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Oskarshamn site investigation

Groundwater flow measurements in permanent installed boreholes

Test campaign no. 2, 2006

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June 2007

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Keywords: Groundwater flow, Dilution test, Tracer test, AP PS 400-06-130.

Abstract

This report describes the performance and evaluation of measurements of ground water flow in nineteen borehole sections in permanent installed boreholes within the site investigation at Oskarshamn (Simpevarp, Ävrö and Laxemar). The objective was to determine the groundwater flow in all borehole sections instrumented for this purpose. This is the second test campaign performed in the monitoring program and is planned to be repeated once every year.

The groundwater flow in the selected borehole sections was determined through dilution measurements during natural undisturbed conditions. Measured flow rates vary from 15 to 2,512 ml/h in the measured sections with Darcy velocities ranging from 1.3 E–9 to 1.4 E–7 m/s. Hydraulic gradients are calculated according to the Darcy concept and ranging from 0.002 to 2.

Sammanfattning

Denna rapport beskriver genomförandet och utvärderingen av grundvattenflödesmätningar i nitton borrhålssektioner i permanent installerade borrhål i Oskarshamnområdet (Simpevarp, Ävrö och Laxemar). Syftet var att bestämma grundvattenflödet i samtliga för ändamålet instrumenterade borrhålssektioner. Denna mätning är den andra som genomförts i moniterings-programmet och mätningarna är planerade att återupprepas en gång per år.

Grundvattenflödet i de utvalda borrhålssektionerna mättes med utspädningsmetoden under naturliga ostörda förhållanden. Uppmätta grundvattenflöden ligger i intervallet 15 till 2 512 ml/timme med beräknade Darcy hastigheter mellan 1.3 E–9 och 1.4 E–7 m/s. Hydrauliska gradienten beräknades till mellan 0.002 och 2.

Contents

1 Introduction

This document reports the results gained by the groundwater flow measurements in permanent installed boreholes, test campaign no. 2, 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 400-06-130. 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 field work was performed in November and December 2006. A map showing the investigation site at Oskarshamn including the boreholes is presented in Figure 1-1.

The original results are stored in the primary data base SICADA and are traceable by the Activity Plan number.

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

Activity Plan	Number	Version
Monitering av grundvattenflöde i permanent installerade borrhål, kampanj 2, 2006.	AP PS 400-06-130	1.0
Method Descriptions	**Number**	**Version**
Mätsystembeskrivning (MSB) – Handhavande del:	SKB MD 368.010	1.0
System för hydrologisk och metrologisk datainsamling. Vattenprovtagning och utspädningsmätning i observationshål.		

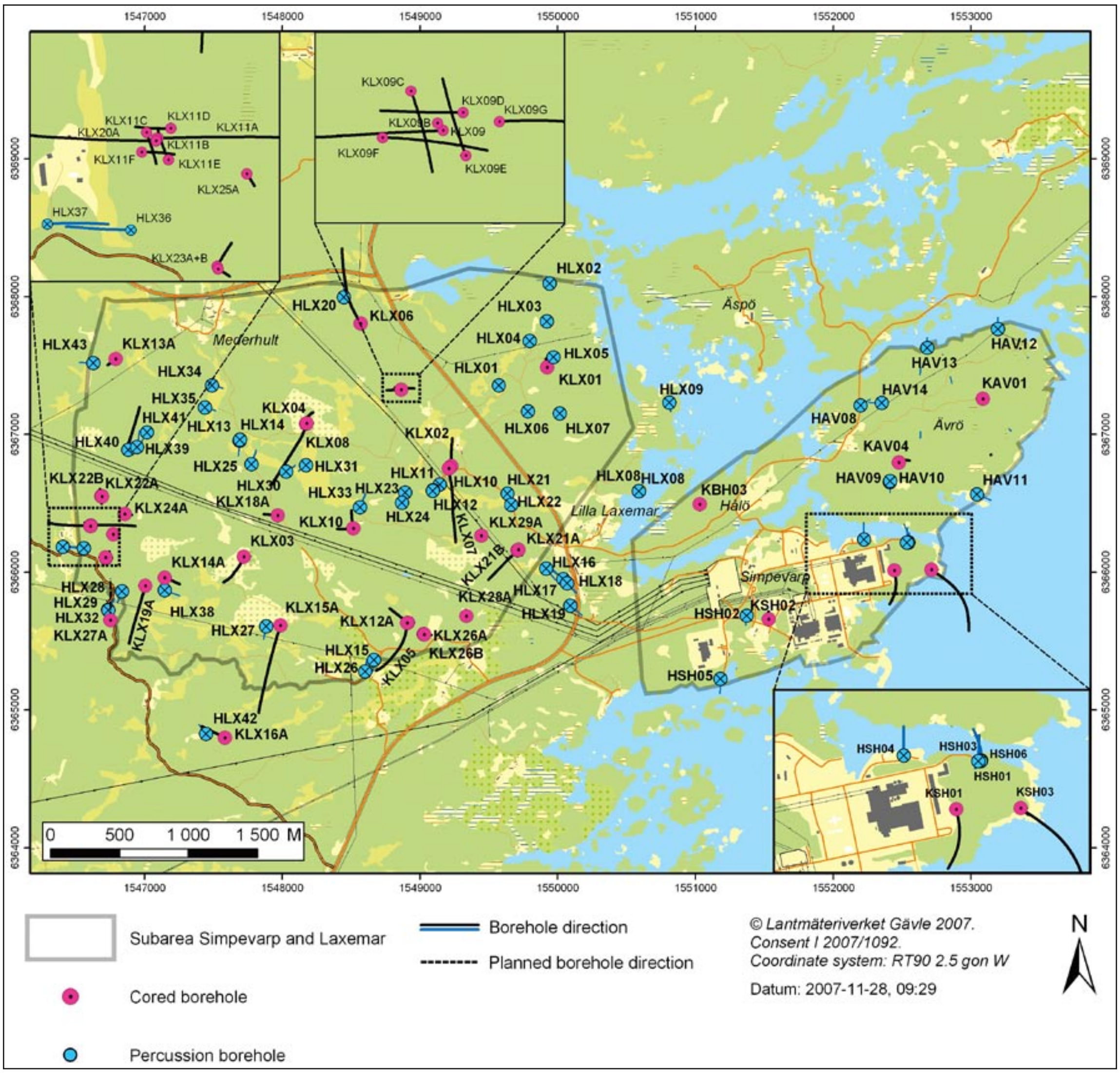


Figure 1-1. *General overview of the Oskarshamn site investigation area.*

2 Objective and scope

The objective of this activity was to determine the groundwater flow in borehole sections in permanent installed boreholes at Oskarshamn. Nineteen borehole sections instrumented for this purpose (circulation sections) were to be measured. This was the second measuring campaign performed in the monitoring program and it is planned to be repeated once every year.

The groundwater flow in the selected borehole sections was determined through dilution measurements during natural undisturbed conditions.

Table 2-1. Borehole sections used for groundwater flow measurements in Oskarshamn, autumn 2006.

Borehole/section	Borehole length (m)	Transmissivity (m^2/s)	Measurement period (YYMMDD–YYMMDD)
KAV01:3	391–434	4.2 E–5*	061206–061214
KLX01:3	171–190	3.6 E–5*	061110–061116 061130–061206
KLX02:5	452–494	3.1 E–7*	061123–061128
KLX02:2	1,145–1,164	3.2 E–7*	061123–061128
KLX03:4	729–751	5.9 E–6*	061206–061212
KLX03:1	965–971	4.6 E–7*	061213–061220
KLX04:5	507–530	2.7 E–6*	061129–061205
KLX04:2	870–897	4.9 E–8**	061129–061205
KLX05:7	241–255	2.2 E–6*	061206–061212
KLX05:3	625–633	1.2 E–8*	061213–061220
KLX06:6	256–275	1.0 E–4*	061117–061123
KLX06:3	554–570	1.1 E–5*	061117–061123
KLX07A:2	753–780	3.5 E–5*	061214–061219
KLX10A:5	351–368	2.1 E–6*	061109–061116
KLX10A:2	689–710	2.8 E–7*	061109–061116
KSH01A:7	238–277	7.4 E–6*	061116–061123
KSH01A:4	532–572	8.4 E–7*	061116–061123
KSH02:4	411–439	3.1 E–7*	061124–061129
KSH02:1	955–963	6.8 E–8*	061124–061129

* From PSS measurements
** From PFL measurements

3 Equipment

3.1 Description of equipment

The boreholes involved in the tests are instrumented with one to seven inflatable packers isolating two to eight borehole sections each. In Figure 3-1 a drawing of the instrumentation in core boreholes is presented. All isolated borehole sections are connected to the HMS-system for pressure monitoring. In general, the sections planned to be used for tracer tests are equipped with three polyamide tubes. Two are used for injection, sampling and circulation in the borehole section and one is used for pressure monitoring. A detailed description of the equipment is given in SKB MD 360.002 and SKB MD 368.001 – 029, SKB internal documents.

