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Oskarshamn site investigation

Hydrochemical logging in KSH02

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October 2003

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Contents

1 Introduction

The following document reports performance of and results from the activity "Hydrochemical logging in KSH02". KSH02 is a 1001 metre deep core drilled borehole, within the site investigation in Simpevarp, Oskarshamn. The work was conducted according to the activity plan AP PS 400-03-024 (SKB internal controlling document). The data is reported to SICADA in field note no Simpevarp 103.

2 Objective and scope

Hydrochemical logging was performed in order to obtain an overview of the chemical composition of the water along the open borehole KSH02. The analysis program was carried out according to SKB chemistry class 3, including isotope options.

3 Equipment

3.1 Description of equipment

For the hydrochemichal logging an approximately 1000 metre long polyamide tube, divided into units of 50 metres was used. The equipment is described in the method description SKB MD 422.001, "Metodbeskrivning för hydrokemisk loggning" (SKB internal controlling document).

The tube units are connected with couplings. The exact length of each tube unit is given in Table 3-1. The water content in each tube unit constitutes one sample and the volume of each sample is approximately two litres. At the lower end of the tube array, a weight is added to keep it straight and to prevent fastening. The first tube lowered down the borehole has a non return valve at the bottom to prevent water outflow. A schematic picture of the equipment used for the hydrochemichal logging is shown in Figure 3-1.

Table 3-1. Length of tube units used at the hydrochemical logging in KSH02.

Unit	Length [m]
1	49.9
2	49.6
3	49.6
4	49.3
5	49.2
6	49.2
7	49.7
8	50.6
9	50.3
10	49.7
11	49.7
12	49.6
13	49.9
14	49.9
15	50.0
16	50.0
17	49.3
18	49.8
19	50.1
20	49.7
Sum:	994.9
Coupling	2.8
Weight	0.82
Total tube	
length:	**998.5**

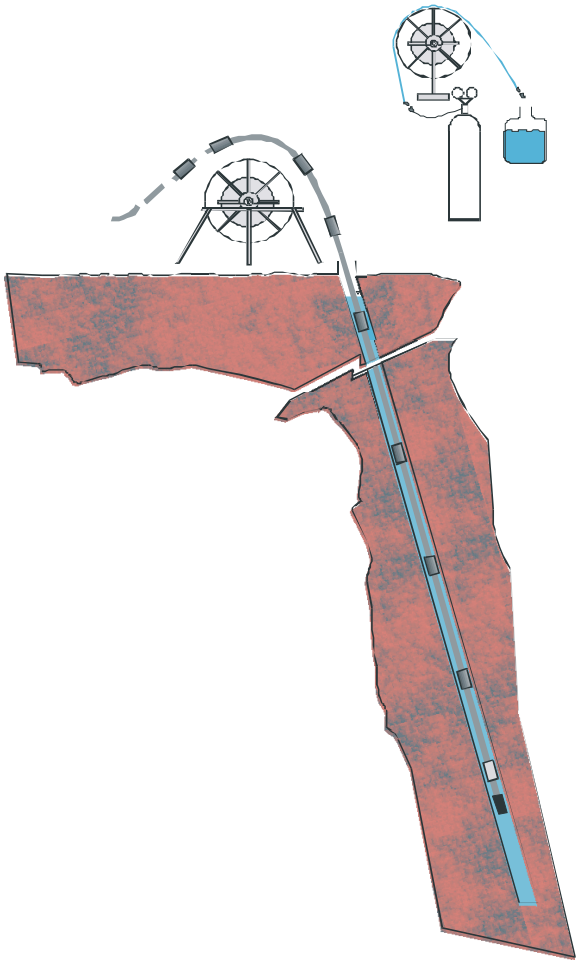

Figure 3-1. *Equipment for hydrochemical logging in boreholes. At the lower end of the tube array there is a non return valve and a weight connected. Each tube unit is 50 metres long.*

4 Performance

The hydrochemichal logging in KSH02 was performed June 18, 2003, according to the activity plan and following the method description. Before the hydrochemical logging the ground water level was measured to 3.17 metres. The first tube unit was lowered at 07:36. The tubes were lowered down the borehole at a rate of five metres/minute. The equipment was lowered to a depth of 991 meter, i.e. the length of the borehole subtracted with 10 meter, to avoid fastening of the equipment. The retrievel of the tubes started at 13:47 and at 15:34 the last tube was lifted up. The tube units were emptied the same evening using pressurized nitrogen gas and the water samples portioned into sample bottles. Each tube unit represents one sample. Sample preparation and consulted laboratories are listed in the activity plan.

