2008-06-18	2008-06-25	15613									
2008-06-25	2008-07-02	15614									
2008-07-02	2008-07-09	15617	0.2	<0.4	0.1	<0.09	<0.02	<0.003	<0.004	<0.03	<0.002
2008-07-09	2008-07-16	15619									
2008-07-16	2008-07-23	15634									
2008-07-30	2008-08-06	15635									
2008-08-06	2008-08-12	15636									
2008-07-16	2008-07-23	15659									
2008-07-30	2008-08-06	15660									
2008-09-01	2008-09-10	15662	0.4	<0.4	0.3	0.10	<0.02	0.00611	<0.004	<0.03	0.003
2008-09-10	2008-09-17	15677									
2008-09-17	2008-09-24	15678									
2008-09-29	2008-10-07	15681									
2008-10-13	2008-10-20	15761									
2008-10-20	2008-10-27	15762									
2008-10-27	2008-11-04	15763	1.6	<0.4	0.2	0.17	0.0096	0.00389	<0.004	<0.03	0.003
2008-11-04	2008-11-11	15772									
2008-11-11	2008-11-18	15787									
2008-11-18	2008-11-24	15788									
2008-11-24	2008-12-02	15789									
2008-12-02	2008-12-08	15790									
2008-12-08	2008-12-15	15805									

Sample period Start	Sample period Stop	Sample number	SO ₄ -S meas. (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	Br (mg/l)	F (mg/l)	HCO ₃ (mg/l)	pH	Conductivity (mS/m)
2008-01-23	2008-01-30	15333		0.6	0.53	<0.2	<0.2		4.96	1.3
2008-02-05	2008-02-14	15335		3.5	2.47	<0.2	<0.2		4.16	5.7
2008-02-27	2008-03-05	15390		1.5	0.68	<0.2	<0.2		4.80	2.2
2008-03-12	2008-03-19	15391		0.8	1.44	<0.2	<0.2		4.64	3.9
2008-03-19	2008-03-26	15488		1.1	1.94	<0.2	<0.2		4.52	7.7
2008-04-09	2008-04-16	15495	0.78	1.6	1.98	<0.2	<0.2		4.41	3.4
2008-04-16	2008-04-24	15537		0.8	3.55	<0.2	<0.2		3.90	3.5
2008-04-24	2008-04-30	15538							4.97	5.3
2008-04-30	2008-05-07	15539		<0.2	2.86	<0.2	<0.2	1.32	6.41	3.0
2008-05-14	2008-05-21	15576		0.6	2.58	<0.2	<0.2	0.80	5.15	3.0
2008-06-18	2008-06-25	15613		<1	<5	<0.5	<0.2		5.17	1.6
2008-06-25	2008-07-02	15614		<1	<5	<0.5	<0.2		4.84	2.6
2008-07-02	2008-07-09	15617	0.25	4.4	<5	<0.5	0.22		5.00	12.9
2008-07-09	2008-07-16	15619		<1	<5	<0.5	<0.2		4.71	2.4
2008-07-16	2008-07-23	15634		<1	<5	<0.5	<0.2		5.00	18.8
2008-07-30	2008-08-06	15635		<1	<5	<0.5	<0.2		4.83	3.8
2008-08-06	2008-08-12	15636		<1	<5	<0.5	<0.2		5.14	1.1
2008-07-16	2008-07-23	15659		5.2	8.60	<0.5	0.71		5.53	1.0
2008-07-30	2008-08-06	15660		5.8	<5	<0.5	<0.2		5.14	1.4
2008-09-01	2008-09-10	15662	0.42	<1	<5	<0.5	<0.2		4.79	1.7
2008-09-10	2008-09-17	15677		1.0	<5	<0.5	<0.2		4.52	2.8
2008-09-17	2008-09-24	15678		<1	<5	<0.5	<0.2		5.12	2.0
2008-09-29	2008-10-07	15681		<1	<5	<0.5	<0.2		5.29	2.3
2008-10-13	2008-10-20	15761		0.8	1.44	<0.2	<0.2		4.91	9.2
2008-10-20	2008-10-27	15762		0.8	1.21	<0.2	<0.2		5.39	4.2
2008-10-27	2008-11-04	15763	0.29	2.7	1.07	<0.2	<0.2		6.47	4.7
2008-11-04	2008-11-11	15772		0.6	1.53	<0.2	<0.2		4.58	8.0
2008-11-11	2008-11-18	15787		2.2	1.30	<0.2	<0.2		5.10	2.5
2008-11-18	2008-11-24	15788		8.7	0.86	0.255	<0.2		5.08	13.0
2008-11-24	2008-12-02	15789		0.8	2.22	<0.2	<0.2		4.38	3.8
2008-12-02	2008-12-08	15790		0.7	1.19	<0.2	<0.2		4.20	3.5
2008-12-08	2008-12-15	15805		0.4	0.81	-0.200	-0.20		4.48	2.3