The tracer dilution tests were performed using four identical equipment set-ups, i.e. allowing four sections to be measured simultaneously. A schematic drawing of the tracer test equipment is shown in Figure 3-2. The basic idea is to have an internal circulation in the borehole section. The circulation makes it possible to obtain a homogeneous tracer concentration in the borehole section and to sample the tracer concentration outside the borehole in order to monitor the dilution of the tracer with time.

Circulation is controlled by a down-hole pump with variable speed and measured by a flow meter. Tracer injections are made with a peristaltic pump and sampling is made by continuously extracting a small volume of water from the system through another peristaltic pump (constant leak) to a fractional sampler. The equipment and test procedure is described in detail in SKB MD 368.010, SKB internal document.

The tracer used was a fluorescent dye tracer, Uranine (Sodium Fluorescein) from Merck (purum quality).

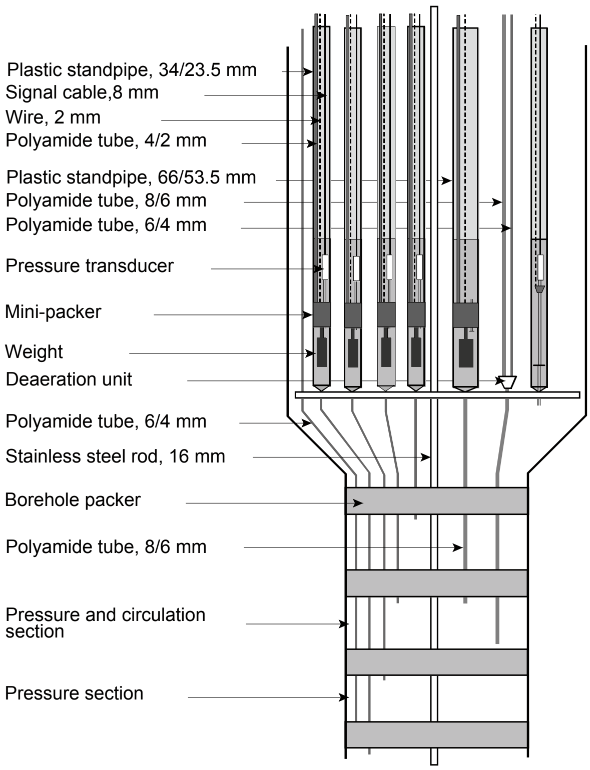


Figure 3-1. *An example of permanent instrumentation in core boreholes with circulation sections.*

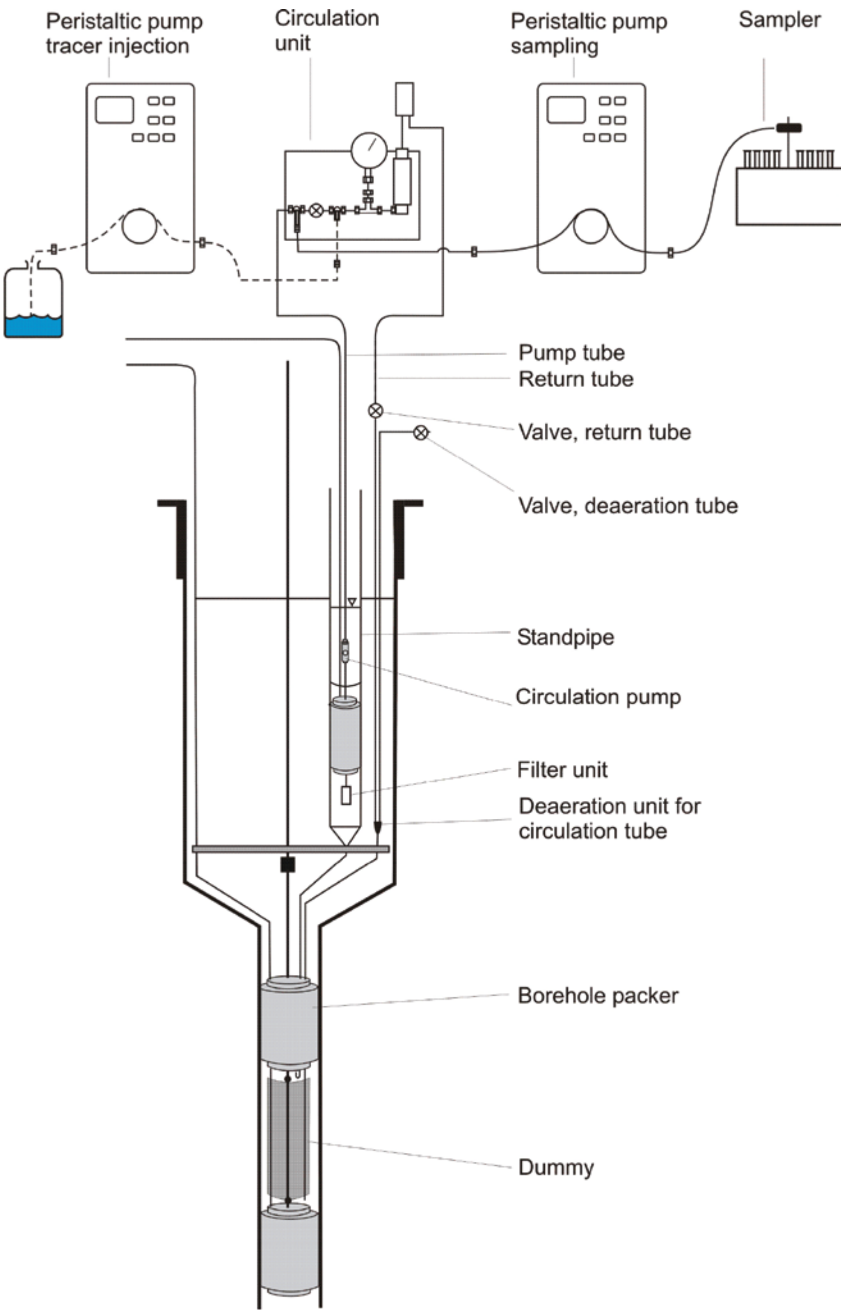


Figure 3-2. *Schematic drawing of the equipment used in tracer dilution measurements.*

4 Execution

4.1 General

In the dilution method a tracer is introduced and homogeneously distributed into a borehole test section. The tracer is subsequently diluted by the ambient groundwater, flowing through the borehole test section. The dilution of the tracer is proportional to the water flow through the borehole section and the groundwater flow is calculated as a function of the decreasing tracer concentration with time, Figure 4-1.

The Method Description used was "System för hydrologisk och metrologisk datainsamling. Vattenprovtagning och utspädningsmätning i observationshål." (SKB MD 368.010, SKB internal document).

4.2 Preparations

Before the field work started, a tracer stock solution (Uranine, 500 mg/l) was mixed and the field equipment was functionality tested and calibrated.