An overview showing the samples obtained at the logging occasion is given in Table 4-1. The hydrochemical data from the logging are stored in the database SICADA in field note no Simpevarp 103. The SKB sample numbers are 5651-5670.

Table 4-1. Overview of samples collected at hydrochemical logging in KSH02. Filled cells represent collected samples.

Tubes			Samples taken out									Archives
Tube unit	Section [m]	SKB:nr	pH, alk., cond.	Major-components	An-ions	Uranine	Deut. O-18	3H Cl-37	Sr-87	Carbon isotopes	S-34	
			250 ml	125 ml	250 ml	100 ml	100 ml	1000 ml	100 ml	4x100 ml	1000 ml	2x250 ml
20	0	5651	charge balance error					231 ml				
	41											
19	41	5652										
	91											
18	91	5653	charge balance error					920 ml				
	141											
17	141	5654										
	191											
16	191	5655						940 ml				
	241											
15	241	5656										
	291											
14	291	5657	charge balance error									
	341											
13	341	5658										
	391											
12	391	5659	charge balance error					520 ml				
	441											
11	441	5660										
	491											
10	491	5661	charge balance error									
	541											
9	541	5662										
	591											
8	591	5663	charge balance error					510 ml				
	641											
7	641	5664										
	691											
6	691	5665	charge balance error									
	741											
5	741	5666										
	791											
4	791	5667	charge balance error					880 ml				
	841											
3	841	5668										
	891											
2	891	5669	charge balance error									
	941											
1	941	5670										
	991											

No control samples or archive samples from even tube units, due to lack of water.

No control samples from odd tube units, AP.

Due to lack of water it was not possible to fill all bottles according to the activity plan. An order of priority was made after contact with the activity leader at SKB and the bottles were filled according to this.

The shortage of water resulted in that no archive samples were collected from every other unit, the first tube unit counted from the top of the borehole. No samples for control analysis of major components could be collected.

There was not enough water for both tritium/Cl-37 and carbon isotope analysis from the same tube unit, see Table 4-1. Tritium/Cl-37 samples from tube units 4, 8, 12, 16, 18 and 20 were not filled properly due to lack of water (see Table 4-1 for amount of water filled into sample bottles). After consulting the activity leader at SKB and the consulted laboratory, it was decided that only samples collected from tube unit 16 and 18 and the fully filled bottles would be sent for tritium/Cl-37 analysis.

A filled tube unit contains approximately 2.5 litres of water. Some of the water samples are filtered; the filter is flushed with sample water to eliminate risk of contamination. This will leave about 2 litres of sample water to be portioned into bottles. Estimates of volumes of water received from each tube unit are given in Table 4-2. Volumes used to flush the fully filled sample bottles for tritium/Cl-37 analyses were not measured and are therefore not included in Table 4-2.

It should be noted that during the hydrochemical logging, there is an excess pressure in the tube units at approximately 550–850 metre borehole depth, with the highest pressure in the tube unit representing the section 791–841 metre.

Table 4-2. Estimates of water amount in tube units.

Tube unit	Total volume recieved [ml]
20	1305
19	2075
18	1995
17	2050
16	2015
15	2050
14	1975[1]
13	2050
12	1995
11	2050
10	1975[1]
9	2050
8	1985
7	2250
6	2075[1]
5	2260
4	2300
3	2150
2	2075
1	2150

[1] Bottles for 3H analysis were flooded.

5 Results

5.1 Analysis results

Results from the different analysis are given in Appendix 1 and shown in Figure 5-1 to 5-9 and in Table 5-1 and 5-2 below. Results are plotted for the mid-point of each tube. For example tube number one from borehole length 941 to 991 metre is plotted at 966 metre and so on. Analysis results from B-10 are not available. Results from analysis of Cl-37 are yet to be reported and the present data compilation will be completed with these data later on.

