P-07-167

Oskarshamn site investigation

Hydrochemical monitoring programme for core drilled boreholes 2006

Summary of analyses from water sampling

Per Askling, Kersti Nilsson
Geosigma AB

November 2007

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-07-167

Oskarshamn site investigation

Hydrochemical monitoring programme for core drilled boreholes 2006

Summary of analyses from water sampling

Per Askling, Kersti Nilsson
Geosigma AB

November 2007

Keywords: Groundwater, Borehole, Chemical analyses, Isotope determinations, AP PS 400-06-060.

Abstract

This report summarises water sampling from nineteen sections in permanently installed core-drilled boreholes; KAV01:3, KLX01:3, KLX02:2, KLX02:5, KLX03:4, KLX04:2, KLX04:5, KLX05:3, KLX05:7, KLX06:3, KLX06:6, KLX07A:2, KLX10A:2, KLX10A:5, KLX12A:2, KSH01A:4, KSH01A:7, KSH02:1 and KSH02:4, within the site investigation programme at Oskarshamn. The water sampling performed in the monitoring programme is repeated twice every year and this report summarises the results from 2006. The objective is to determine the groundwater composition in the sections instrumented for this purpose.

The results from this activity include groundwater chemistry data in accordance with SKB class 3 and SKB class 5. The data were obtained during June and July 2006 (summer sampling campaign – eleven sections) and October, November and December 2006 (winter sampling campaign – nineteen sections).

All analytical data from the activity are stored in the SICADA database.

Sammanfattning

Denna rapport sammanfattar vattenprovtagning från nitton sektioner i de permanent installerade kärnborrhålen KAV01:3, KLX01:3, KLX02:2, KLX02:5, KLX03:4, KLX04:2, KLX04:5, KLX05:3, KLX05:7, KLX06:3, KLX06:6, KLX07A:2, KLX10A:2, KLX10A:5, KLX12A:2, KSH01A:4, KSH01A:7, KSH02:1 and KSH02:4 inom platsundersökningen i Oskarshamn. Provtagningen utförs två gånger per år och denna rapport sammanfattar resultaten för 2006. Syftet är att bestämma grundvattensammansättningen i samtliga för ändamålet instrumenterade borrhålssektioner.

Resultaten från denna aktivitet inkluderar vattenkemidata enligt SKB kemiklass 3 och SKB kemiklass 5. Proverna är tagna under juni och juli 2006 (sommarprovtagning – elva sektioner) och oktober, november och december 2006 (vinterprovtagning – nitton sektioner).

Alla resultat från vattenanalyserna finns i databasen SICADA.

Contents

1 Introduction

This document reports data collected within the Hydrochemical monitoring programme for core drilled boreholes 2006, 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 400-06-060. Controlling documents for performing this activity are listed in Table 1-1. The Activity Plan and Method Description are SKB internal controlling documents. The field work was performed during June to July 2006 and October to December 2006 and is reported in the database SICADA, traceable using the Activity Plan number.

The activity includes water sampling from boreholes (Table 1-2) according to SKB chemistry class 5 including options of trace elements and the isotopes $\delta^{34}S$, $\delta^{37}Cl$, $^{87}Sr/^{86}Sr$, $^{10}B/^{11}B$, ^{14}C, $\delta^{13}C$, ^{226}Ra, ^{222}Rn, ^{238}U, ^{234}U and ^{230}Th.

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

Activity Plan	**Number**	**Version**
Hydrokemiskt moniteringsprogram för kärnborrhål 2006	AP PS 400-06-060	1.0
Method Description	**Number**	**Version**
System för hydrologisk och metrologisk datainsamling	SKB MD 368.010	1.0 (2004-05-26)

Table 1-2. Borehole, borehole section, borehole length and hydraulic transmissivity.

Borehole:Section	**Borehole length (m)**	**Hydraulic transmissivity (m^2/s)**
KAV01:3	391–434	1.8 E–5
KLX01:3	171–190	1.1 E–5
KLX02:2	1,145–1,164	3.2 E–7
KLX02:5	452–494	1.0 E–7
KLX03:4*	729–751	5.9 E–6
KLX04:2*	870–897	3.5 E–8
KLX04:5*	507–530	2.7 E–6
KLX05:3*	625–633	1.2 E–8
KLX05:7*	241–255	6.2 E–7
KLX06:3	554–570	1 E–5 (uncertain)
KLX06:6	256–275	> 5 E–5 (uncertain)
KLX07A:2	753–780	3.5 E–5
KLX10A:2*	689–710	1 E–7
KLX10A:5*	351–368	1 E–6
KLX12A:2*	535–545	2 E–7
KSH01A:4	532–572	8.4 E–7
KSH01A:7	238–277	7.4 E–6
KSH02:1	955–963	6.8 E–8
KSH02:4	411–439	9.7 E–8

* Not in the summer sampling campaign 2006.

All the water samples in the summer sampling campaign were analysed according to SKB chemistry class 5 including the options mentioned above. Most of the samples in the winter sampling campaign were analysed according to SKB chemistry class 3 including options $\delta^{18}O$, $\delta^{2}H$ and ^{3}H and the remaining water samples were analysed according to SKB chemistry class 5 (including the options mentioned above for the summer sampling campaign).

Determination of density and field measurements of pH and temperature were also performed. Archive samples were stored in a freezer. A map showing the investigation site at Oskarshamn is presented in Figure 1-1.

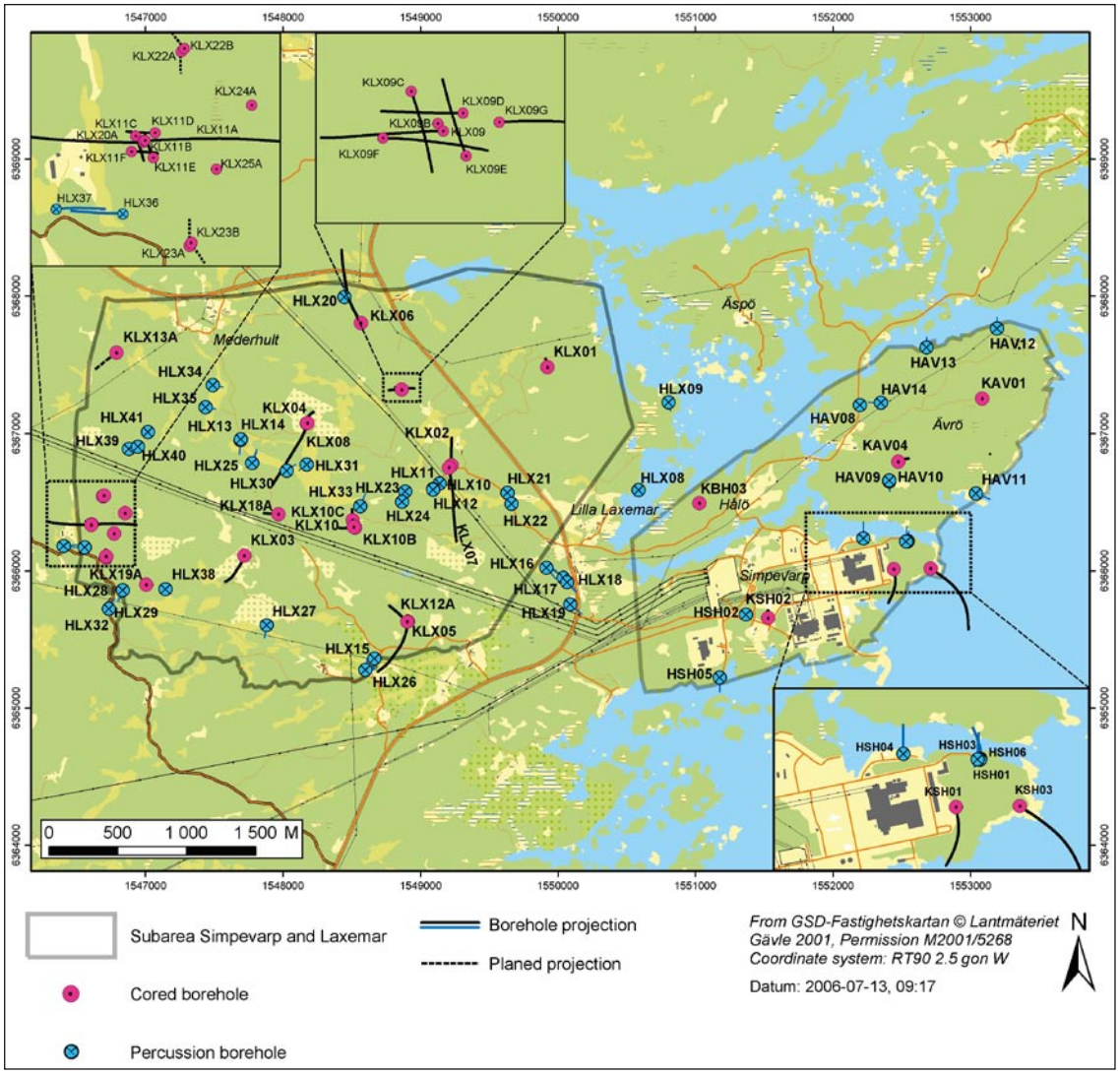

Figure 1-1. *Overview of the Oskarshamn site investigation area, including the boreholes.*

2 Objective and scope

This report summarises results from the water samples collected within the Hydrochemical monitoring programme for core drilled boreholes 2006. According to the general programme for the site investigation area, the core drilled boreholes are monitored. The water sampling is performed in circulation sections that are sealed off using permanently installed packers. The monitoring programme will last at least until the decision about a future repository is made.

3 Equipment

3.1 Description of equipment

The water sampling is performed in borehole sections with permanently installed packers. The pump equipment used for the water sampling is schematically presented in Figure 3-1.