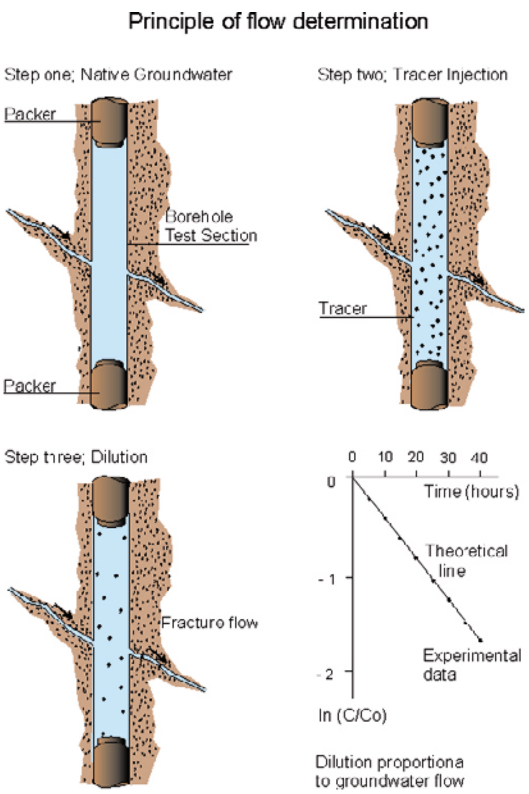


Figure 4-1. *General principles of dilution and flow determination.*

4.3 Execution of field work

Tracer dilution tests were performed in nineteen borehole sections listed in Table 2-1.

The tests were made by injecting a slug of tracer (Uranine, 500 mg/l) in the selected borehole section with an adjusted injection flow during the time it takes to circulate one section volume and in this way dilute the tracer to approximately 0.5 mg/l as a start concentration in the borehole section. Using the equipment described in Chapter 3.1 the tracer solution in the borehole section was continuously circulated and sampled allowing the natural groundwater flow to dilute the tracer. Circulation was maintained between 5 and 8 days and the sampler was set up to change tubes every 120 minutes.

For detailed descriptions see the Method Description "System för hydrologisk och metrologisk datainsamling. Vattenprovtagning och utspädningsmätning i observationshål." (SKB MD 368.010, SKB internal document) and the Activity Plan "Monitering av grundvattenflöde i permanent installerade borrhål, kampanj 2, 2006" (SKB AP PS 400-06-130, SKB internal document).

4.4 Analyses and interpretations

The samples were analysed for dye tracer content at the Geosigma Laboratory using a Jasco FP 777 Spectrofluorometer.

4.4.1 Tracer dilution calculations

Flow rates were calculated from the decay of tracer concentration versus time through dilution with natural unlabelled groundwater. The so-called "dilution curves" were plotted as the natural logarithm of concentration versus time, cf. /1/. Theoretically, a straight-line relationship exists between the natural logarithm of the relative tracer concentration (c/c_0) and time (t):

$$\ln (c/c_0) = -(Q_{bh}/V) \cdot \Delta t \qquad (4\text{-}1)$$

where Q_{bh} (m^3/s) is the groundwater flow rate through the borehole section and V (m^3) is the volume of the borehole section. By plotting ln (c/c_0) versus t, and by knowing the borehole volume V, Q_{bh} may then be obtained from the straight-line slope. If c_0 is constant, it is sufficient to use ln c in the plot.

The sampling procedure with a constant flow of 5–7.5 ml/h also creates a dilution of tracer. The sampling flow rate is therefore subtracted from the value obtained from equation 4-1.

The flow, Q_{bh}, may be translated into a Darcy velocity by taking into account the distortion of the flow caused by the borehole and the angle between the borehole and flow direction. In practise, a 90° angle between the borehole axis and the flow direction is assumed and the relation between the flow in the rock, the Darcy velocity, v (m/s), and the measured flow through the borehole section, Q_{bh}, can be expressed as:

$$Q_{bh} = v \cdot L_{bh} \cdot 2r_{bh} \cdot \alpha \qquad (4\text{-}2)$$

where L_{bh} is the length of the borehole section (m), r_{bh} is the borehole radius (m) and α is the factor accounting for the distortion of flow caused by the borehole.

Hydraulic gradients are roughly estimated from Darcy's law where the gradient, *I*, is calculated as the function of the Darcy velocity, *v*, with the conductivity, *K*:

$$I = \frac{v}{K} = \frac{Q_{bh} \cdot L_{bh}}{\alpha \cdot A \cdot T_{bh}} = \frac{Q_{bh} \cdot L_{bh}}{2 \cdot d_{bh} \cdot L_{bh} \cdot T_{bh}} \qquad (4\text{-}3)$$

where T_{bh} is the transmissivity of the section, *A* the cross section area between the packers and d_{bh}, the borehole diameter.

The factor α is commonly given the value 2 in the calculations, which is the theoretical value for a homogeneous porous media. Since the rock mostly is heterogeneous and the angles in the sections not always 90° the calculation of the hydraulic gradient is a rough estimation.

4.5 Nonconformities

- Gasification occurred in most of the borehole sections disturbing the circulation of groundwater in the borehole section and the sampling.
- Gasification was extreme in borehole KLX02:2 and it stopped the circulation pump and made the circulation of groundwater in the borehole section and the sampling to be very instable. *This is considered to have impact on the quality of the measurements.*
- In borehole KAV01:3 the sampler didn't change tubes in two occasions which resulted in flooding of the equipment and loss of samples. The circulation pump stopped which resulted in loss of samples. This is not considered to have any impact on the quality of the measurements as there are enough data of good quality for evaluation.
- In borehole KLX02:5 there were orange-brown coloured sediments in the samples and the pH value was low which caused a lot of buffering before the analysis. *This is considered to have impact on the quality of the measurements*.
- Mobile electric power stations run by diesel affected the frequency of the sampler. When the sampler was set up to change tubes every 120 minutes it changed tubes after approximately 108, 109 and 118 minutes depending on the power station. This was compensated for in the evaluation.

5 Results

Original data from the reported activity are stored in the primary database Sicada. Data are traceable in Sicada by the Activity Plan number (AP PF 400-06-100). Only data in databases are accepted for further interpretation and modelling. The data presented in this report are regarded as copies of the original data. Data in the databases may be revised, if needed. However, such revision of the database will not necessarily result in a revision of this report, although the normal procedure is that major data revisions entail a revision of P-reports. Minor data revisions are normally presented as supplements, available at www.skb.se.

The results obtained within this activity are groundwater flow rates in borehole sections KAV01:3, KLX01:3, KLX02:5, KLX02:2, KLX03:4, KLX03:1, KLX04:5, KLX04:2, KLX05:7, KLX05:3, KLX06:6, KLX06:3, KLX07A:2, KLX10A:5, KLX10A:2, KSH01A:7, KSH01A:4, KSH02:4 and KSH02:1 during natural conditions. The groundwater flow rates calculated together with transmissivities and volumes used will obtain Darcy velocities and hydraulic gradients as additional results, see Table 5-1.

A comparison between test campaign no. 1, 2005 /2/ and test campaign no. 2, 2006 is shown in Table 5-2. The results from 2005 have been recalculated since the volumes have been corrected.

Table 5-1. Results from groundwater flow measurements in permanent installed boreholes, test campaign no. 2, 2006.

Borehole/section	Borehole length (m)	Transmissivity (m^2/s)	Volume (ml)	Measured flow (ml/h)	Darcy velocity (m/s)	Hydraulic gradient
KAV01:3	391–434	4.2 E–5*	47,760	2,512	1.4 E–7	0.15
KLX01:3	171–190	3.6 E–5*	34,930	246	2.4 E–8	0.012
KLX02:5	452–494	3.1 E–7*	70,200	152	6.6 E–9	0.90
KLX02:2	1,145–1,164	3.2 E–7*	90,590	46	4.4 E–9	0.26
KLX03:4	729–751	5.9 E–6*	66,610	39	3.2 E–9	0.012
KLX03:1	965–971	4.6 E–7*	65,600	56	1.7 E–8	0.22
KLX04:5	507–530	2.7 E–6*	54,120	33	2.6 E–9	0.022
KLX04:2	870–897	4.9 E–8**	83,340	42	2.8 E–9	1.6
KLX05:7	241–255	2.2 E–6*	30,040	35	4.6 E–9	0.029
KLX05:3	625–633	1.2 E–8*	48,080	15	3.4 E–9	2.3
KLX06:6	256–275	1.0 E–4*	35,860	121	1.2 E–8	0.002
KLX06:3	554–570	1.1 E–5*	52,880	47	5.4 E–9	0.008
KLX07A:2	753–780	3.5 E–5*	77,030	1,066	7.2 E–8	0.056
KLX10A:5	351–368	2.1 E–6*	39,870	1,104	1.2 E–7	0.96
KLX10A:2	689–710	2.8 E–7*	66,620	135	1.2 E–8	0.88
KSH01A:7	238–277	7.4 E–6*	52,090	119	5.6 E–9	0.030
KSH01A:4	532–572	8.4 E–7*	76,980	441	2.0 E–8	0.96
KSH02:4	411–439	3.1 E–7*	54,140	20	1.3 E–9	0.12
KSH02:1	955–963	6.8 E–8*	67,330	33	7.6 E–9	0.89

* From PSS measurements
** From PFL measurements

Table 5-2. Results from groundwater flow measurements in permanent installed boreholes. Comparison between test campaign no. 1, 2005 and test campaign no. 2, 2006.