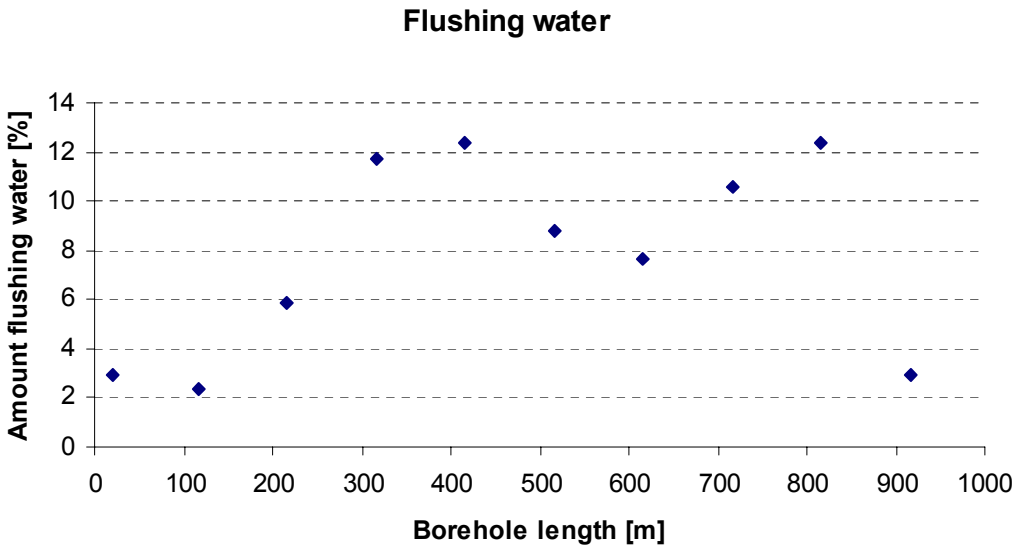

Figure 5-1. *Amount of flushing water remaining in KSH02 at different depths at the time of the hydrochemical logging.*