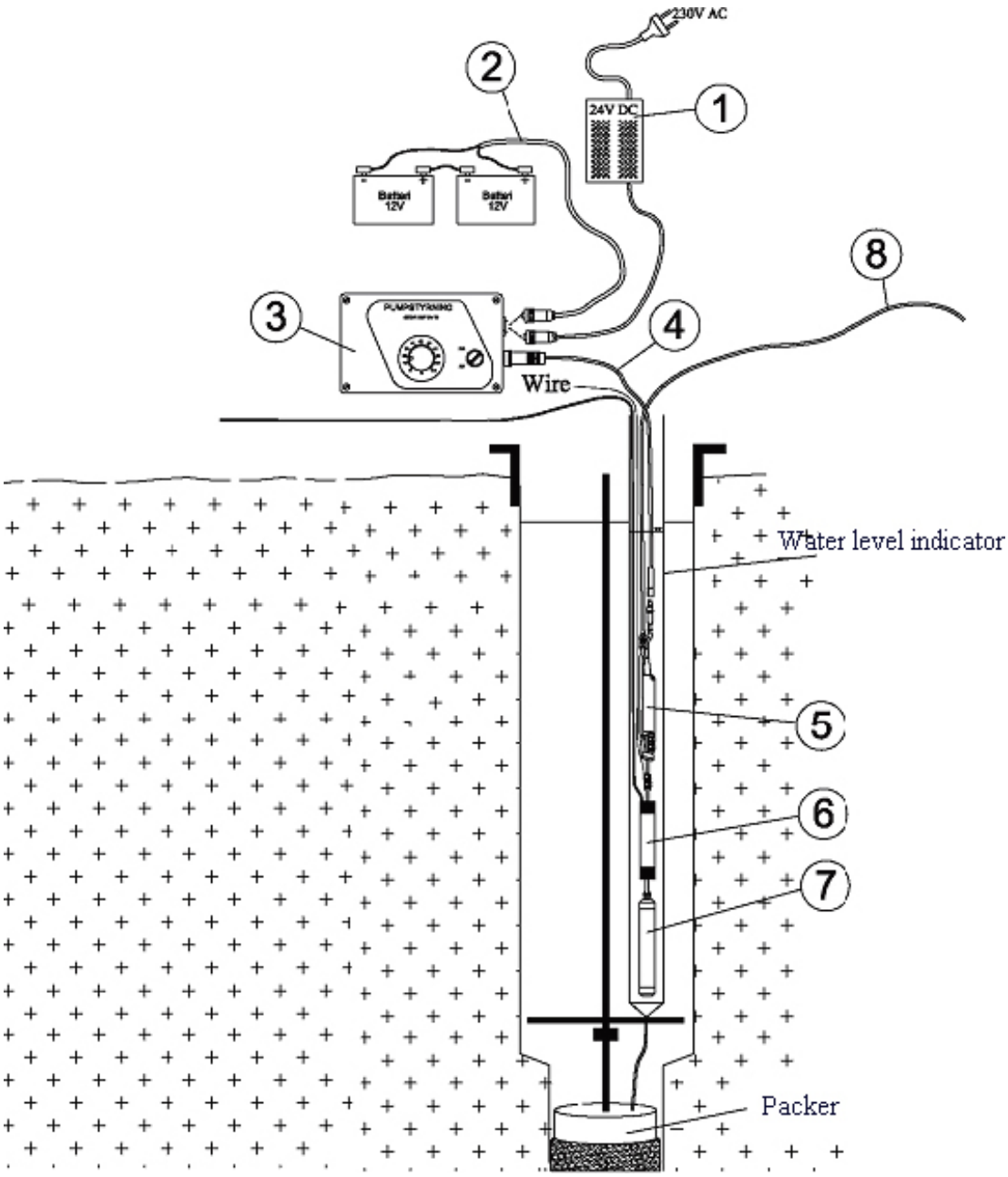

Figure 3-1. *Schematic drawing of the equipment used for water sampling; 1. Battery eliminator 2. Battery cable 3. Pump control GEOPUMP UV 45 4. Pump Cable 5. GEOPUMP UV 45 6. Mini packer 7. Filter holder with filter 8. Pump tube, polyamide 8/6 mm.*

4 Execution

4.1 General

The water sampling was performed using identical equipment set-ups, one in each borehole section, a schematic drawing is shown in Figure 3-1. The water volume in the pipe plus the volume in the section should preferably be converted five times, but at least three times before the water sample is taken (Table 4-1). The pumping volume is controlled by the down-hole pump.
The drawdown is not allowed to exceed 20 m.

The water pumped up from the boreholes is collected in a tank and emptied onto the rinse plate at Simpevarp.

The activity was performed in accordance with the Activity Plan AP PS 400-06-060 and following the Method Description SKB MD 368.010 (System för hydrologisk och metrologisk datainsamling. Vattenprovtagning och utspädningsmätning i observationshål, SKB internal controlling document).

4.2 Preparations

The function of each pump was checked using a bucket. The tubes were cleaned or exchanged before installation in the borehole.

4.3 Execution of field work

The water sampling was performed in nineteen sections listed in Table 4-1. The samples were collected after conversion of water at least three times in each section. For a detailed description see Method Description SKB MD 368.010 (System för hydrologisk och metrologisk datainsamling. Vattenprovtagning och utspädningsmätning i observationshål, SKB internal controlling document).

The water level in the borehole sections was logged in order to determine the maximal drawdown during the sampling period.

4.4 Handling of water analysis data

The following routines for quality control and data management are generally applied for hydrogeochemical analytical data, independently of sampling method or sampling object.

Some of the constituents are determined by more than one method and/or laboratory. All analytical results are stored in the SICADA database. The applied hierarchy path “Hydrochemistry/ Hydrochemical investigation/Analyses/Water in the database” contains two types of tables, raw data tables and primary data tables (final data tables).

Table 4-1. Volume in tube and section and calculated pumping time.

Borehole	Borehole Length (m)	Volume (tube + section) (L)	Volume x 3 (L)	Volume x 5 (L)	Calculated* pumping time (3 times the Volume)	Calculated* pumping time (5 times the Volume)
KAV01:3	391–434	27.777	83.331	138.885	2 h 47 min	4 h 38 min
KLX01:3	171–190	16.235	48.705	81.175	1 h 38 min	2 h 43 min
KLX02:2	1,145–1,164	43.774	131.322	218.870	4 h 23 min	7 h 18 min
KLX02:5	452–494	32.255	96.765	161.275	3 h 14 min	5 h 23 min
KLX03:4	729–751	32.573	97.719	162.865	3 h 16 min	5 h 26 min
KLX04:2	870–897	37.890	113.670	189.450	3 h 48 min	6 h 19 min
KLX04:5	507–530	26.365	79.095	131.825	2 h 39 min	4 h 24 min
KLX05:3	625–633	25.051	75.153	125.255	2 h 31 min	4 h 11 min
KLX05:7	241–255	16.157	48.471	80.785	1 h 37 min	2 h 42 min
KLX06:3	554–570	25.661	76.983	128.305	2 h 34 min	4 h 17 min
KLX06:6	256–275	18.217	54.651	91.085	1 h 50 min	3 h 3 min
KLX07A:2	753–780	34.887	104.661	174.435	3 h 30 min	5 h 49 min
KLX10A:5	351–368	20.248	60.744	101.240	2 h 2 min	3 h 23 min
KLX10A:2	689–710	31.114	93.342	155.570	3 h 7 min	5 h 12 min
KLX12A:2	535–545	23.160	69.480	115.800	2 h 19 min	3 h 52 min
KSH01A:4	532–572	32.892	98.676	164.460	3 h 18 min	5 h 29 min
KSH01A:7	238–277	24.252	72.756	121.260	2 h 26 min	4 h 3 min
KSH02:1	955–963	34.302	102.906	171.510	3 h 26 min	5 h 44 min
KSH02:4	411–439	25.227	75.681	126.135	2 h 32 min	4 h 13 min

* When the water flow is 500 mL/min.

Data on **basic water analyses** are inserted into the raw data tables for further evaluation. The evaluation results in a final reduced data set for each sample. These data sets are compiled in a primary data table named “water composition”. The evaluation is based on:

- Comparison of the results from different laboratories and/or methods.
- Calculation of charge balance errors, equation (1). Relative errors within ± 5% are considered acceptable.

$$\text{Relative error}\,(\%) = 100 \times \frac{\sum \text{cations}(\text{equivalents}) - \sum \text{anions}(\text{equivalents})}{\sum \text{cations}(\text{equivalents}) + \sum \text{anions}(\text{equivalents})} \qquad (1)$$

- General judgement of plausibility based on earlier results and experience.

All results from **special analyses of trace metals and isotopes** are inserted directly into primary data tables. In cases where the analyses are repeated or performed by more than one laboratory, a “best choice” notation will indicate those results which are considered most reliable.

An overview of the data management is given in Figure 4-1.

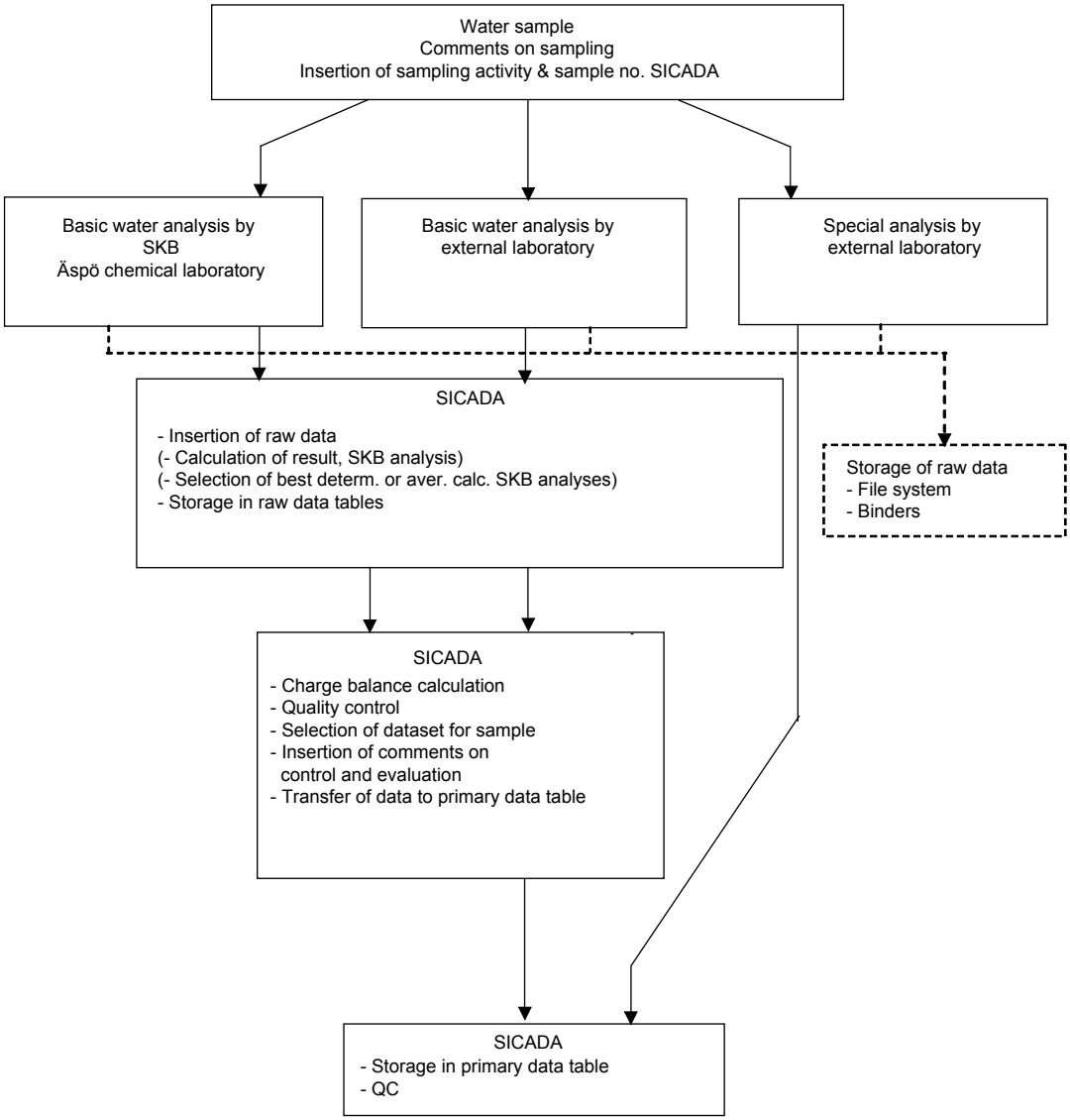

Figure 4-1. *Overview of data management for hydrogeochemical data.*

4.5 Water sampling, sample treatment and analyses

The pumped water from the borehole section is conveyed from the pipe into the sample bottles. Filtration and conservation of the samples was performed on-line at the site. A water sample is defined as groundwater collected on one occasion and consists of several sample portions, labelled with the same sample number.