Borehole/ section	Borehole length (m)	Transmissivity (m^2/s)	Volume (ml)	Measured (ml/h) 2005	Flow 2006	Darcy (m/s) 2005	Velocity 2006	Hydraulic 2005	Gradient 2006
KAV01:3	391–434	4.2 E–5*	47,760	3,657	2,512	2.1E–7	1.4 E–7	0.22	0.15
KLX01:3	171–190	3.6 E–5*	34,930	353	246	3.4E–8	2.4 E–8	0.018	0.012
KLX02:5	452–494	3.1 E–7*	70,200	184	152	8.0E–9	6.6 E–9	1.1	0.90
KLX02:2	1,145–1,164	3.2 E–7*	90,590	128	46	1.2E–8	4.4 E–9	0.73	0.26
KLX03:4	729–751	5.9 E–6*	66,610		39		3.2 E–9		0.012
KLX03:1	965–971	4.6 E–7*	65,600		56		1.7 E–8		0.22
KLX04:5	507–530	2.7 E–6*	54,120	40	33	3.2E–9	2.6 E–9	0.027	0.022
KLX04:2	870–897	4.9 E–8**	83,340	44	42	3.0E–9	2.8 E–9	1.6	1.6
KLX05:7	241–255	2.2 E–6*	30,040		35		4.6 E–9		0.029
KLX05:3	625–633	1.2 E–8*	48,080		15		3.4 E–9		2.3
KLX06:6	256–275	1.0 E–4*	35,860	131	121	1.3E–8	1.2 E–8	0.002	0.002
KLX06:3	554–570	1.1 E–5*	52,880	53	47	6.1E–9	5.4 E–9	0.009	0.008
KLX07A:2	753–780	3.5 E–5*	77,030		1,066		7.2 E–8		0.056
KLX10A:5	351–368	2.1 E–6*	39,870		1,104		1.2 E–7		0.96
KLX10A:2	689–710	2.8 E–7*	66,620		135		1.2 E–8		0.88
KSH01A:7	238–277	7.4 E–6*	52,090	112	119	5.3E–9	5.6 E–9	0.028	0.030
KSH01A:4	532–572	8.4 E–7*	76,980	541	441	2.5E–8	2.0 E–8	1.2	0.96
KSH02:4	411–439	3.1 E–7*	54,140	39	20	2.6E–9	1.3 E–9	0.23	0.12
KSH02:1	955–963	6.8 E–8*	67,330	49	33	1.1E–8	7.6 E–9	1.3	0.89

* From PSS measurements
** From PFL measurements

In Figure 5-1 an example of a typical tracer dilution curve is shown. The flow rate is calculated from the slope of the straight-line fit. The results show that the groundwater flow during natural undisturbed conditions varies from 15 to 2,512 ml/h in the measured sections with Darcy velocities ranging from 1.3 E–9 to 1.4 E–7 m/s. Hydraulic gradients are calculated according to the Darcy concept and ranging from 0.002 to 2.

Tracer dilution graphs together with straight line fits for each borehole section are presented in Appendix 1. The straight line fits to the experimental data are generally good with regression coefficients between 0.85 and 0.998 for 13 of 19 borehole sections. For six borehole section it vary between 0.49 and 0.79. However, in a few cases (KLX01:3, KLX02:5, KLX04:5, KSH01A:7, and KLX10A:2) one may distinguish more than one slope on the experimental curves. This may be a result of a changing hydraulic gradient during the measurement. Another effect that may be seen in the dilution data is that mixing takes quite a long time in sections having large volume and long tubing. This decreases the circulation capacity of the pump. This effect is clearly visible in the data from KLX02:2 (1,145–1,164 m), KLX03:1 (965–971 m) and KSH02:1 (955–963 m) where mixing takes more than two days.

Groundwater level during the entire test period is shown for the selected boreholes in Appendix 2. The groundwater levels are generally stable during the measurement period. A noticeable exception is borehole section KLX03:1.

The original results are stored in the primary data base SICADA. The data in this data base is available for further interpretation and is traceable by the Activity Plan number (AP PS 400-06-130).