Sample period Start	Sample period Stop	Sample number	³ H (TU)	δ ² H (‰ VSMOW)	δ ¹⁸ O (‰ VSMOW)
2008-01-23	2008-01-30	15333	7.50	-95.8	-12.70
2008-02-05	2008-02-14	15335			
2008-02-27	2008-03-05	15390			
2008-03-12	2008-03-19	15391			
2008-03-19	2008-03-26	15488			
2008-04-09	2008-04-16	15495	9.80	-96.8	-13.00
2008-04-16	2008-04-24	15537			
2008-04-24	2008-04-30	15538			
2008-04-30	2008-05-07	15539			
2008-05-14	2008-05-21	15576			
2008-06-18	2008-06-25	15613			
2008-06-25	2008-07-02	15614			
2008-07-02	2008-07-09	15617	16.40	-71.7	-10.20
2008-07-09	2008-07-16	15619			
2008-07-16	2008-07-23	15634			
2008-07-30	2008-08-06	15635			
2008-08-06	2008-08-12	15636			
2008-07-16	2008-07-23	15659			
2008-07-30	2008-08-06	15660			
2008-09-01	2008-09-10	15662	7.80	-55.3	-7.90
2008-09-10	2008-09-17	15677			
2008-09-17	2008-09-24	15678			
2008-09-29	2008-10-07	15681			
2008-10-13	2008-10-20	15761			
2008-10-20	2008-10-27	15762			
2008-10-27	2008-11-04	15763	7.80	-79.7	-12.90
2008-11-04	2008-11-11	15772			
2008-11-11	2008-11-18	15787			
2008-11-18	2008-11-24	15788			
2008-11-24	2008-12-02	15789			
2008-12-02	2008-12-08	15790			
2008-12-08	2008-12-15	15805			
Sample period Start	Sample period Stop	Sample number	³ H (TU)	δ ² H (‰ VSMOW)	δ ¹⁸ O (‰ VSMOW)
2008-01-09	2008-04-30	15540	8.00	-86.3	-11.40
2008-04-30	2008-07-02	15615	14.20	-53.8	-7.60
2008-07-02	2008-09-29	15679	10.70	-67.8	-9.70
2008-09-29	2008-12-15	15825	9.90	-87.9	-11.90