An overview of sample treatment and analysis methods is given in Appendix 1. The routines are applicable independently of sampling method or type of sampling object. Six samples (11145, 11186, 11210, 11463, 11486 and 11496) were sent for control analysis of main components. Fifteen samples (11145, 11146, 11176, 11185, 11186, 11208, 11209, 11210, 11461, 11462, 11483, 11484, 11487, 11493 and 11511) were sent for control analysis of bromide to another laboratory. The analytical results are not reported here, but are present in the database SICADA.

5 Results

The results obtained within this activity are water chemistry data from the summer sampling campaign in borehole sections KAV01:3, KLX01:3, KLX02:2, KLX02:5, KLX06:3, KLX06:6, KLX07A:2, KSH01A:4, KSH01A:7, KSH02:1 and KSH02:4 and from the winter sampling campaign in borehole sections KAV01:3, KLX01:3, KLX02:2, KLX02:5, KLX03:4, KLX04:2, KLX04:5, KLX05:3, KLX05:7, KLX06:3, KLX06:6, KLX07A:2, KLX10A:2, KLX10A:5, KLX12A:2, KSH01A:4, KSH01A:7, KSH02:1 and KSH02:4. The results from the chemical analyses are presented below and in Appendix 2. The results are stored in the SICADA data base and are traceable by the Activity Plan number and sample number. It is the data in the data base that will be used for further interpretation (modelling).

5.1 Basic water analyses

The basic water analyses include Na, K, Ca, Mg, Si, Li, S, Sr, SO_4^{2-}, Cl^-, HCO_3^-, Br^- and F^-. Furthermore, measurements are made of pH, electrical conductivity, drill water content and density. The basic water analysis data and relative charge balance errors are compiled in Appendix 2, Table A2-1. The charge balance error gives an indication of the quality and uncertainty of the analyses of major constituents. The charge balance error exceeds the acceptable level of ± 5% in one case, for KLX02:5. The error was most likely due to an unstable HCO_3^- value.

Values of pH from laboratory and field analyses during the summer sampling campaign are compared in Figure 5-1 and during the winter sampling campaign in Figure 5-2.

Sulphate (SO_4^{2-}) analysed using ion chromatography (IC) is compared with sulphate determined as total sulphur using inductively coupled plasma atomic emission spectrometry (ICP-AES), during the winter sampling campaign in Figure 5-3 and during the summer sampling campaign in Figure 5-4. In most samples, the sulphur content exists as sulphate species, but in i.e. KLX02:2 (both summer and winter sampling campaigns) the hydrogen sulphide concentration was very high, resulting in a large discrepancy between the data points for KLX02:2 in Figures 5-3 and 5-4.

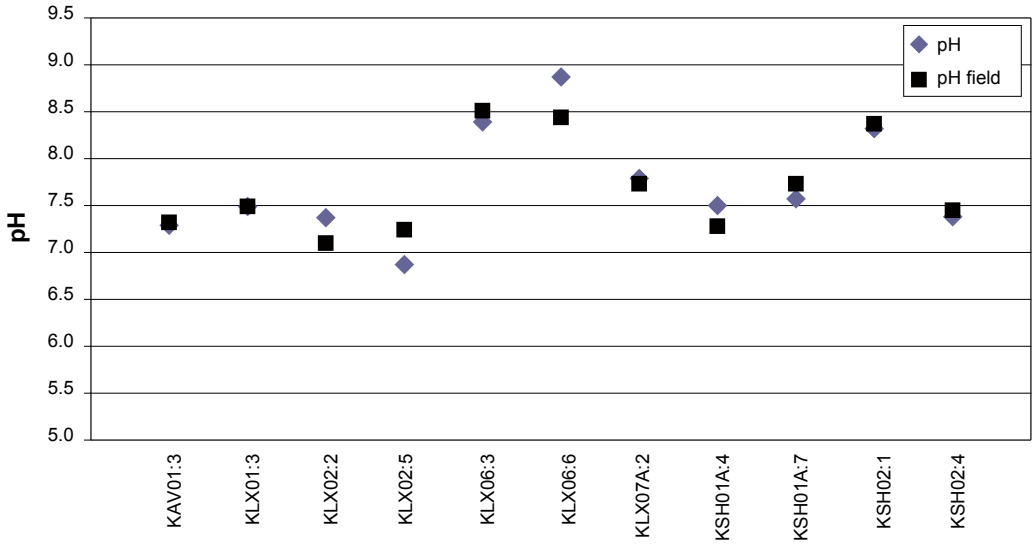

Figure 5-1. *pH from laboratory and field analyses, summer sampling campaign.*

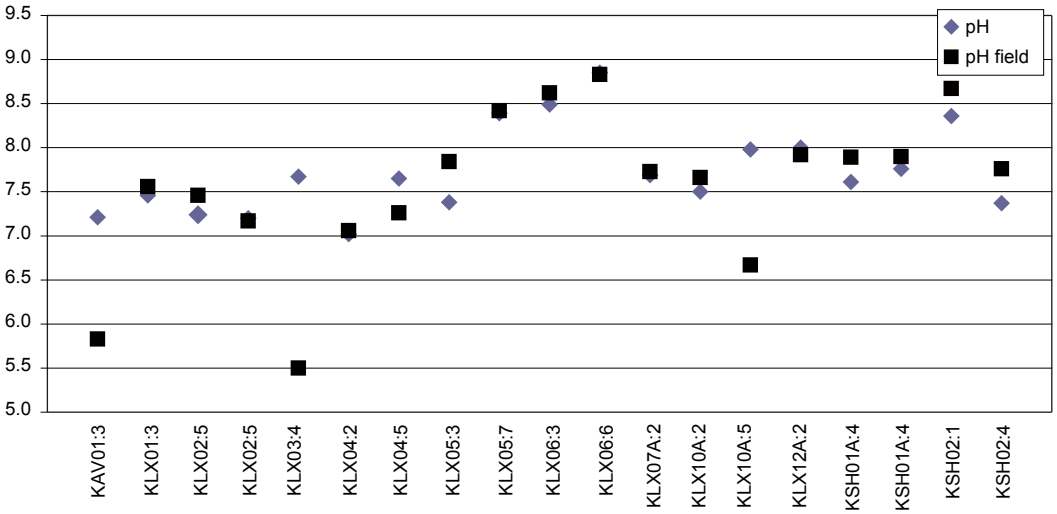

Figure 5-2. *pH from laboratory and field analyses, winter sampling campaign.*

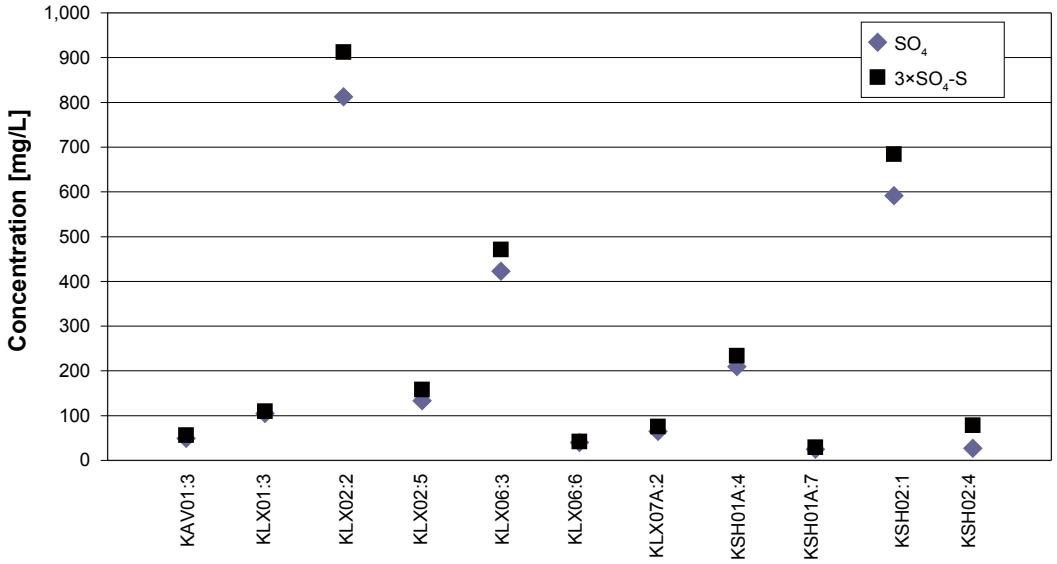

Figure 5-3. *Sulphate (SO_4 by IC) data compared to sulphate calculated from total sulphur ($3\times SO_4$-S by ICP) data from samples collected in the investigated sections during summer.*

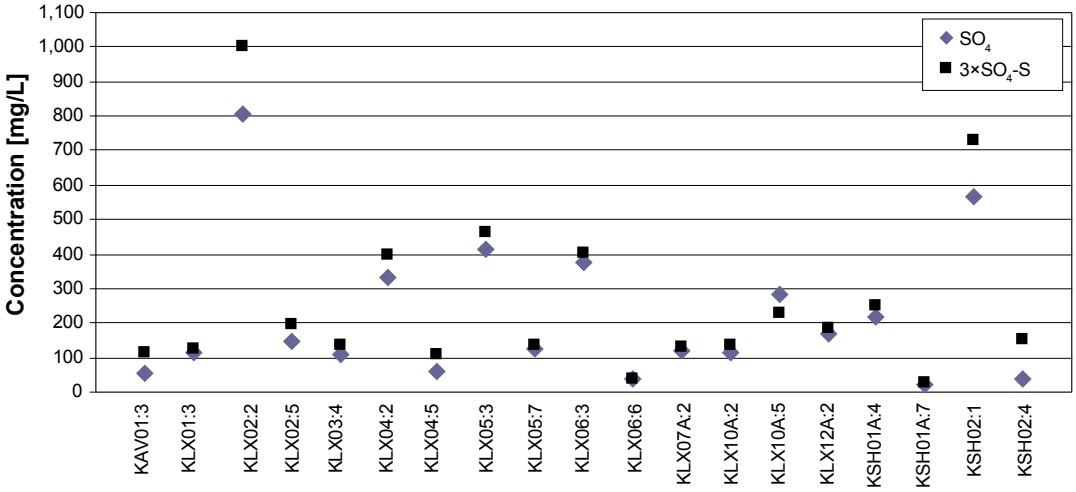

Figure 5-4. *Sulphate (SO_4 by IC) data compared to sulphate calculated from total sulphur ($3\times SO_4$-S by ICP) data from samples collected in the investigated sections during winter.*

The DOC and TOC content was very high in two of the samples (KLX02:5 and KSH02:4) during the summer sampling campaign.

The DOC values from the water sampling performed in KSH02A in 2003/2004 were low /1/, but during the hydrochemical monitoring sampling campaign in 2005 /2/, there was a smell of diesel and an oily film on top of the sample portions. Consequently, the tubes had to be changed before sampling in these borehole sections. No DOC or TOC analyses were performed on these samples. During the winter sampling campaign in 2006, borehole KSH02:4 was sampled according to chemistry class 3, thus not analysed regarding organic carbon.

In 1993, sampling in borehole KLX02 was performed in the sections 315.0–321.5 m, 798.0–803.8 m, 1,090.0–1,096.0 m and 1,420.0–1,700.5 m (SKB sample numbers 2712, 2722, 2724, 2731, 2736 and 2738). At this occasion, the DOC concentrations were 1–6 mg/L in all of the samples. In the sampling series performed in 1999 (SKB sample numbers 2929–2934, 2942 and 3007) in borehole KLX02, the DOC content was high (98.0 mg/L) in the deep section 1,345.0–1,355.0 m, while in sections 1,155.0–1,165.0 m and 1,090.0–1,097.0 m it was only 10.0 and 16.0 mg/L, respectively.