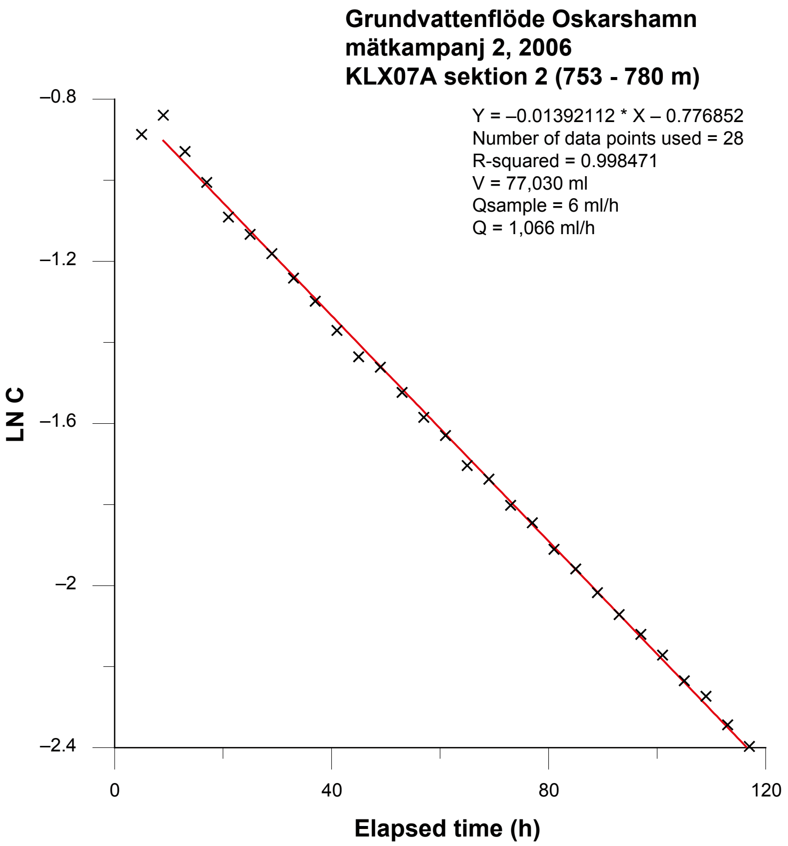


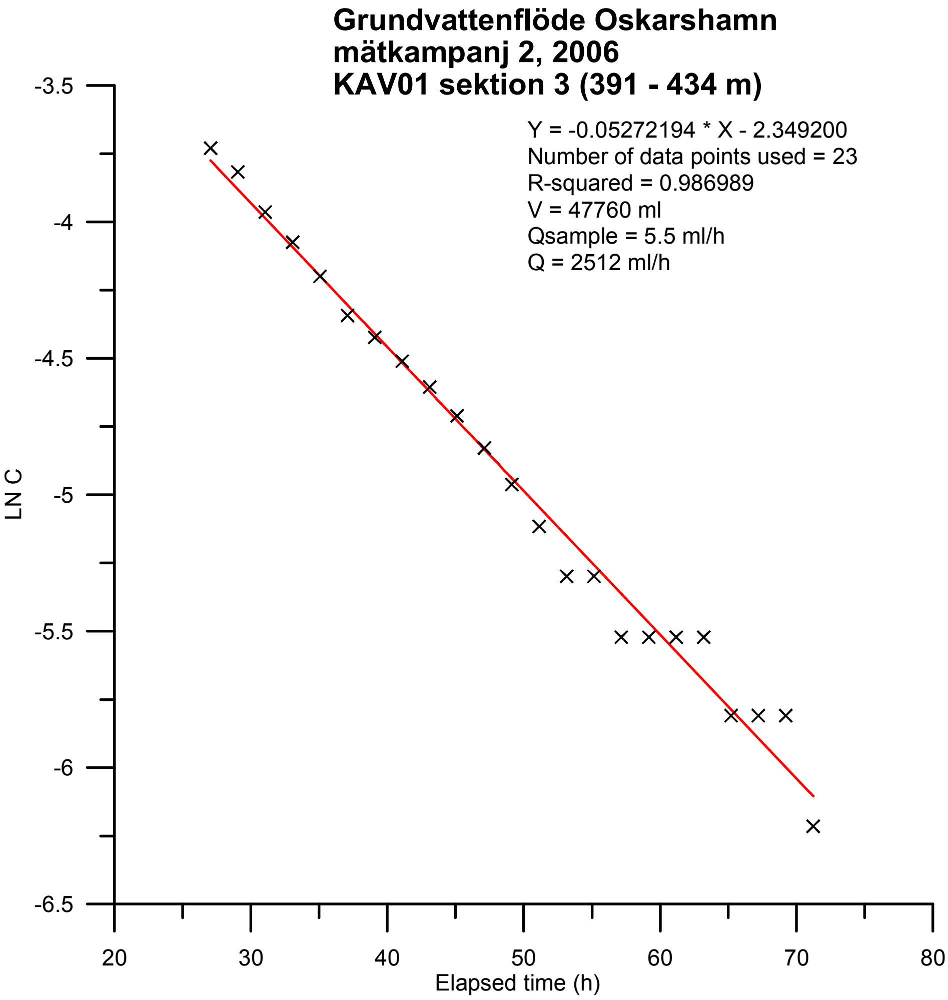
Figure 5-1. *Example of a tracer dilution graph for borehole KLX07A:2, including straight-line fit.*

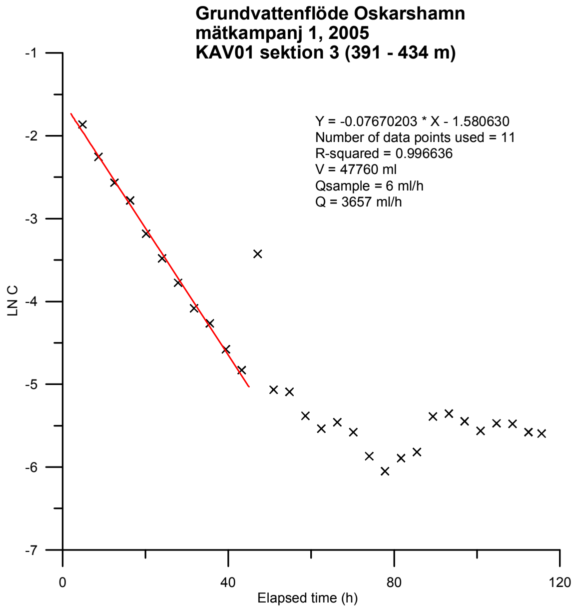
6 References

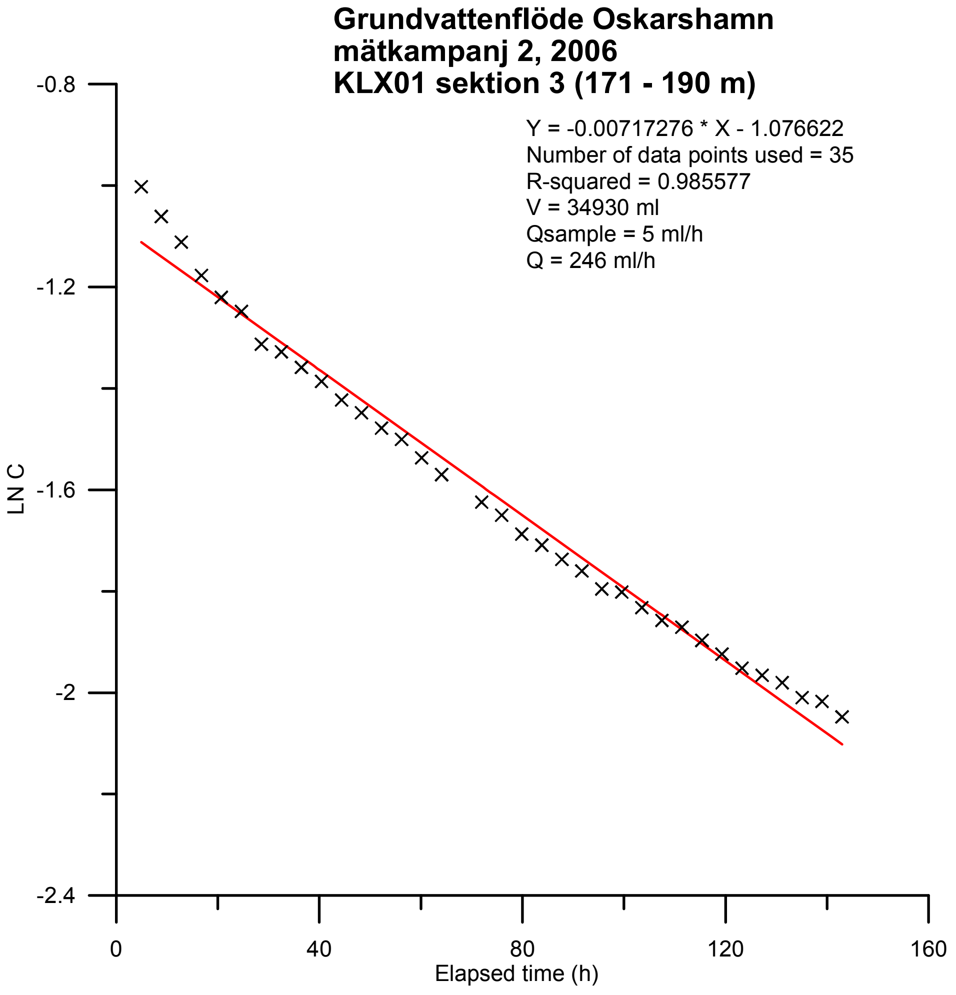
/1/ **Gustafsson E, 2002**. Bestämning av grundvattenflödet med utspädningsteknik – Modifiering av utrustning och kompletterande mätningar. SKB R-02-31 (in Swedish), Svensk Kärnbränslehantering AB.

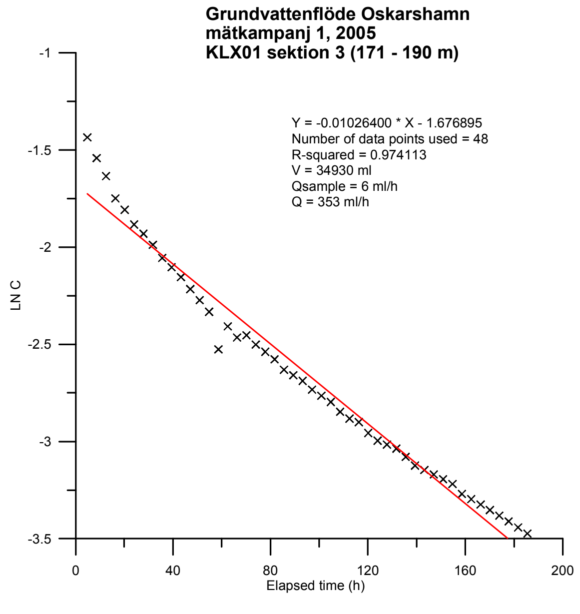
/2/ **Askling P, Andersson P, 2006**. Groundwater flow measurements in permanent installed boreholes, Test campaign no. 1, 2005, Oskarshamn site investigation. SKB P-06-61, Svensk Kärnbränslehantering AB.