Sample period Start	Sample period Stop	Sample number	Al (ug/l)	Ba (ug/l)	Cd (ug/l)	Cr (ug/l)	Cu (ug/l)	Co (ug/l)	Hg (ug/l)	Ni (ug/l)
2008-01-23	2008-01-30	15333								
2008-02-05	2008-02-14	15335								
2008-02-27	2008-03-05	15390								
2008-03-12	2008-03-19	15391								
2008-03-19	2008-03-26	15488								
2008-04-09	2008-04-16	15495								
2008-04-16	2008-04-24	15537								
2008-04-24	2008-04-30	15538								
2008-04-30	2008-05-07	15539								
2008-05-14	2008-05-21	15576								
2008-06-18	2008-06-25	15613								
2008-06-25	2008-07-02	15614								
2008-07-02	2008-07-09	15617								
2008-07-09	2008-07-16	15619								
2008-07-16	2008-07-23	15634								
2008-07-30	2008-08-06	15635								
2008-08-06	2008-08-12	15636								
2008-07-16	2008-07-23	15659								
2008-07-30	2008-08-06	15660								
2008-09-01	2008-09-10	15662								
2008-09-10	2008-09-17	15677								
2008-09-17	2008-09-24	15678								
2008-09-29	2008-10-07	15681								
2008-10-13	2008-10-20	15761								
2008-10-20	2008-10-27	15762								
2008-10-27	2008-11-04	15763	4.8900	0.7050	0.0135	0.1750	0.7870	0.0143	<0.002	0.5820
2008-11-04	2008-11-11	15772								
2008-11-11	2008-11-18	15787								
2008-11-18	2008-11-24	15788								
2008-11-24	2008-12-02	15789								
2008-12-02	2008-12-08	15790								
2008-12-08	2008-12-15	15805								

Sample period Start	Sample period Stop	Sample number	Mo (ug/l)	Pb (ug/l)	V (ug/l)	Zn (ug/l)	U (ug/l)	Th (ug/l)	Sc (ug/l)	Rb (ug/l)
2008-01-23	2008-01-30	15333								
2008-02-05	2008-02-14	15335								
2008-02-27	2008-03-05	15390								
2008-03-12	2008-03-19	15391								
2008-03-19	2008-03-26	15488								
2008-04-09	2008-04-16	15495								
2008-04-16	2008-04-24	15537								
2008-04-24	2008-04-30	15538								
2008-04-30	2008-05-07	15539								
2008-05-14	2008-05-21	15576								
2008-06-18	2008-06-25	15613								
2008-06-25	2008-07-02	15614								
2008-07-02	2008-07-09	15617								
2008-07-09	2008-07-16	15619								
2008-07-16	2008-07-23	15634								
2008-07-30	2008-08-06	15635								
2008-08-06	2008-08-12	15636								
2008-07-16	2008-07-23	15659								
2008-07-30	2008-08-06	15660								
2008-09-01	2008-09-10	15662								
2008-09-10	2008-09-17	15677								
2008-09-17	2008-09-24	15678								
2008-09-29	2008-10-07	15681								
2008-10-13	2008-10-20	15761								
2008-10-20	2008-10-27	15762								
2008-10-27	2008-11-04	15763	<0.05	0.2090	0.1640	8.1900	0.0058	<0.02	<0.05	0.321
2008-11-04	2008-11-11	15772								
2008-11-11	2008-11-18	15787								
2008-11-18	2008-11-24	15788								
2008-11-24	2008-12-02	15789								
2008-12-02	2008-12-08	15790								
2008-12-08	2008-12-15	15805								

Sample period Start	Sample period Stop	Sample number	Y (ug/l)	Zr (ug/l)	Sb (ug/l)	Cs (ug/l)	La (ug/l)	Hf (ug/l)	Tl (ug/l)	Ce (ug/l)
2008-01-23	2008-01-30	15333								
2008-02-05	2008-02-14	15335								
2008-02-27	2008-03-05	15390								
2008-03-12	2008-03-19	15391								
2008-03-19	2008-03-26	15488								
2008-04-09	2008-04-16	15495								
2008-04-16	2008-04-24	15537								
2008-04-24	2008-04-30	15538								
2008-04-30	2008-05-07	15539								
2008-05-14	2008-05-21	15576								
2008-06-18	2008-06-25	15613								
2008-06-25	2008-07-02	15614								
2008-07-02	2008-07-09	15617								
2008-07-09	2008-07-16	15619								
2008-07-16	2008-07-23	15634								
2008-07-30	2008-08-06	15635								
2008-08-06	2008-08-12	15636								
2008-07-16	2008-07-23	15659								
2008-07-30	2008-08-06	15660								
2008-09-01	2008-09-10	15662								
2008-09-10	2008-09-17	15677								
2008-09-17	2008-09-24	15678								
2008-09-29	2008-10-07	15681								
2008-10-13	2008-10-20	15761								
2008-10-20	2008-10-27	15762								
2008-10-27	2008-11-04	15763	0.0071	<0.03	0.119	<0.03	0.0136	<0.005	<0.01	0.0239
2008-11-04	2008-11-11	15772								
2008-11-11	2008-11-18	15787								
2008-11-18	2008-11-24	15788								
2008-11-24	2008-12-02	15789								
2008-12-02	2008-12-08	15790								
2008-12-08	2008-12-15	15805								