However, the TOC content in the sample from KLX02:5 had fallen from 150 mg/L in the summer to 50 mg/L when sampled during the winter campaign.

The chloride concentrations are plotted versus the corresponding electric conductivity values in Figure 5-5. The plot gives an approximate indication that the values are reasonable. The data from the borehole sections agree well with earlier data from the Äspö Hard Rock Laboratory.

5.2 Trace elements (rare earth metals and others)

The analyses of trace and rare earth metals include U, Th, As, Sc, Cd, Hg, V, Rb, Y, Zr, In, Cs, Ba, La, Hf, Tl, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu. Commonly occurring metals, such as Cu, Zn, Pb and Mo are not included in the analysis programme due to contamination considerations. The trace element data are compiled in Appendix 2, Table A2-2.

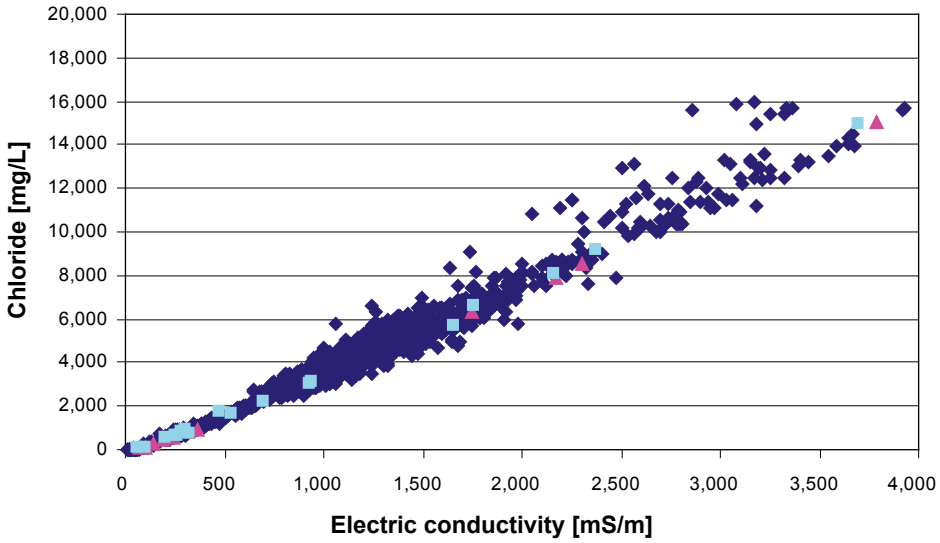

Figure 5-5. *Chloride concentration versus electrical conductivity. Data points from the summer sampling campaign are shown as pink triangles and data points from winter sampling campaign are shown as turquoise squares. Data from earlier investigations at the Äspö Hard Rock Laboratory are used to show the overall trend (blue rhombs).*

5.3 Stable and radioactive isotopes

The isotope determinations include the stable isotopes δ^2H, $\delta^{18}O$ $\delta^{34}S$, $\delta^{37}Cl$, $^{87}Sr/^{86}Sr$, $^{10}B/^{11}B$*, ^{14}C, $\delta^{13}C$ as well as the radioactive isotope ^3H (TU),^{226}Ra, ^{222}Rn, ^{238}U, ^{234}U and ^{230}Th. The isotope data are compiled in Appendix 2, Table A2-3. The ^3H and $\delta^{18}O$ results from the summer sampling campaign and winter sampling of the investigated sections are presented in Figures 5-6 and 5-7, respectively. The ^3H content was below the detection limit (0.8 Tritium Units (TU)) in KLX06:3, KLX06:6, KSH01A:4 and KSH02:4 during the summer and winter sampling campaigns. It was below the detection limit only during the summer sampling campaign in KSH01A:7 and only during the winter sampling campaign in KLX03:4, KLX04:2, KLX05:3, KLX05:7 and KSH02:1.

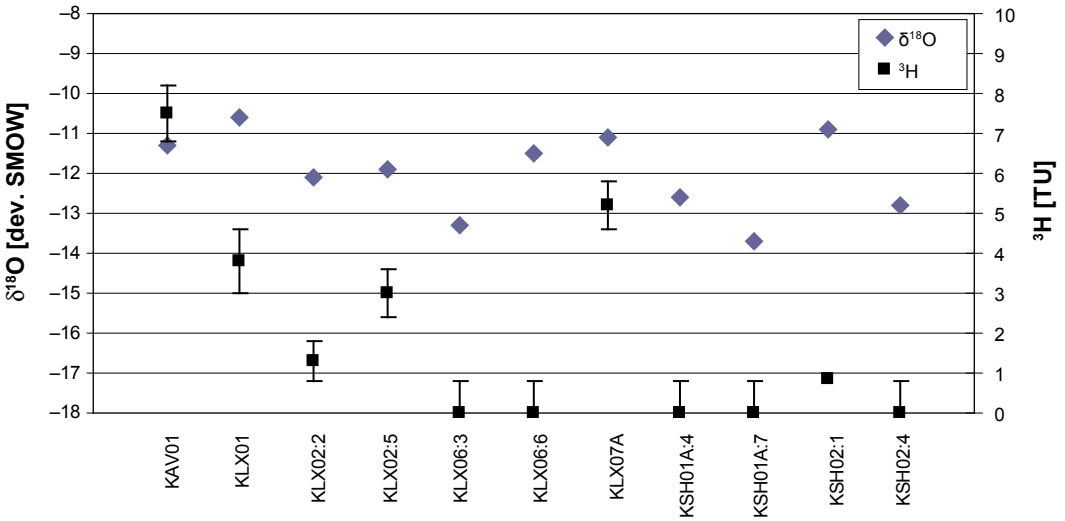

Figure 5-6. *$\delta^{18}O$ and ^3H data from samples collected in the investigated sections, summer sampling campaign.*

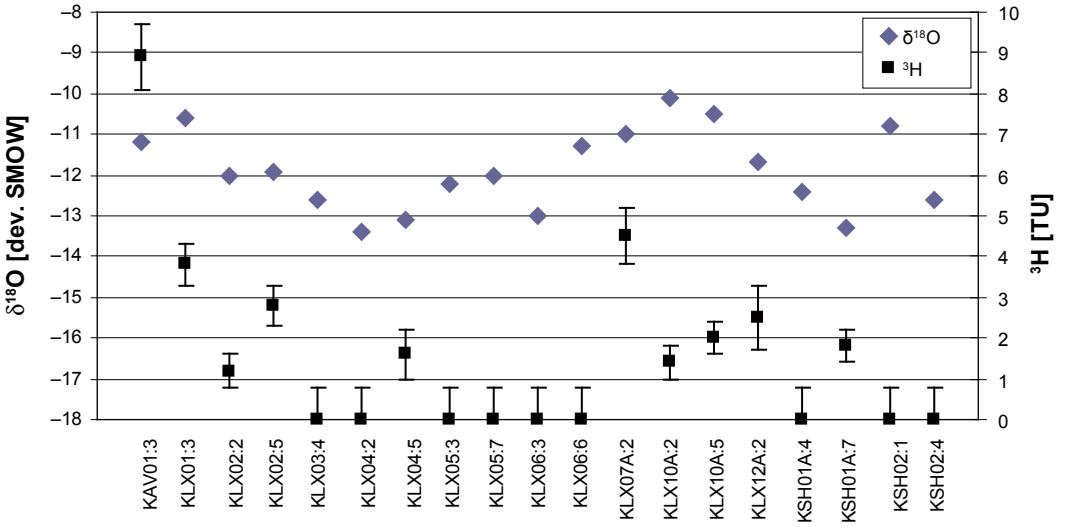

Figure 5-7. *$\delta^{18}O$ and ^3H data from samples collected in the investigated sections, winter sampling campaign.*

* The B-isotope ratio is given as $^{10}B/^{11}B$ (the result reported from the consulting laboratory). If one wants to use the notation according to international standard for environmental isotopes, $^{11}B/^{10}B$, it is necessary to invert the $^{10}B/^{11}B$ value ($1/^{10}B/^{11}B$).

6 Summary

- Comparison of the results from different laboratories and/or methods showed agreement in most cases.
- The charge balance error exceeded the acceptable level of ± 5% in one case, for KLX02:5 (summer sampling).
- General judgement of plausibility based on earlier results and experience indicated reasonable values, in most cases.

7 References

/1/ **Wacker P, Berg C, 2004.** Oskarshamn site investigation. Water sampling in KSH02A. Summary of water sampling analysis in connection with Pipe String System (PSS) and Single Well Injection Withdrawal (SWIW) measurements. Hydrochemical monitoring programme for core drilled boreholes 2005. Summary of analyses from water sampling. SKB P-04-281, Svensk Kärnbränslehantering AB.

/2/ **Wacker P, 2006.** Oskarshamn site investigation. Hydrochemical monitoring programme for core drilled boreholes 2005. Summary of analyses from water sampling. SKB P-06-127, Svensk Kärnbränslehantering AB.

Appendix 1

Sampling and analysis methods

Table A1-1. Sample handling routines and analysis methods.

Component group	Component/element	Sample container (material)	Volume (mL)	Filtering	Preparation/conservation*	Analysis method	Analysis within – or delivery time to lab.	Included in SKB class
Drill water	Uranine	Glass (brown)	100	No	No	Spectrofluorometry	–	3,5
Anions	HCO_3 pH(lab) cond (lab)	Plastic	250	No	No	Titration Pot. meas, Cond. meas.	The same day – maximum 24 hours	3,5
	Cl^-, SO_4^{2-}, Br^-, F^-	Plastic	250	Yes (in connection with analysis)	No	Titration (Cl^-) IC (Cl^-, SO4, Br^-, F^-) ISE (F^-)	Not critical (month)	3,5
	Br^{-*}, I^-	Plastic	100	Yes	No	ICP MS	Not critical (month)	5
Cations, Si and S	Na, K, Ca, Mg, S(tot), Si(tot), Li, Sr	Plastic (acid washed)	100	Yes	Yes (1 mL HNO_3, suprapur)	ICP AES ICP MS	Not critical (month)	3,5
Cations	Fe, Mn	Plastic (acid washed)	100	Yes	Yes (1mL HNO_3)	ICP AES ICP MS	Not critical (month)	5
Fe(II), Fe(tot)	Fe(II), Fe(tot)	Plastic-PEH (acid washed)	500	Yes	Yes (5 mL HCl)	Spectrophotometry Ferrozine method	As soon as possible the same day	5
Hydrogen sulphide	HS^-	Glass (Winkler)	About 120×2	Yes	Yes (1 mL 1 M NaOH+1 mL 1M ZnAc)	Spectrophotometry	Immediately or if conserved, a few days	5
Nutrient salts	NO_2, NO_3+NO_2, PO_4	Plastic	250	Yes	Yes Frozen, transported in isolated bag	Spectrophotometry	Short transportation time	5
	NH_4	Plastic cylinder	50	No	No	Spectrophotometry	Maximum 24 hours	5
Environmental metals	Al, As, Ba, B, Cd, Co, Cr, Cu, Hg, Mo, Ni, P, Pb, V, Zn, In	Plastic	100	Yes	Yes (1 mL HNO_3 suprapur)	ICP AES ICP MS	Not critical (month)	5