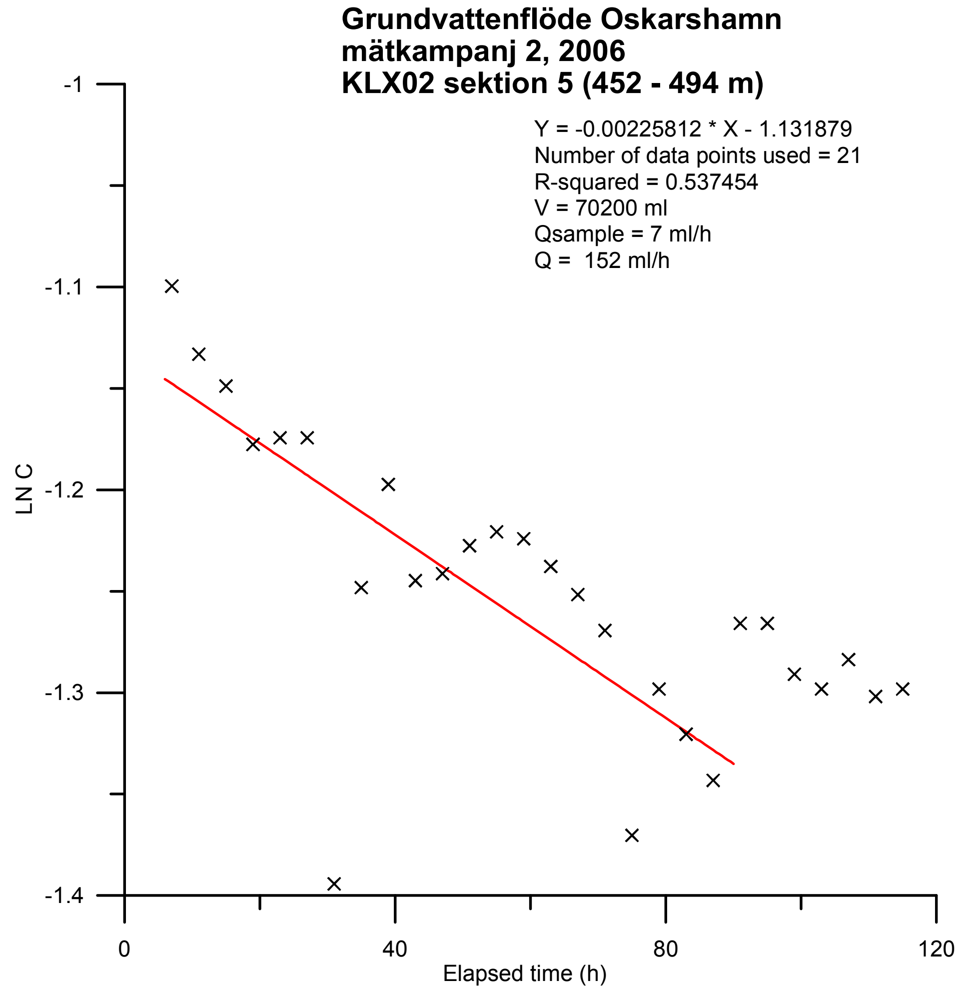
Tracer dilution graphs

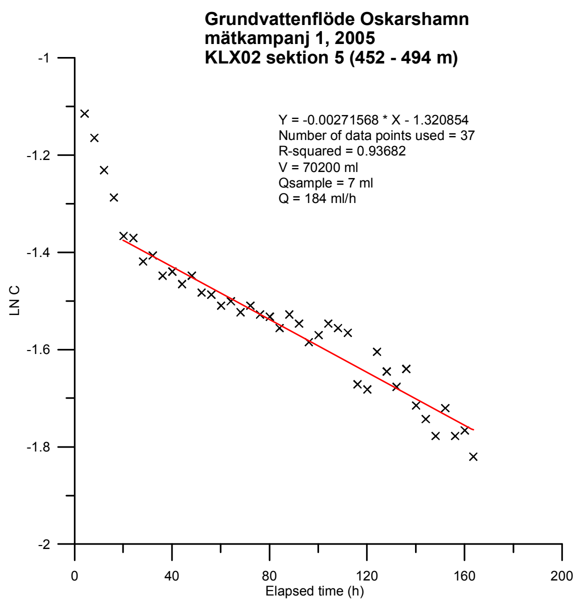


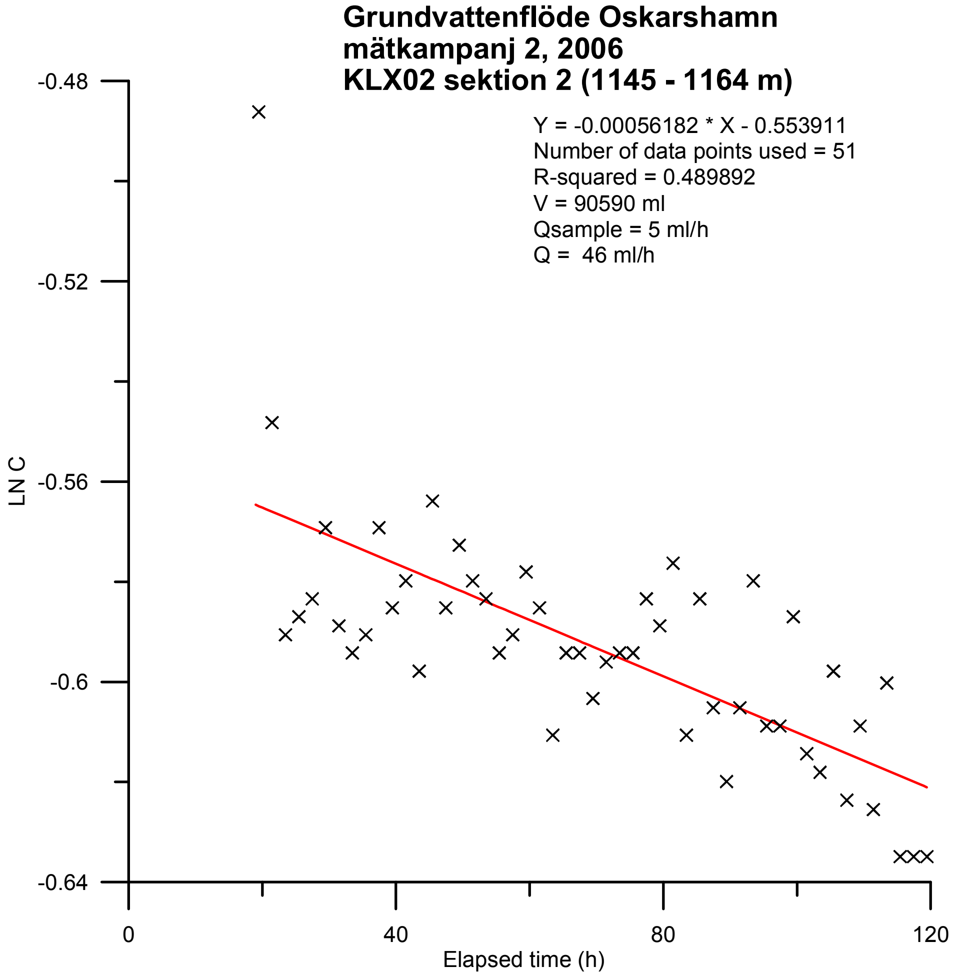


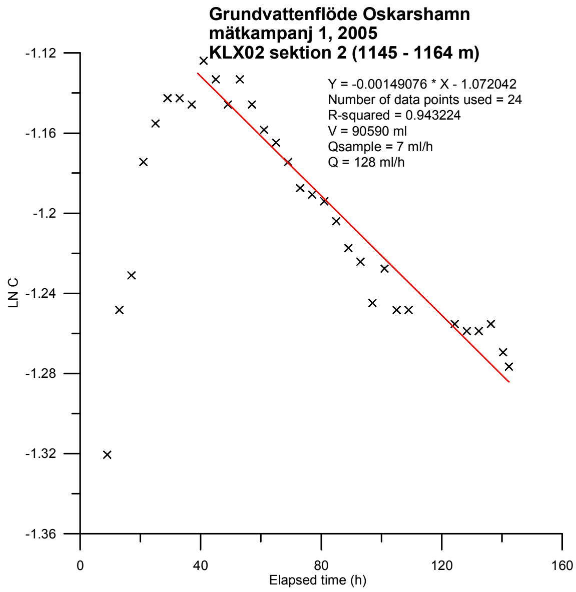

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX01 sektion 3 (171 - 190 m)
Y = -0.00717276 * X - 1.076622
Number of data points used = 35
R-squared = 0.985577
V = 34930 ml
Qsample = 5 ml/h
Q = 246 ml/h
LN C
-0.8
-1.2
-1.6
-2
-2.4
0
40
80
120
160
Elapsed time (h)