Sample period Start	Sample period Stop	Sample number	Pr (ug/l)	Nd (ug/l)	Sm (ug/l)	Eu (ug/l)	Gd (ug/l)	Tb (ug/l)	Dy (ug/l)	Ho (ug/l)
2008-01-23	2008-01-30	15333								
2008-02-05	2008-02-14	15335								
2008-02-27	2008-03-05	15390								
2008-03-12	2008-03-19	15391								
2008-03-19	2008-03-26	15488								
2008-04-09	2008-04-16	15495								
2008-04-16	2008-04-24	15537								
2008-04-24	2008-04-30	15538								
2008-04-30	2008-05-07	15539								
2008-05-14	2008-05-21	15576								
2008-06-18	2008-06-25	15613								
2008-06-25	2008-07-02	15614								
2008-07-02	2008-07-09	15617								
2008-07-09	2008-07-16	15619								
2008-07-16	2008-07-23	15634								
2008-07-30	2008-08-06	15635								
2008-08-06	2008-08-12	15636								
2008-07-16	2008-07-23	15659								
2008-07-30	2008-08-06	15660								
2008-09-01	2008-09-10	15662								
2008-09-10	2008-09-17	15677								
2008-09-17	2008-09-24	15678								
2008-09-29	2008-10-07	15681								
2008-10-13	2008-10-20	15761								
2008-10-20	2008-10-27	15762								
2008-10-27	2008-11-04	15763	<0.005	0.0119	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2008-11-04	2008-11-11	15772								
2008-11-11	2008-11-18	15787								
2008-11-18	2008-11-24	15788								
2008-11-24	2008-12-02	15789								
2008-12-02	2008-12-08	15790								
2008-12-08	2008-12-15	15805								

Sample period Start	Sample period Stop	Sample number	Er (ug/l)	Tm (ug/l)	Yb (ug/l)	Lu (ug/l)
2008-01-23	2008-01-30	15333				
2008-02-05	2008-02-14	15335				
2008-02-27	2008-03-05	15390				
2008-03-12	2008-03-19	15391				
2008-03-19	2008-03-26	15488				
2008-04-09	2008-04-16	15495				
2008-04-16	2008-04-24	15537				
2008-04-24	2008-04-30	15538				
2008-04-30	2008-05-07	15539				
2008-05-14	2008-05-21	15576				
2008-06-18	2008-06-25	15613				
2008-06-25	2008-07-02	15614				
2008-07-02	2008-07-09	15617				
2008-07-09	2008-07-16	15619				
2008-07-16	2008-07-23	15634				
2008-07-30	2008-08-06	15635				
2008-08-06	2008-08-12	15636				
2008-07-16	2008-07-23	15659				
2008-07-30	2008-08-06	15660				
2008-09-01	2008-09-10	15662				
2008-09-10	2008-09-17	15677				
2008-09-17	2008-09-24	15678				
2008-09-29	2008-10-07	15681				
2008-10-13	2008-10-20	15761				
2008-10-20	2008-10-27	15762				
2008-10-27	2008-11-04	15763	<0.005	<0.004	<0.005	<0.005
2008-11-04	2008-11-11	15772				
2008-11-11	2008-11-18	15787				
2008-11-18	2008-11-24	15788				
2008-11-24	2008-12-02	15789				
2008-12-02	2008-12-08	15790				
2008-12-08	2008-12-15	15805				