Component group	Component/element	Sample container (material)	Volume (mL)	Filtering	Preparation/conservation*	Analysis method	Analysis within – or delivery time to lab.	Included in SKB class
Lantanoids, U, Th and so on	Sc, Rb, Y, Zr, I, Sb, Cs, La, Hf, Tl, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, U, Th	Plastic	100	Yes	Yes (1 mL HNO_3 suprapur)	ICP AES ICP MS	Not critical (month)	5
Dissolved organic Carbon	DOC	Plastic	250	Yes	Yes Frozen, transported in isolated bag	UV oxidation, IR Carbon analysator Shimadzu TOC5000	Short transportation time	5
Total organic Carbon	TOC	Plastic	250	No	Yes Frozen, transported in isolated bag	UV oxidation, IR Carbon analysator Shimadzu TOC5000	Short transportation time	5
Environmental isotopes	$\delta^{2}H$, $\delta^{18}O$	Plastic	100	No	No	MS	Not critical (month)	3,5
Tritium,	^{3}H (enhanced.)	Plastic (dry bottle)	500	No	Flooded at least once.	LSC	Not critical (month)	3,5
Chlorine-37	$\delta^{37}Cl$	Plastic	500	No	No	ICP MS	Not critical (month)	5
Carbon isotopes	$\delta^{13}C$, pmC (^{14}C)	Glass (brown)	100×2	No	No	(A)MS	A few days	5
Sulphur isotopes	$\delta^{34}S$	Plastic	1,000	No	No	Combustion, ICP MS	No limit	5
Strontium isotopes	$^{87}Sr/^{86}Sr$	Plastic	100	No	No	TIMS	Days or Week	5
Uranium and Thorium isotopes	^{234}U, ^{235}U, ^{238}U, ^{232}Th, ^{230}Th	Plastic (HDPE)	1,000	No	No	Chemical Separat. Alfa spectroscopy	No limit	5
Boron isotopes	$^{10}B/^{11}B$***	Plastic	100	Yes	Yes (1 mL HNO_3 suprapur)	ICP MS	No limit	5
Radon and Radium isotopes	^{222}Rn, ^{226}Ra	Plastic HDPE	1,000	No	No	LSS	Immediate transport	5

Component group	Component/element	Sample container (material)	Volume (mL)	Filtering	Preparation/conservation*	Analysis method	Analysis within – or delivery time to lab.	Included in SKB class
Density	Density	Plastic	250	No	Yes	Pycnometer	–	5
Archive samples with acid	–	Plastic (washed in acid)	100×2 ****	Yes	Yes (1 mL HNO_3)	–	Storage in freeze container	4,5
Archive samples without acid	–	Plastic	250×2 ****	Yes	No	–	Storage in freeze container	2,4,5

* Suprapur acid is used for conservation of samples.

** When bromide is analysed for control of the IC result.

*** The B-isotope ratio is given as $^{10}B/^{11}B$ (the result reported from the consulting laboratory). If one wants to use the notation according to international standard for environmental isotopes, $^{11}B/^{10}B$, it is necessary to invert the $^{10}B/^{11}B$ value ($1/^{10}B/^{11}B$).

**** Minimum number, the number of archive samples can vary depending on how many similar samples that are collected at the same occasion.

Abbreviations and definitions:

IC	Ion chromatograph
ISE	Ion selective electrode
ICP AES	Inductively Coupled Plasma Atomic Emission Spectrometry
ICP MS	Inductively Coupled Plasma Mass Spectrometry
INAA	Instrumental Neutron Activation Analysis
MS	Mass Spectrometry
LSC	Liquid Scintillation Counting
(A)MS	(Accelerator) Mass Spectrometry
TIMS	Thermal Ionization Mass Spectrometry
LSS	Liquid Scintillation Spectroscopy

Table A1-2. Reporting limits and measurement uncertainties.

Component	Method	Detection limit	Reporting limit or range	Unit	Measurement uncertainty[2]	"Total" uncertainty[3]
Uranine	Spectro-fluorometry	0.05		µg/L	15%	15%
pH	Pot. meas.	–	–	–	5%	–
Cond.	Cond. meas.	0.02	1	mS/m	4%	–
HCO^-_3	Alkalinity titration	0.2	1	mg/L	4%	< 10%
Cl^- Cl^-	Mohr titration IC	5 0.2	70 0.5	mg/L	5% 6%	< 10% 10%
SO_4	IC	0.2	0.5	mg/L	6%	15%
Br^- Br^-	IC ICP	0.2 –	0.7 0.001–0.010[1]	mg/L	9% 15%	20%
F^- F^-	IC Potentiometry	0.2 –	0.6 –	mg/L	10% –	20% –
I^-	ICP	–	0.001–0.010[1]	mg/L	15%	20%
Na	ICP	–	0.1	mg/L	4%	10%
K	ICP	–	0.4	mg/L	6%	15%
Ca	ICP	–	0.1	mg/L	4%	10%
Mg	ICP	–	0.09	mg/L	4%	10%
S(tot)	ICP	–	0.160	mg/L	10%	15%
Si(tot)	ICP	–	0.03	mg/L	4%	15%
Sr	ICP	–	0.002	mg/L	4%	15%
Li	ICP	–	0.2–2[1]	µg/L	10%	20%
Fe	ICP	–	0.4–4[1]	µg/L	6%	10%
Mn	ICP	–	0.03–0.1	µg/L	8%	10%
Al, Zn	ICP	–	0.2–0.7[1]	µg/L	12%	–
Ba, Cr, Mo, Pb	ICP	–	0.01–0.3[1]	µg/L	7–10%	–
Cd, Hg	ICP	–	0.002–0.5[1]	µg/L	9 and 5% resp.	–
Co, V	ICP	–	0.005–0.05[1]	µg/L	8 and 5% resp.	–
Cu	ICP	–	0.1–0.5[1]	µg/L	8%	–
Ni	ICP	–	0.05–0.5[1]	µg/L	8%	–
P	ICP	–	1–40[1]	µg/L	6%	15%
As	ICP	–	0.01–0.5[1]	µg/L	20%	Within the same size (low conc.)
La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y, Hf	ICP	–	0.005–0.05[1]	µg/L	10%	Within the same size (low conc.)
Sc, In, Th	ICP	–	0.05–0.5[1]	µg/L	10%	Within the same size (low conc.)
Rb, Zr, Sb, Cs, Tl	ICP	–	0.025–0.25[1]	µg/L	10%	Within the same size (low conc.)
U	ICP	–	0.001–0.01[1]	µg/L	12%	Within the same size (low conc.)
Fe(II), Fe(tot)	Spectro-photometry	5	20	µg/L	15% (> 30 µg/L)	20%
NH_4-N	Spectro-photometry	3	11–50 > 50	µg/L	10 µg/L 23%	–
NO_2-N	Spectro-photometry	–	0.1–20 > 20	µg/L	0.1 µg/L 2%	15%
NO_2-N+NO_3-N	Spectro-photometry	–	0.2–20 > 20	µg/L	0.2 µg/L 2.5%	15%

Component	Method	Detection limit	Reporting limit or range	Unit	Measurement uncertainty[2]	"Total" uncertainty[3]
PO_4-P	Spectro-photometry	–	0.5–20 > 20	µg/L	0.4 µg/L 2.2%	15%
HS^-	Spectro-photometry	2	30–200 200–500	µg/L	30 µg/L 18%	20%
DOC	See Table A9-1	–	0.5	mg/L	8%	30%
TOC	See Table A9-1	–	0.5	mg/L	10%	30%
δ^2H	MS	–	2	‰ SMOW[4]	1.0‰	–
$\delta^{18}O$	MS	–	0.1	‰ SMOW[4]	0.2‰	–
^3H	LSC	–	0.8 or 0.1	TU[5]	0.8 or 0.1 TU	–
$\delta^{37}Cl$	ICP MS	–	0.2‰ (20 mg/L)	‰ SMOC[6]	–	–
$\delta^{13}C$	A (MS)	–	> 20 mg carbon	‰ PDB[7]	–	–
pmC (^{14}C)	A (MS)	–	> 20 mg carbon	PmC[8]	–	–
δ^{34} S	ICP MS	–	0.2‰	‰ CDT[9]	0.2‰	–
$^{87}Sr/^{86}Sr$	MS	–	–	No unit (ratio)[10]	0.000020	–
$^{10}B/^{11}B$	ICP MS	–	–	No unit (ratio)[10]	0.0020	–
^{234}U, ^{235}U, ^{238}U, ^{232}Th, ^{230}Th	Alfa spectr.	–	0.05	Bq/L[11]	0.05 Bq/L	Right order of magnitude
^{222}Rn, ^{226}Rn	LSS	–	0.1	Bq/L	0.05 Bq/L	
Density	Pycnometer			g/mL	0.15%	Within the same size

1. Reporting limits at salinity ≤ 0.4% (520 mS/m) and ≤ 3.5% (3,810 mS/m) respectively.
2. Measurement uncertainty reported by consulted laboratory, generally 95% confidence interval.
3. Estimated total uncertainty by experience (includes effects of sampling and sample handling).
4. Per mill deviation[12] from SMOW (Standard Mean Oceanic Water).
5. TU=Tritium Units, where one TU corresponds to a Tritium/hydrogen ratio of 10^{-18} (1 Bq/L Tritium = 8.45 TU).
6. Per mill deviation[12] from SMOC (Standard Mean Oceanic Chloride).
7. Per mill deviation[12] from PDB (the standard PeeDee Belemnite).
8. The following relation is valid between pmC (percent modern carbon) and Carbon-14 age:
   $pmC = 100 \times e^{((1,950-y-1.03t)/8,274)}$
   where y = the year of the C-14 measurement and t = C-14 age
9. Per mill deviation[12] from CDT (the standard Canyon Diablo Troilite).
10. Isotope ratio without unit.
11. The following expressions are applicable to convert activity to concentration, for uranium-238 and thorium-232:
    1 ppm U = 12.4 Bq/kg^{238}U
    1 ppm Th = 3.93 Bq/kg^{232}Th
12. Isotopes are often reported as per mill deviation from a standard. The deviation is calculated as:
    $\delta^yI = 1,000 \times (K_{sample}–K_{standard})/K_{standard}$, where K= the isotope ratio and ^yI = ^2H, ^{18}O, ^{37}Cl, ^{13}C or ^{34}S etc.

Appendix 2

Compilation August/September 2007, results below the line refer to winter sampling

Table A2-1. Water Composition.