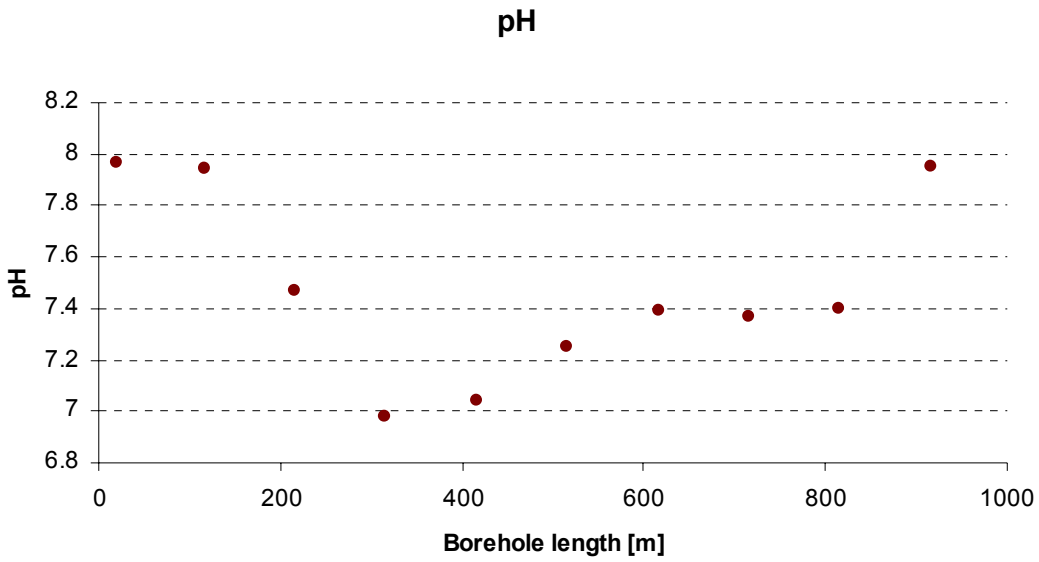

Figure 5-2. *pH at different depths in KSH02. Results from June 18, 2003.*

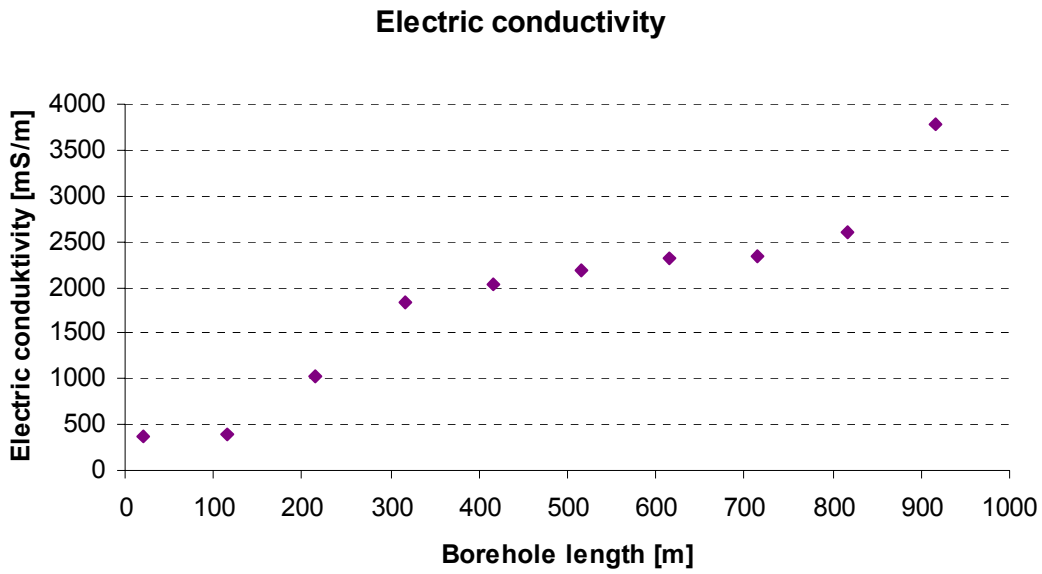

Figure 5-3. *Measurements of electric conductivity show increasing values down the borehole KSH02.*

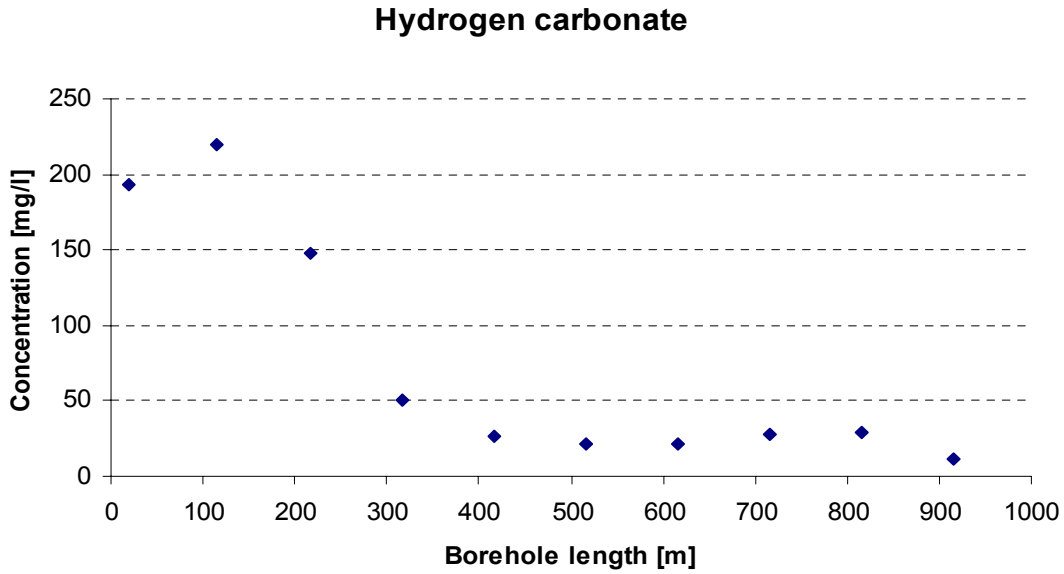

Figure 5-4. *Results from analysis of hydrogen carbonate obtained from the hydrochemical logging in KSH02.*