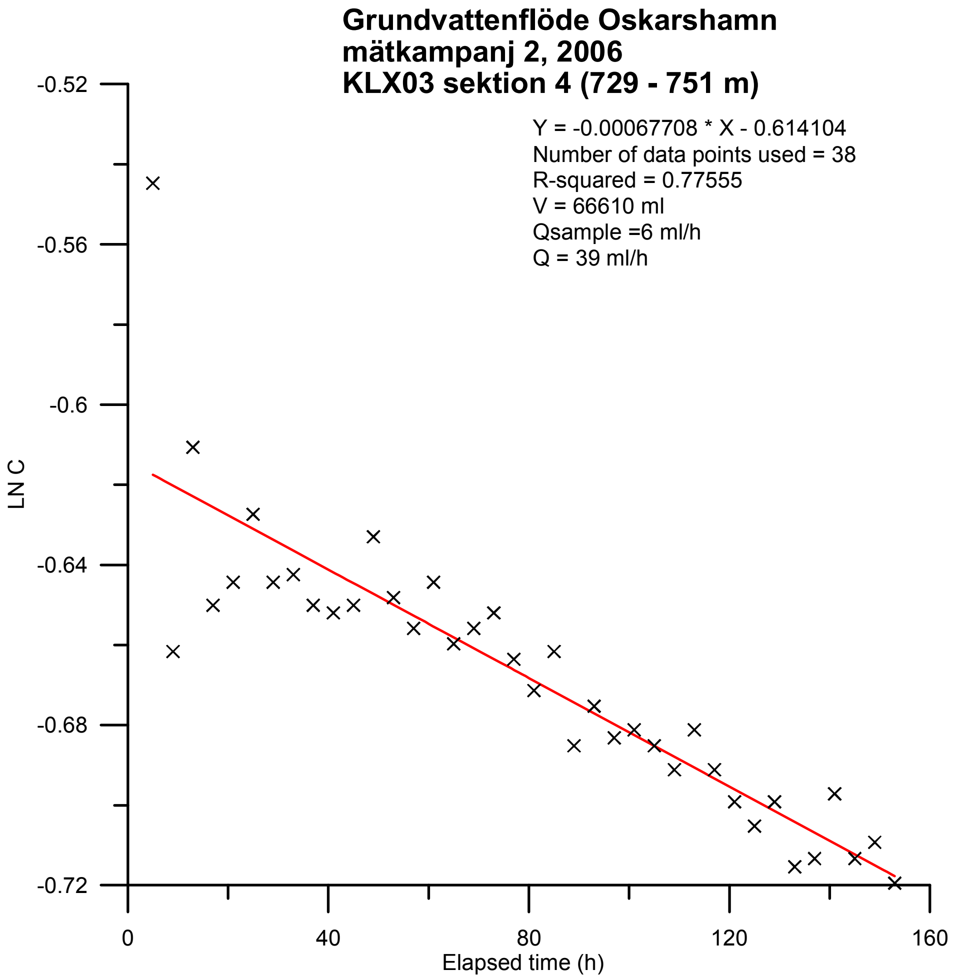

Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KLX01 sektion 3 (171 - 190 m)
Y = -0.01026400 * X - 1.676895
Number of data points used = 48
R-squared = 0.974113
V = 34930 ml
Qsample = 6 ml/h
Q = 353 ml/h
LN C
-1
-1.5
-2
-2.5
-3
-3.5
0
40
80
120
160
200
Elapsed time (h)

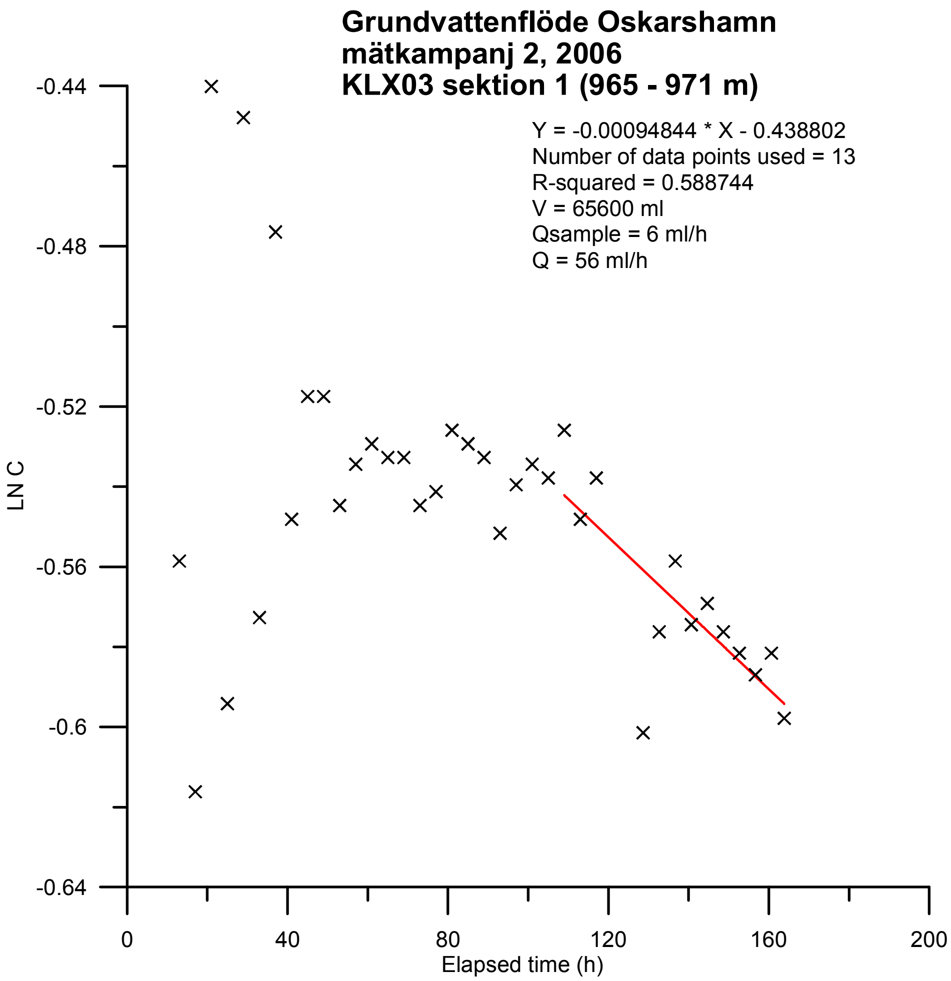

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX02 sektion 5 (452 - 494 m)
Y = -0.00225812 * X - 1.131879
Number of data points used = 21
R-squared = 0.537454
V = 70200 ml
Qsample = 7 ml/h
Q = 152 ml/h
LN C
-1
-1.1
-1.2
-1.3
-1.4
0
40
80
120
Elapsed time (h)