Idcode	Secup m	Seclow m	Sample no.	Sampling date and time	pH field	Temperature field °C	Charge Bal%	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	HCO_3^- mg/L	Cl^- mg/L	SO_4^{2-} mg/L	SO_4-S mg/L	Br^- (IC/ISE) mg/l	F^- mg/L
KAV01:3	391.00	434.00	11187	2006-06-28 07:30	7.32	12.1	0.88	212	4.54	151	14.3	197	473	49.4	18.7	2.48	1.53
KLX01:3	171.00	190.00	11209	2006-07-05 08:15	7.49	12.2	0.32	181	4.91	31.3	5.8	277	110	105	36.7	0.40	3.75
KLX02:2	1,145.00	1,164.00	11145	2006-06-21 07:55	7.10	14.8	0.66	3,680	16.5	5,730	8.3	17	15,000	813	304	117	1.60
KLX02:5	452.00	494.00	11144	2006-06-14 07:34	7.24	18.3	7.70	368	3.56	136	10.3	92	563	133	52.7	2.30	2.55
KLX06:3	554.00	570.00	11208	2006-07-04 08:19	8.51	13.9	0.40	569	8.66	203	13.0	71	878	423	157	4.40	3.55
KLX06:6	256.00	275.00	11210	2006-07-04 09:30	8.44	14.9	–0.79	134	2.61	8.7	1.4	227	57.7	39.8	14.1	0.24	6.12
KLX07A:2	753.00	780.00	11146	2006-06-20 15:50	7.73	14.6	0.76	218	4.35	60.3	8.0	146	318	65.1	25.1	1.70	2.91
KSH01A:4	532.00	572.00	11176	2006-06-20 07:30	7.28	13.3	0.43	3,180	12.6	2,140	39.7	18	8,560	209	77.9	62.7	1.62
KSH01A:7	238.00	277.00	11175	2006-06-20 11:00	7.73	15.2	0.20	2,610	11.9	1,220	62.5	19	6,320	25.3	9.68	35.4	1.13
KSH02:1	955.00	963.00	11185	2006-06-27 14:45	8.37	15.1	–0.63	4,920	15.8	5,510	5.7	6	17,100	592	228	127.0	1.43
KSH02:4	411.00	439.00	11186	2006-06-27 07:15	7.45	15.4	–0.42	3,100	10.4	1,770	13.4	97	7,910	26.9	26.1	58.4	1.41
KAV01:3	391.00	434.00	11483	2006-10-31 14:15	5.83	10.3	–1.20	242	4.92	174	15.3	202	546	53.1	38	3.00	1.45
KLX01:3	171.00	190.00	11484	2006-10-31 13:50	7.56	11.7	–1.49	192	4.99	30.5	5.4	278	122	112	41	0.44	4.15
KLX02:2	1,145.00	1,164.00	11485	2006-10-31 08:45	7.46	11.2	–1.18	3,450	17.2	5,640	10.2	21	15,000	809	334	119	1.75
KLX02:5	452.00	494.00	11486	2006-10-31 08:45	7.17	10.7	0.89	393	3.77	133	10.2	131	645	145	65.5	2.78	2.48
KLX03:4	729.00	751.00	11482	2006-11-28 12:35	5.50	9.6	–0.89	745	7.01	345	12.6	124	1,660	107	44.9	10.9	2.40
KLX04:2	870.00	897.00	11509	2006-11-14 17:20	7.06	9.2	–2.18	1,130	5.77	835	11.5	69	3,070	331	133	22.0	1.82
KLX04:5	507.00	530.00	11510	2006-11-14 15:53	7.26	9.0	–1.71	416	5.52	163	16.6	103	873	62.2	36.9	4.90	2.33
KLX05:3	625.00	633.00	11511	2006-12-05 19:07	7.84	12.3	2.09	2,500	12.2	1,360	8.7	11	5,690	415	154	39.0	1.88
KLX05:7	241.00	255.00	11463	2006-10-24 12:30	8.42	11.3	–1.33	449	4.31	55.3	7.3	180	626	126	45.6	2.53	3.25
KLX06:3	554.00	570.00	11461	2006-10-24 14:45	8.62	11.0	–0.08	514	8.27	169	10.6	86	778	376	135	4.45	3.18
KLX06:6	256.00	275.00	11464	2006-10-24 14:45	8.83	11.5	–1.95	130	2.58	8.4	1.3	224	58.7	40.6	13.5	0.24	6.24
KLX07A:2	753.00	780.00	11462	2006-12-05 15:10	7.73	10.3	–0.45	430	5.28	129	12.3	76	797	121	42.8	4.50	2.35
KLX10A:2	689.00	710.00	11466	2006-10-25 11:02	7.66	9.5	–2.12	1,280	14.1	580	59.9	114	3,160	113	45.1	12.3	1.66
KLX10A:5	351.00	368.00	11465	2006-10-25 11:02	6.67	9.3	–3.19	859	7.41	221	32.3	98	1,700	284	76.4	11.8	4.45
KLX12A:2	535.00	545.00	11487	2006-11-14 16:00	7.92	8.6	–1.23	1,100	6.89	345	13.6	91	2,220	168	60.9	11.3	2.05
KSH01A:4	532.00	572.00	11493	2006-11-08 07:30	7.89	10.6	–2.32	3,060	11.5	2,290	42.8	19	9,130	218	84.2	66.9	1.66
KSH01A:7	238.00	277.00	11494	2006-11-08 07:30	7.90	10.7	–4.12	2,430	10.0	1,200	68.7	20	6,570	24.5	9.6	37.5	1.22
KSH02:1	955.00	963.00	11495	2006-11-08 09:00	8.67	10.3	–0.18	4,850	17.3	5,730	5.8	7	17,200	566	244	103	1.45
KSH02:4	411.00	439.00	11496	2006-11-08 09:00	7.76	10.0	–2.60	2,930	10.3	1,850	13.9	95	8,090	36.8	50.8	55.5	1.37

Idcode	Secup m	Seclow m	Sample no.	Si mg/L	Fe mg/L	Fe-tot mg/L	Fe(II) mg/L	Mn mg/L	Li mg/L	Sr mg/L	I^- mg/L	pH	DOC mg/L	TOC mg/L	HS^- mg/L	Drill_water %	ElCond mS/m
KAV01:3	391.00	434.00	11187	7.54	0.92	0.85	0.837	1.130	0.088	1.60	0.020	7.29	11	12	0.295	0.12	192
KLX01:3	171.00	190.00	11209	7.87	4.3	4.05	4.05	0.352	0.012	0.383	0.009	7.49	9.0	9.1	0.053	0.14	103
KLX02:2	1,145.00	1,164.00	11145	11.7	1.59	1.36	1.34	0.540	2.520	103	0.644	7.37	1.2	1.5	0.165	0.54	3,790
KLX02:5	452.00	494.00	11144	8.64	15.0	15.0	14.9	0.712	0.097	1.52	0.020	6.87	140	150	0.112	4.73	245
KLX06:3	554.00	570.00	11208	6.66	0.142	0.135	0.127	0.113	0.092	3.98	0.046	8.39	3.3	3.5	0.154	10.3	360
KLX06:6	256.00	275.00	11210	7.35	0.0615	0.055	0.050	0.0145	0.020	0.235	0.004	8.87	3.4	3.5	0.143	3.56	65.7
KLX07A:2	753.00	780.00	11146	8.45	0.535	0.516	0.502	0.230	0.041	0.639	0.017	7.80	3.6	3.8	0.094	1.75	141
KSH01A:4	532.00	572.00	11176	5.92	0.322	0.356	0.344	0.461	0.716	36.8	0.344	7.51	1.2	1.2	0.265	17.5	2,310
KSH01A:7	238.00	277.00	11175	5.33	0.611	0.604	0.584	0.626	0.477	21.3	0.191	7.57	1.0	1.0	0.135	6.61	1,750
KSH02:1	955.00	963.00	11185	5.58	0.0473	0.072	0.055	0.076	0.997	95.4	0.771	8.32	1	< 1.0	0.299	0.82	4,200
KSH02:4	411.00	439.00	11186	10.6	0.0312	0.055	0.045	0.160	0.439	28.5	0.393	7.38	240	240	> 2	17.5	2,170
KAV01:3	391.00	434.00	11483	7.17	0.897	–	–	1.28	0.083	2.01	–	7.21	–	–	–	0.09	201
KLX01:3	171.00	190.00	11484	7.38	3.69	–	–	0.306	0.012	0.388	–	7.46	–	–	–	0.10	105
KLX02:2	1,145.00	1,164.00	11485	11.0	1.78	1.89	1.89	0.683	2.32	100	0.551	7.24	2.0	1.9	0.171	0.87	3,700
KLX02:5	452.00	494.00	11486	8.58	8.79	8.50	8.46	0.536	0.091	1.58	0.015	7.20	47	50	0.370	1.30	264
KLX03:4	729.00	751.00	11482	8.92	0.0936	0.117	0.111	0.227	0.110	6.19	0.125	7.67	11	11	1.560	8.33	536
KLX04:2	870.00	897.00	11509	9.10	0.411	–	–	0.272	0.275	15.2	–	7.02	–	–	–	2.78	930
KLX04:5	507.00	530.00	11510	8.91	0.302	0.312	0.304	0.355	0.092	2.84	0.051	7.65	4.7	4.8	0.837	2.27	301
KLX05:3	625.00	633.00	11511	5.18	0.122	–	–	0.108	0.189	23.6	–	7.38	–	–	–	7.31	1,660
KLX05:7	241.00	255.00	11463	5.06	0.709	–	–	0.101	0.050	1.05	0.025	8.39	7.3	7.4	0.080	0.99	253
KLX06:3	554.00	570.00	11461	6.43	0.0495	0.057	0.043	0.0648	0.087	3.32	0.048	8.49	3.6	3.6	0.509	9.31	327
KLX06:6	256.00	275.00	11464	7.04	0.057	0.077	0.063	0.0122	0.021	0.232	0.003	8.85	3.5	3.5	0.186	3.62	65.5
KLX07A:2	753.00	780.00	11462	7.61	0.423	–	–	0.268	0.072	1.84	–	7.69	–	–	–	4.01	287
KLX10A:2	689.00	710.00	11466	7.62	0.190	–	–	0.302	0.169	9.68	–	7.50	–	–	–	11.8	944
KLX10A:5	351.00	368.00	11465	6.12	0.195	–	–	0.186	0.093	3.48	–	7.98	–	–	–	35.2	477
KLX12A:2	535.00	545.00	11487	7.63	0.172	0.169	0.164	0.193	0.116	6.29	0.095	8.00	5.5	4.8	4.07	7.10	699
KSH01A:4	532.00	572.00	11493	5.05	0.219	–	–	0.461	0.728	34.0	–	7.61	–	–	–	9.27	2,370
KSH01A:7	238.00	277.00	11494	4.69	0.602	–	–	0.670	0.446	19.6	–	7.76	–	–	–	4.32	1,760
KSH02:1	955.00	963.00	11495	5.32	0.0408	–	–	0.086	1.07	94.1	–	8.36	–	–	–	0.59	4,200
KSH02:4	411.00	439.00	11496	9.71	0.0334	–	–	0.167	0.414	28.2	–	7.37	–	–	–	10.8	2,160