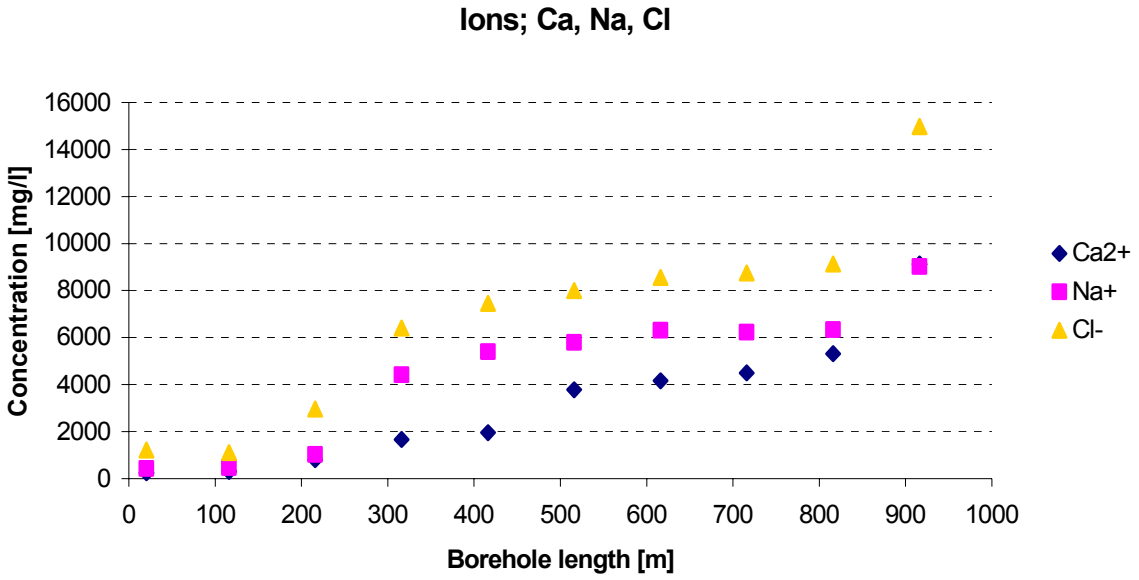

Figure 5-5. *Results from analysis of calcium-, sodium- and chloride-ions.*

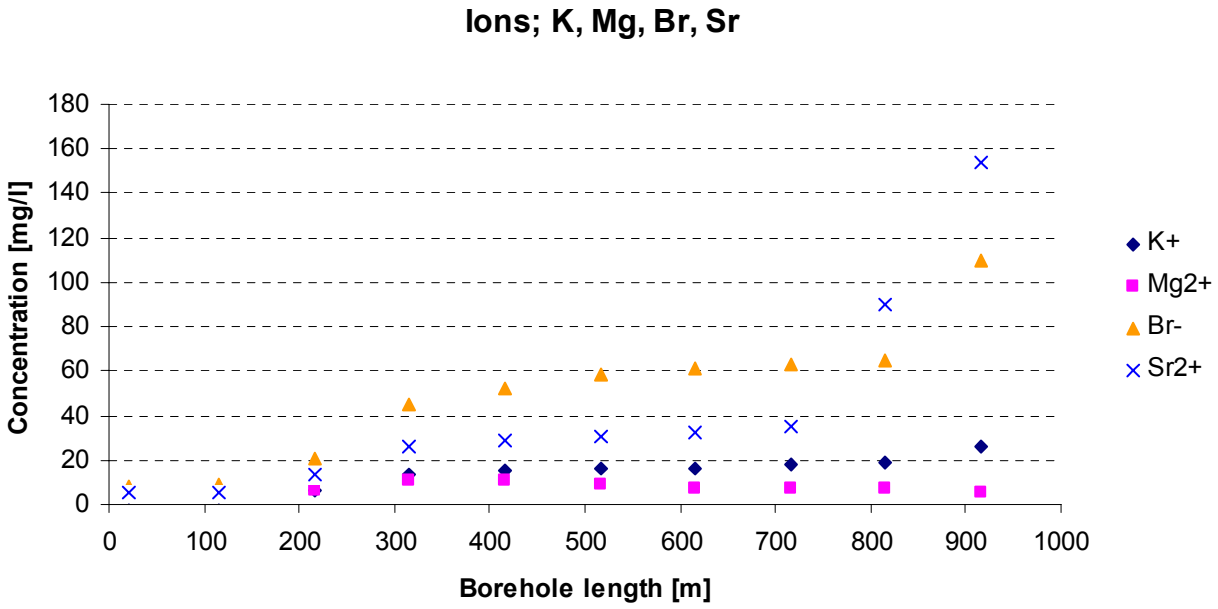

Figure 5-6. *Alalysis results of potassium-, magnesium-, bromide- and strontium-ions from water samples taken at the hydrochemical logging in KSH02.*

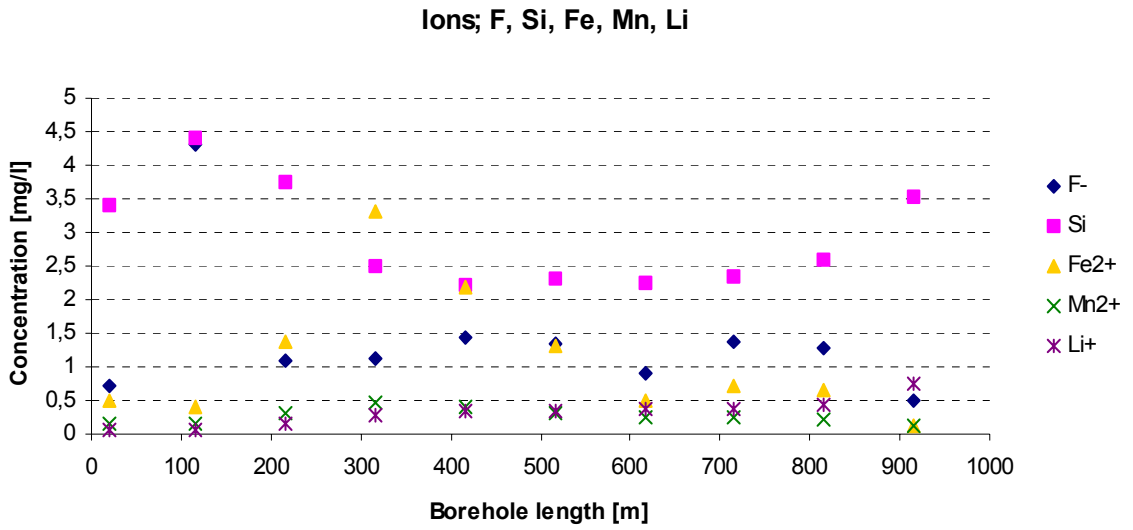

Figure 5-7. *Concentrations of fluoride-, silicon-, iron-, manganese- and lithium-ions obtaine from samples taken June 18, 2003, in KSH02.*