Idcode	Secup m	Seclow m	Sample no.	NH_4-N mg/L	NO_2-N mg/L	NO_3-N mg/L	NO_2-N+NO_3-N mg/L	PO_4-P mg/L	P (ICP) mg/L	Density g/mL
KAV01:3	391.00	434.00	11187	0.0607	< 0.0002	0.0014	0.0015	0.0006	0.0034	0.9978
KLX01:3	171.00	190.00	11209	0.1530	< 0.0002	0.0013	0.0013	0.0012	0.0225	0.9975
KLX02:2	1,145.00	1,164.00	11145	0.0975	0.0003	< 0.0003	0.0005	0.0050	< 0.04	1.0160
KLX02:5	452.00	494.00	11144	0.0185	< 0.0002	< 0.0003	< 0.0003	< 0.0005	0.00529	0.9980
KLX06:3	554.00	570.00	11208	0.120	< 0.0002	0.0047	0.0047	0.0057	0.012	0.9987
KLX06:6	256.00	275.00	11210	0.0273	0.0003	0.0035	0.0038	0.0252	0.0242	0.9974
KLX07A:2	753.00	780.00	11146	0.130	0.0002	0.0008	0.0010	0.0032	0.0117	0.9975
KSH01A:4	532.00	572.00	11176	0.0375	0.0003	0.0005	0.0007	0.0010	< 0.04	1.0074
KSH01A:7	238.00	277.00	11175	0.0793	< 0.0002	< 0.0003	< 0.0003	< 0.0005	0.133	1.0045
KSH02:1	955.00	963.00	11185	0.0051	< 0.0002	0.0006	0.0006	0.0005	< 0.010	1.0178
KSH02:4	411.00	439.00	11186	0.0436	< 0.0002	0.0004	0.0004	0.0011	< 0.010	1.0066
KAV01:3	391.00	434.00	11483	–	–	–	–	–	–	0.9979
KLX01:3	171.00	190.00	11484	–	–	–	–	–	–	x
KLX02:2	1,145.00	1,164.00	11485	0.156	< 0.0002	0.0007	0.0007	0.0007	< 0.04	x
KLX02:5	452.00	494.00	11486	0.0481	< 0.0002	0.0005	0.0005	< 0.0005	0.00442	0.9987
KLX03:4	729.00	751.00	11482	0.172	< 0.0002	< 0.0003	0.0003	0.0072	0.0127	0.9992
KLX04:2	870.00	897.00	11509	–	–	–	–	–	–	1.0011
KLX04:5	507.00	530.00	11510	0.161	0.0002	< 0.0003	0.0003	0.0015	0.00757	0.9982
KLX05:3	625.00	633.00	11511	–	–	–	–	–	–	1.0045
KLX05:7	241.00	255.00	11463	0.0447	< 0.0002	< 0.0003	< 0.0003	0.0037	0.0129	x
KLX06:3	554.00	570.00	11461	0.120	< 0.0002	< 0.0003	< 0.0003	0.0059	0.0136	0.9984
KLX06:6	256.00	275.00	11464	0.0299	< 0.0002	< 0.0003	< 0.0003	0.0225	0.0276	0.9972
KLX07A:2	753.00	780.00	11462	–	–	–	–	–	–	0.9975
KLX10A:2	689.00	710.00	11466	–	–	–	–	–	–	1.0009
KLX10A:5	351.00	368.00	11465	–	–	–	–	–	–	0.9992
KLX12A:2	535.00	545.00	11487	0.0142	<0.0002	0.0007	0.0008	0.0008	0.00864	1.0000
KSH01A:4	532.00	572.00	11493	–	–	–	–	–	–	1.0079
KSH01A:7	238.00	277.00	11494	–	–	–	–	–	–	x
KSH02:1	955.00	963.00	11495	–	–	–	–	–	–	1.0191
KSH02:4	411.00	439.00	11496	–	–	–	–	–	–	1.0067

– = Not analysed
< “value” = Result less than detection limit
x = No result due to analytical problems
ChargeBal % = Rel. charge balance error %
SICADA: “water_composition”

Compilation July 2007, results below the line refer to winter sampling

Table A2-2. Trace elements.

Idcode	Secup m	Seclow m	Sample no.	Sampling date and time	U µg/L	Th µg/L	As µg/L	Sc µg/L	Cd µg/L	Hg µg/L	V µg/L	Y µg/L	Rb µg/L
KAV01:3	391.00	434.00	11187	2006-06-28 07:30	1.10	0.188	< 0.1	0.161	0.0239	< 0.002	2.63	4.05	5.88
KLX01:3	171.00	190.00	11209	2006-07-05 08:15	0.304	0.105	0.24	0.0799	< 0.002	< 0.002	2.66	1.30	5.32
KLX02:2	1,145.00	1,164.00	11145	2006-06-21 07:55	0.0714	< 0.2	< 10	1.69	< 0.05	0.0037	0.403	1.74	69.8
KLX02:5	452.00	494.00	11144	2006-06-14 07:34	0.0856	< 0.04	< 0.5	< 0.1	< 0.004	0.0102	0.469	0.290	7.03
KLX06:3	554.00	570.00	11208	2006-07-04 08:19	0.129	< 0.02	< 0.1	< 0.05	< 0.002	< 0.002	0.363	0.0752	23.7
KLX06:6	256.00	275.00	11210	2006-07-04 09:30	1.19	0.0205	0.28	< 0.05	< 0.005	0.0032	0.491	0.0361	5.45
KLX07A:2	753.00	780.00	11146	2006-06-20 15:50	0.561	< 0.02	0.379	< 0.05	< 0.002	< 0.002	0.673	0.162	7.41
KSH01A:4	532.00	572.00	11176	2006-06-20 07:30	0.102	< 0.2	< 5	< 0.5	< 0.05	< 0.002	0.121	0.578	31.1
KSH01A:7	238.00	277.00	11175	2006-06-20 11:00	0.074	< 0.2	< 5	< 0.5	< 0.05	< 0.002	0.426	0.422	26.4
KSH02:1	955.00	963.00	11185	2006-06-27 14:45	< 0.005	< 0.2	< 1	< 0.5	0.0263	0.0066	0.317	0.476	63.7
KSH02:4	411.00	439.00	11186	2006-06-27 07:15	0.0336	< 0.2	< 1	< 0.5	0.0252	0.0084	0.207	0.335	22.9
KLX02:2	1,145.00	1,164.00	11485	2006-10-31 08:45	0.171	< 0.2	< 1	2.67	0.0073	0.0023	0.37	1.63	70.1
KLX02:5	452.00	494.00	11486	2006-10-31 08:45	0.198	< 0.02	< 0.1	0.0526	0.0144	0.0027	0.527	0.244	7.73
KLX03:4	729.00	751.00	11482	2006-11-28 12:35	0.152	< 0.2	< 0.5	< 0.4	< 0.02	0.0138	2.2	0.231	53.1
KLX04:5	507.00	530.00	11510	2006-11-14 15:53	0.741	< 0.02	0.15	< 0.05	< 0.002	< 0.002	0.375	0.137	12.8
KLX05:7	241.00	255.00	11463	2006-10-24 12:30	1.38	< 0.02	< 0.1	< 0.05	0.0515	0.0045	0.281	0.048	10.3
KLX06:3	554.00	570.00	11461	2006-10-24 14:45	0.206	< 0.02	0.22	0.057	0.031	< 0.002	0.317	0.0936	23.6
KLX06:6	256.00	275.00	11464	2006-10-24 14:45	1.66	< 0.02	0.408	< 0.05	0.0162	< 0.002	0.499	0.0369	5.9
KLX12A:2	535.00	545.00	11487	2006-11-14 16:00	0.249	< 0.2	< 0.5	< 0.4	< 0.02	0.0123	0.217	0.0777	18.3

Idcode	Secup m	Seclow m	Sample no.	Sampling date and time	Zr µg/L	In µg/L	Cs µg/L	Ba µg/L	La µg/L	Hf µg/L	Tl µg/L	Ce µg/L	Pr µg/L	Nd µg/L	Sm µg/L
KAV01: 3	391.00	434.00	11187	2006-06-28 07:30	2.39	< 0.05	0.241	179	1.96	0.0354	< 0.005	4.12	0.476	2.07	0.481
KLX01: 3	171.00	190.00	11209	2006-07-05 08:15	1.31	< 0.05	0.155	29	0.914	0.0183	< 0.005	1.56	0.195	0.894	0.167
KLX02: 2	1,145.00	1,164.00	11145	2006-06-21 07:55	0.558	< 0.5	3.150	303	2.29	< 0.05	< 0.05	0.673	< 0.05	0.109	< 0.05
KLX02: 5	452.00	494.00	11144	2006-06-14 07:34	0.0689	< 0.1	0.147	766	0.342	< 0.01	< 0.01	0.306	0.0291	0.123	0.0231
KLX06: 3	554.00	570.00	11208	2006-07-04 08:19	0.0903	< 0.05	0.332	699	0.0797	< 0.005	< 0.005	0.0924	0.0115	0.0489	0.0117
KLX06: 6	256.00	275.00	11210	2006-07-04 09:30	0.178	< 0.05	0.125	24.5	0.140	< 0.005	< 0.005	0.196	0.0181	0.0649	0.008
KLX07A: 2	753.00	780.00	11146	2006-06-20 15:50	0.0530	< 0.05	0.387	57.9	0.106	< 0.005	< 0.005	0.134	0.0168	0.0685	0.0114
KSH01A: 4	532.00	572.00	11176	2006-06-20 07:30	< 0.3	< 0.5	1.53	282	0.314	< 0.05	< 0.05	0.235	< 0.05	0.0691	< 0.05
KSH01A: 7	238.00	277.00	11175	2006-06-20 11:00	< 0.3	< 0.5	1.23	1,440	0.137	< 0.05	< 0.05	0.0966	< 0.05	< 0.05	< 0.05
KSH02: 1	955.00	963.00	11185	2006-06-27 14:45	< 0.3	< 0.5	5.19	143	0.457	< 0.05	< 0.05	0.139	< 0.05	< 0.05	< 0.05
KSH02: 4	411.00	439.00	11186	2006-06-27 07:15	< 0.3	< 0.5	14.8	11,600	0.683	< 0.05	< 0.05	0.617	< 0.05	0.133	0.0597
KLX02: 2	1,145.00	1,164.00	11485	2006-10-31 08:45	0.0321	< 0.5	3.06	385	1.84	< 0.05	< 0.05	0.607	< 0.05	0.0121	< 0.005
KLX02: 5	452.00	494.00	11486	2006-10-31 08:45	0.197	< 0.05	0.153	791	0.315	< 0.005	< 0.005	0.241	0.0257	0.0953	0.0188
KLX03: 4	729.00	751.00	11482	2006-11-28 12:35	0.481	< 0.2	9.53	332	0.264	< 0.02	< 0.03	0.302	0.0364	0.155	0.026
KLX04: 5	507.00	530.00	11510	2006-11-14 15:53	0.131	< 0.05	0.593	361	0.145	< 0.005	< 0.005	0.182	0.0212	0.0828	0.0154
KLX05: 7	241.00	255.00	11463	2006-10-24 12:30	0.14	< 0.05	0.137	50.2	0.0279	< 0.005	< 0.005	0.0347	< 0.005	0.0216	0.0054
KLX06: 3	554.00	570.00	11461	2006-10-24 14:45	0.056	< 0.05	0.292	429	0.0736	< 0.005	< 0.005	0.0882	0.0125	0.0512	0.0114
KLX06: 6	256.00	275.00	11464	2006-10-24 14:45	0.122	< 0.05	0.142	27.2	0.146	< 0.005	< 0.005	0.191	0.0205	0.076	0.0095
KLX12A: 2	535.00	545.00	11487	2006-11-14 16:00	0.634	< 0.2	0.231	121	0.0634	< 0.02	< 0.03	0.0731	< 0.02	0.0332	< 0.02