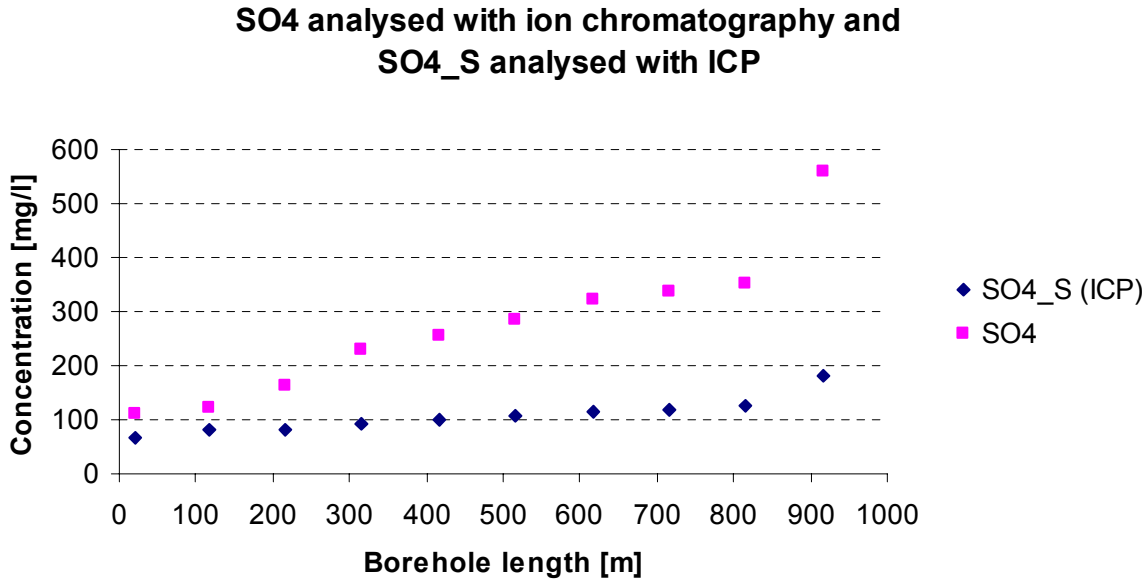

Figure 5-8. *Results from SO_4 and SO_4_S analysis. Sulphate is measured by ion chromatography and total sulphur is determined by ICP AES (Inductively Coupled Plasma Atomic Emission Spectrometry).*

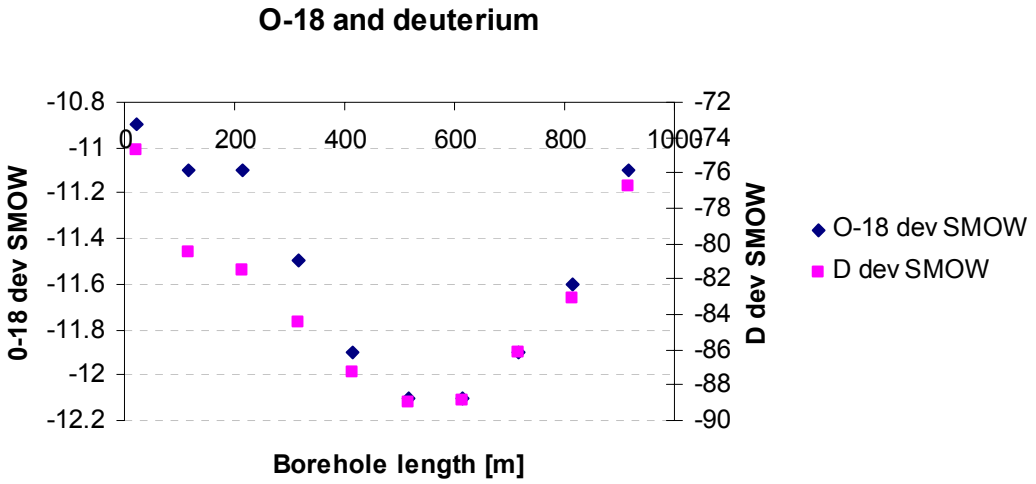

Figure 5-9. *O-18 and deuterium is given as per mill deviation from SMOW (Standard Mean Oceanic Water).*

Table 5-1. Analysis results show small differences in S34 and constant Sr87/Sr86 values along KSH02. The S34 is given as the standard Cañon Diablo Triolite (CDT) and Tritium is given in Tritium Units.

Mean length	S34 dev CDT	Sr87/Sr86	Tr TU
20.5		0.715925	
66	17.8		
116		0.715938	10.90
166	17.2		
216		0.715917	8.60
266	16.4		
316			3.40
366	16.4		
416		0.715697	
466	16.7		
516			<0.8
566			
616		0.715632	
666			
716		0.715819	<0.8
766			
816			
866			
916		0.715948	<0.8
966	14.5		

Table 5-2. Results from the analysis of carbon isotopes. C13 is given as per mill deviation from Belemnite and C14 as percent modern carbon.

Mean length	C13 dev PDB	C14 pmc	Age BP years
416	-14	63.3	3630
616	*	*	*
816	-20.9	70.6	2745

* There was no CO_2 in the sample to date.

6 Conclusions

The charge balance error, giving an indication of the quality and uncertainty of the analyses, exceeded the acceptable level of ± 5% in nine out of ten cases, see Appendix 1. It is not clear why there are such large relative charge balance errors. The results from the analysis of anions does not seem to be the cause of the charge balance error.

Compared with results from hydrochemical logging in previous core-drilled boreholes within the site investigations, the content of flushing water was quite low in KSH02 at the time of the hydrochemical logging. For example, the highest amount of flushing water in KSH02 is about 12%, while the lowest amount measured in KSH01 was about 11%.

Due to a misunderstanding, analysis for B-10 was not ordered from the laboratory and is therefore not available in this report.