Idcode	Secup m	Seclow m	Sample no.	Sampling date and time	Eu µg/L	Gd µg/L	Tb µg/L	Dy µg/L	Ho µg/L	Er µg/L	Tm µg/L	Yb µg/L	Lu µg/L
KAV01: 3	391.00	434.00	11187	2006-06-28 07:30	0.0868	0.614	0.0827	0.493	0.113	0.367	0.0457	0.372	0.0634
KLX01: 3	171.00	190.00	11209	2006-07-05 08:15	0.0377	0.191	0.0238	0.164	0.0365	0.115	0.0164	0.121	0.0209
KLX02: 2	1,145.00	1,164.00	11145	2006-06-21 07:55	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
KLX02: 5	452.00	494.00	11144	2006-06-14 07:34	< 0.05	0.0195	< 0.01	0.0174	< 0.01	0.0164	< 0.01	0.0185	< 0.01
KLX06: 3	554.00	570.00	11208	2006-07-04 08:19	0.0515	0.0093	< 0.005	0.0058	< 0.005	< 0.005	< 0.005	0.0069	< 0.005
KLX06: 6	256.00	275.00	11210	2006-07-04 09:30	< 0.005	0.0075	< 0.005	0.0054	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
KLX07A: 2	753.00	780.00	11146	2006-06-20 15:50	< 0.005	0.0121	< 0.005	0.01	< 0.005	0.0092	< 0.005	0.0078	< 0.005
KSH01A: 4	532.00	572.00	11176	2006-06-20 07:30	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
KSH01A: 7	238.00	277.00	11175	2006-06-20 11:00	< 0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
KSH02: 1	955.00	963.00	11185	2006-06-27 14:45	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.130	< 0.05
KSH02: 4	411.00	439.00	11186	2006-06-27 07:15	< 0.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.08	< 0.05
KLX02: 2	1,145.00	1,164.00	11485	2006-10-31 08:45	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.005	< 0.05	< 0.05	< 0.005
KLX02: 5	452.00	494.00	11486	2006-10-31 08:45	0.0446	0.0245	< 0.005	0.0228	0.0062	0.0195	< 0.005	0.0235	0.0075
KLX03: 4	729.00	751.00	11482	2006-11-28 12:35	< 0.02	0.0376	< 0.02	0.0247	< 0.02	0.0207	< 0.02	0.0278	< 0.02
KLX04: 5	507.00	530.00	11510	2006-11-14 15:53	< 0.008	0.0158	< 0.005	0.0115	< 0.005	0.0085	< 0.005	0.0094	< 0.005
KLX05: 7	241.00	255.00	11463	2006-10-24 12:30	< 0.005	< 0.005	< 0.005	0.0053	< 0.005	< 0.005	< 0.005	0.0053	< 0.005
KLX06: 3	554.00	570.00	11461	2006-10-24 14:45	0.0181	0.0083	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
KLX06: 6	256.00	275.00	11464	2006-10-24 14:45	< 0.005	0.0075	< 0.005	0.0059	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
KLX12A: 2	535.00	545.00	11487	2006-11-14 16:00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

< “value” = Result less than detection limit
A = Results will be reported later
SICADA: “trace_elements_1”, “trace_elements_2”

Compilation July 2006, results below the line refer to winter sampling

Table A2-3. Isotopes I (H-, O-, B-, S-, Sr- C- and Cl-isotopes).

Idcode	Secup m	Seclow m	Sample no.	Sampling date and time	$\delta^{2}H$ dev SMOW	^{3}H TU	$\delta^{18}O$ dev SMOW	$^{10}B/^{11}B$ no unit	$\delta^{34}S$ dev CDT	$\delta^{13}C$ dev PDB	$^{87}Sr/^{86}Sr$ no unit	^{14}C pmC	AGE_BP years	$\delta^{37}Cl$ dev SMOC
KAV01:3	391.00	434.00	11187	2006-06-28 07:30	–79.9	7.5	–11.3	0.2359	23.7	xx	0.716595	xx	xx	0.33
KLX01:3	171.00	190.00	11209	2006-07-05 08:15	–78.3	3.8	–10.6	0.2364	28.3	–15.56	0.716951	xx	xx	0.19
KLX02:2	1,145.00	1,164.00	11145	2006-06-21 07:55	–83.7	1.3	–12.1	0.2370	11.4	x	0.720118	x	x	0.74
KLX02:5	452.00	494.00	11144	2006-06-14 07:34	–89.5	3.0	–11.9	0.2331	24.5	19.17	0.721514	61.94	3,793	0.03
KLX06:3	554.00	570.00	11208	2006-07-04 08:19	–98.8	< 0.8	–13.3	0.2375	12.9	–18.27	0.715811	xx	xx	0.26
KLX06:6	256.00	275.00	11210	2006-07-04 09:30	–83.9	< 0.8	–11.5	0.2371	32.9	–16.38	0.716043	xx	xx	0.23
KLX07A:2	753.00	780.00	11146	2006-06-20 15:50	–79.6	5.2	–11.1	0.2371	16.8	–17.88	0.719466	57.28	4,422	0.41
KSH01A:4	532.00	572.00	11176	2006-06-20 07:30	–90.7	< 0.8	–12.6	0.2364	19.3	x	0.715614	x	x	0.32
KSH01A:7	238.00	277.00	11175	2006-06-20 11:00	–100.2	< 0.8	–13.7	0.2357	28.0	x	0.711495	x	x	0.19
KSH02:1	955.00	963.00	11185	2006-06-27 14:45	–73.5	0.84	–10.9	0.2386	13.3	x	0.715958	x	x	0.59
KSH02:4	411.00	439.00	11186	2006-06-27 07:15	–91.2	< 0.8	–12.8	0.2374	21.3	21.38	0.715390	x	x	0.69
KAV01:3	391.00	434.00	11483	2006-10-31 14:15	–74.1	8.9	–11.2	–	–	–	–	–	–	–
KLX01:3	171.00	190.00	11484	2006-10-31 13:50	–71.9	3.8	–10.6	–	–	–	–	–	–	–
KLX02:2	1,145.00	1,164.00	11485	2006-10-31 08:45	–75.4	1.2	–12.0	0.2375	12.5	x	0.717464	x	x	0.56
KLX02:5	452.00	494.00	11486	2006-10-31 08:45	–78.9	2.8	–11.9	0.2363	24.4	–14.78	0.716214	61.61	3,836	0.24
KLX03:4	729.00	751.00	11482	2006-11-28 12:35	–92.2	< 0.8	–12.6	0.2376	27.4	–18.08	0.715693	49.98	5,517	0.26
KLX04:2	870.00	897.00	11509	2006-11-14 17:20	–97.7	2.8	–13.4	–	–	–	–	–	–	–
KLX04:5	507.00	530.00	11510	2006-11-14 15:53	–96.5	1.6	–13.1	0.2370	18.0	–17.14	0.715900	55.31	4,702	0.29
KLX05:3	625.00	633.00	11511	2006-12-05 19:07	–87.6	< 0.8	–12.2	–	–	–	–	–	–	–
KLX05:7	241.00	255.00	11463	2006-10-24 12:30	–81.4	< 0.8	–12.0	0.2352	27.0	–15.60	0.715282	29.28	9,811	0.01
KLX06:3	554.00	570.00	11461	2006-10-24 14:45	–88.4	< 0.8	–13.0	0.2364	13.5	–18.84	0.715787	37.61	7,800	0.16
KLX06:6	256.00	275.00	11464	2006-10-24 14:45	–75.4	< 0.8	–11.3	0.2357	30.9	–16.47	0.715759	35.62	8,237	0.44
KLX07A:2	753.00	780.00	11462	2006-12-05 15:10	–80.8	4.5	–11.0	–	–	–	–	–	–	–
KLX10A:2	689.00	710.00	11466	2006-10-25 11:02	–71.1	1.4	–10.1	–	–	–	–	–	–	–
KLX10A:5	351.00	368.00	11465	2006-10-25 11:02	–73.8	2.0	–10.5	–	–	–	–	–	–	–
KLX12A:2	535.00	545.00	11487	2006-11-14 16:00	–86.3	2.5	–11.7	0.2358	19.5	–19.3	0.714981	xx	xx	0.13
KSH01A:4	532.00	572.00	11493	2006-11-08 07:30	–87.9	< 0.8	–12.4	–	–	–	–	–	–	–
KSH01A:7	238.00	277.00	11494	2006-11-08 07:30	–98.2	1.8	–13.3	–	–	–	–	–	–	–
KSH02:1	955.00	963.00	11495	2006-11-08 09:00	–74.2	< 0.8	–10.8	–	–	–	–	–	–	–
KSH02:4	411.00	439.00	11496	2006-11-08 09:00	–91.9	< 0.8	–12.6	–	–	–	–	–	–	–

– = Not analysed
< “value” = Result less than detection limit
A = Will be reported later
x = No result due to analytical problems
xx = No result due to transportation problems
SICADA: “isotopes_1”

Compilation July 2007, result below the line refer to winter sampling

Table A2-4. Isotopes II. U– Th– Ra– and Rn isotopes.

Idcode	Secup m	Seclow m	Sample no.	Sampling date and time	^{238}U mBq/L	^{235}U mBq/L	^{234}U mBq/L	^{232}Th mBq/L	^{230}Th mBq/L	^{226}Ra Bq/L	^{222}Rn Bq/L At time of analysis	^{222}Rn Bq/L At time of collection
KAV01:3	391.00	434.00	11187	2006-06-28 07:30	16.4	0.46	42.4	0.24	1.18	0.072	100	173
KLX01:3	171.00	190.00	11209	2006-07-05 08:15	4.15	0.23	8.26	0.36	0.71	< 0.015	11.0	14.5
KLX02:2	1,145.00	1,164.00	11145	2006-06-21 07:55	1.20	–	2.30	–	0.31	< 0.015	56.0	94.0
KLX02:5	452.00	494.00	11144	2006-06-14 07:34	3.88	–	1.97	–	< 0.5	< 0.015	318	442
KLX06:3	554.00	570.00	11208	2006-07-04 08:19	1.81	< 0.02	5.02	0.12	0.12	< 0.015	174	250
KLX06:6	256.00	275.00	11210	2006-07-04 09:30	14.6	0.93	43.5	0.18	0.38	< 0.015	180	248
KLX07A:2	753.00	780.00	11146	2006-06-20 15:50	9.00	–	24.1	–	0.38	< 0.015	37.0	74.0
KSH01A:4	532.00	572.00	11176	2006-06-20 07:30	1.40	–	4.10	–	0.78	< 0.015	109	188
KSH01A:7	238.00	277.00	11175	2006-06-20 11:00	0.88	–	2.10	–	0.26	< 0.015	94.0	152
KSH02:1	955.00	963.00	11185	2006-06-27 14:45	0.10	–	0.34	–	0.13	0.0196	130	248
KSH02:4	411.00	439.00	11186	2006-06-27 07:15	1.30	–	3.20	–	0.29	3.31	217	736
KLX02:2	1,145.00	1,164.00	11485	2006-10-31 08:45	1.40	0.30	3.80	0.20	0.20	4.30	22.0	87.0
KLX02:5	452.00	494.00	11486	2006-10-31 08:45	1.80	0.20	4.10	0.20	0.30	0.109	125	509
KLX03:4	729.00	751.00	11482	2006-11-28 12:35	1.90	0.20	4.70	0.30	0.60	0.124	102	194
KLX04:5	507.00	530.00	11510	2006-11-14 15:53	8.20	0.30	50.7	0.10	0.20	0.703	470	923
KLX05:7	241.00	255.00	11463	2006-10-24 12:30	11.5	0.90	42.2	0.30	0.70	0.017	199	397
KLX06:3	554.00	570.00	11461	2006-10-24 14:45	2.50	0.20	7.80	0.30	0.80	0.015	118	224
KLX06:6	256.00	275.00	11464	2006-10-24 14:45	20.4	0.90	62.5	0.30	0.70	0.263	109	220
KLX12A:2	535.00	545.00	11487	2006-11-14 16:00	2.00	0.08	5.20	0.20	0.40	0.089	40.0	75.0

– = Not analysed
A = Results will be reported later
< “value” = Result less than detection limit
SICADA: “isotopes_2”