Appendix 1 Water composition

IDCODE	Secup m	Seclow m	Sample no.	Rel. charge balance	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	HCO3 mg/L	Cl mg/L	SO4 mg/L	SO4-S mg/L	Br mg/l	F mg/L	Si mg/L	Fe mg/L	Mn mg/L	Li mg/L
KSH02	0	41	5651	-13,6	426	3,63	252	3,4	193	1206,6	111,3	68,4	8,00	0,72	3,4	0,515	0,15	0,063
KSH02	41	91	5652															
KSH02	91	141	5653	-5,6	463	3,37	309	3,8	220	1114,1	122,02	80,1	8,89	4,32	4,4	0,401	0,15	0,066
KSH02	141	191	5654															
KSH02	191	241	5655	-3,50	1020	6,58	798	6,4	148	2960	164,55	81,8	20,57	1,08	3,8	1,39	0,31	0,144
KSH02	241	291	5656															
KSH02	291	341	5657	19,20	4420	13,5	1660	11,1	51	6403,7	229,2	94,4	44,78	1,13	2,5	3,32	0,48	0,287
KSH02	341	391	5658															
KSH02	391	441	5659	21,10	5400	15,2	1950	11	27	7462,9	255,02	99,6	52,14	1,44	2,2	2,2	0,41	0,335
KSH02	441	491	5660															
KSH02	491	541	5661	31,00	5800	15,9	3780	9,2	21	7996,4	285,04	106	58,39	1,33	2,3	1,32	0,31	0,355
KSH02	541	591	5662															
KSH02	591	641	5663	31,90	6300	16,1	4160	7,4	22	8557,5	322,7	114	61,36	0,92	2,2	0,505	0,24	0,368
KSH02	641	691	5664															
KSH02	691	741	5665	32,10	6230	17,6	4500	6,9	28	8749,8	337,74	117	62,82	1,38	2,3	0,715	0,24	0,377
KSH02	741	791	5666															
KSH02	791	841	5667	34,20	6340	19,3	5310	7,3	29	9122,1	351,37	127	64,64	1,28	2,6	0,667	0,23	0,441
KSH02	841	891	5668															
KSH02	891	941	5669	32,40	9020	25,9	9120	5,4	11	14973,6	561,09	183	109,97	0,51	3,5	0,124	0,11	0,743
KSH02	941	991	5670															

IDCODE	Secup m	Seclow m	Sample no.	Rel. charge balance	Sr mg/L	pH	ElCond mS/m	Flushing water %	D dev SMOW	O18 dev SMOW	Tr TU	S34 dev CDT	SR87/SR86	C13 dev PDB	C14 pmc	C14 Age BP years
KSH02	0	41	5651	-13,6	5,49	7,97	378,8	2,94	-74,7	-10,90			0,715925			
KSH02	41	91	5652									17,8				
KSH02	91	141	5653	-5,6	5,44	7,94	396,2	2,35	-80,5	-11,10	10,90		0,715938			
KSH02	141	191	5654									17,2				
KSH02	191	241	5655	-3,50	13,2	7,47	1022	5,88	-81,5	-11,10	8,60		0,715917			
KSH02	241	291	5656									16,4				
KSH02	291	341	5657	19,20	25,8	6,98	1834	11,76	-84,5	-11,50	3,40					
KSH02	341	391	5658									16,4				
KSH02	391	441	5659	21,10	29,2	7,04	2039	12,35	-87,3	-11,90			0,715697	-14	63,3	3630
KSH02	441	491	5660									16,7				
KSH02	491	541	5661	31,00	30,2	7,25	2186	8,82	-89,0	-12,10	<0.8					
KSH02	541	591	5662													
KSH02	591	641	5663	31,90	32,3	7,39	2324	7,65	-88,9	-12,10			0,715632			
KSH02	641	691	5664													
KSH02	691	741	5665	32,10	35,1	7,37	2344	10,59	-86,2	-11,90	<0.8		0,715819			
KSH02	741	791	5666													
KSH02	791	841	5667	34,20	89,9	7,4	2607	12,35	-83,1	-11,60				-20,9	70,6	2745
KSH02	841	891	5668													
KSH02	891	941	5669	32,40	154	7,95	3788	2,94	-76,7	-11,10	<0.8		0,715948			
KSH02	941	991	5670									14,5				