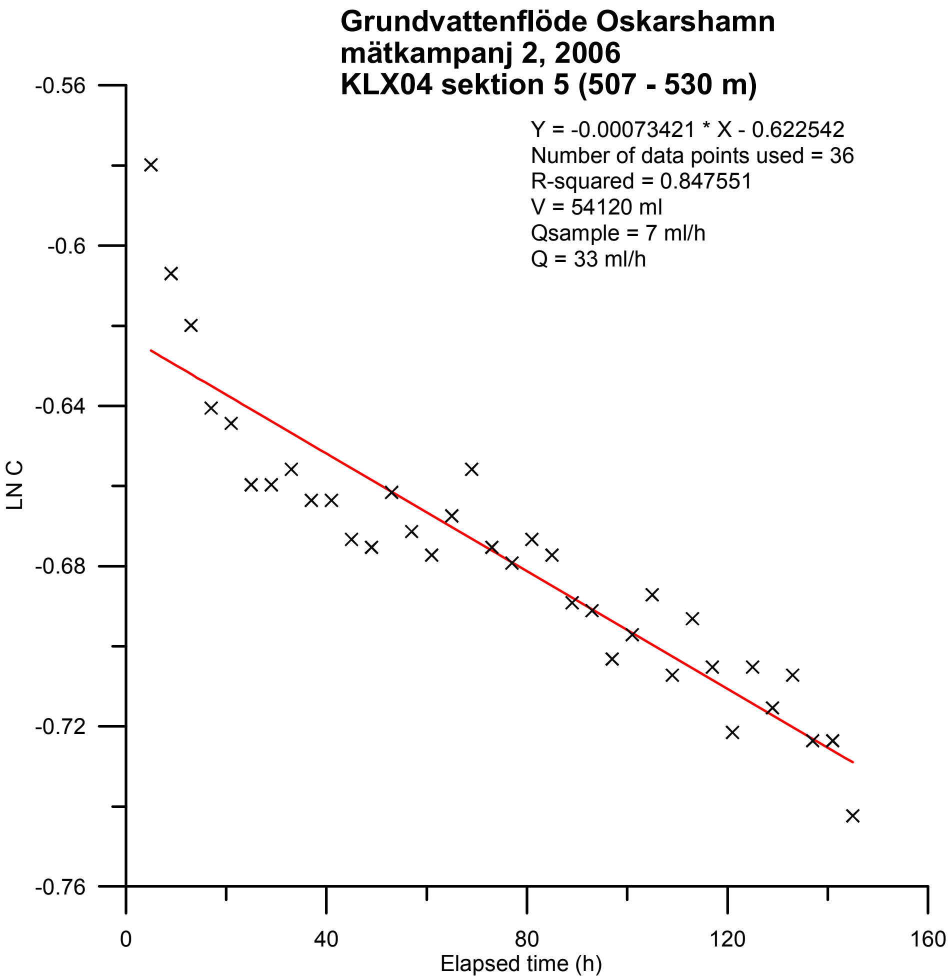

Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KLX02 sektion 5 (452 - 494 m)
Y = -0.00271568 * X - 1.320854
Number of data points used = 37
R-squared = 0.93682
V = 70200 ml
Qsample = 7 ml
Q = 184 ml/h
LN C
-1
-1.2
-1.4
-1.6
-1.8
-2
0
40
80
120
160
200
Elapsed time (h)

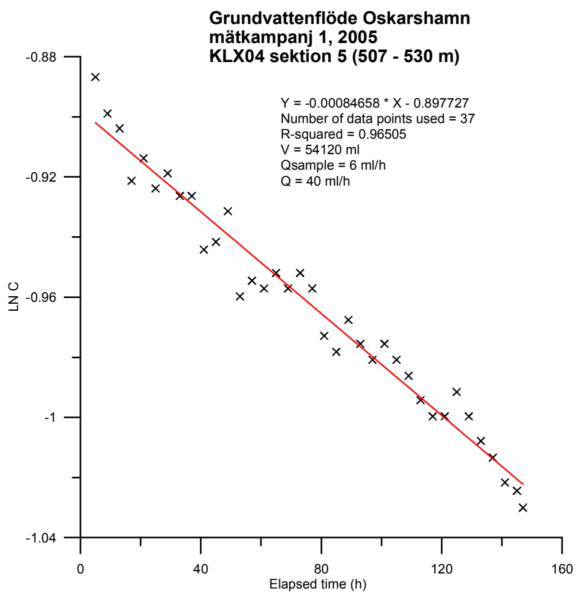

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX02 sektion 2 (1145 - 1164 m)
Y = -0.00056182 * X - 0.553911
Number of data points used = 51
R-squared = 0.489892
V = 90590 ml
Qsample = 5 ml/h
Q = 46 ml/h
LN C
-0.48
-0.52
-0.56
-0.6
-0.64
0
40
80
120
Elapsed time (h)

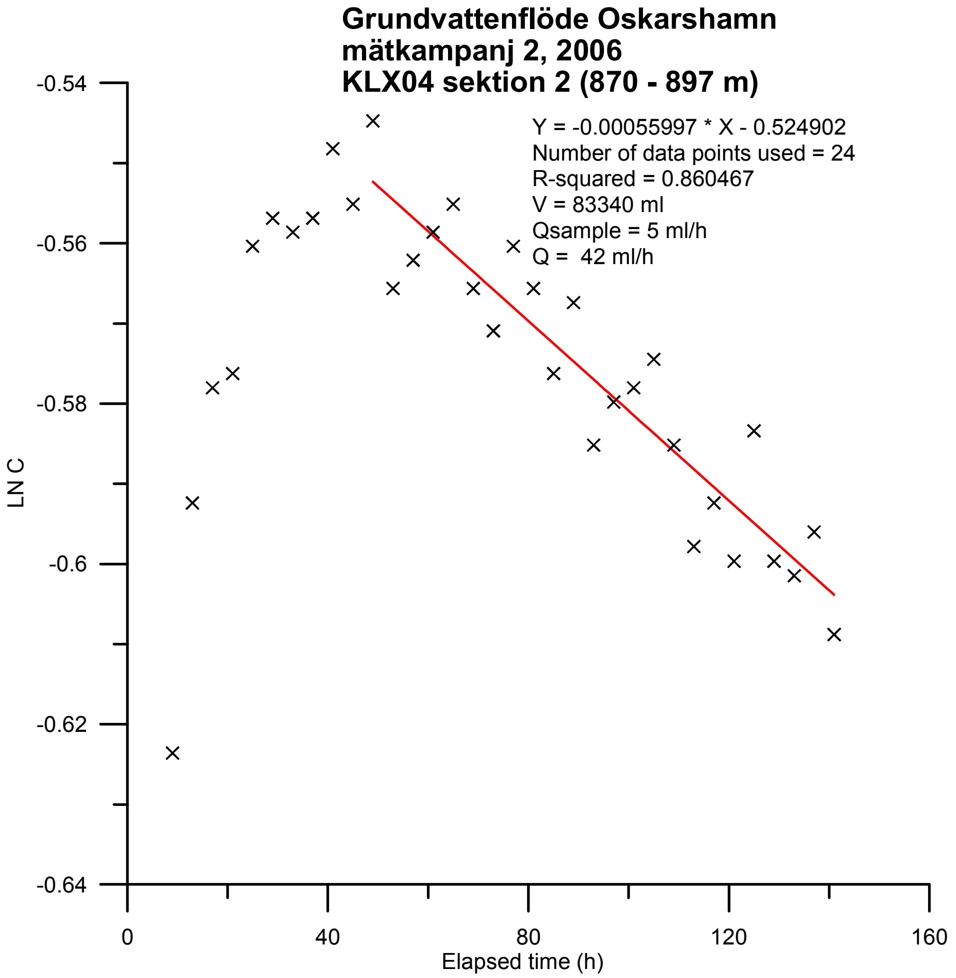

Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KLX02 sektion 2 (1145 - 1164 m)
Y = -0.00149076 * X - 1.072042
Number of data points used = 24
R-squared = 0.943224
V = 90590 ml
Qsample = 7 ml/h
Q = 128 ml/h
LN C
-1.12
-1.16
-1.2
-1.24
-1.28
-1.32
-1.36
0
40
80
120
160
Elapsed time (h)

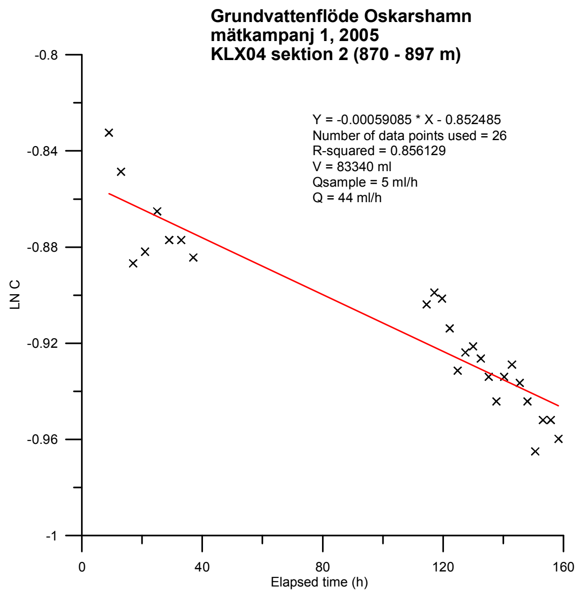

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX03 sektion 4 (729 - 751 m)
Y = -0.00067708 * X - 0.614104
Number of data points used = 38
R-squared = 0.77555
V = 66610 ml
Qsample =6 ml/h
Q = 39 ml/h
-0.52
-0.56
-0.6
-0.64
-0.68
-0.72
LN C
0
40
80
120
160
Elapsed time (h)

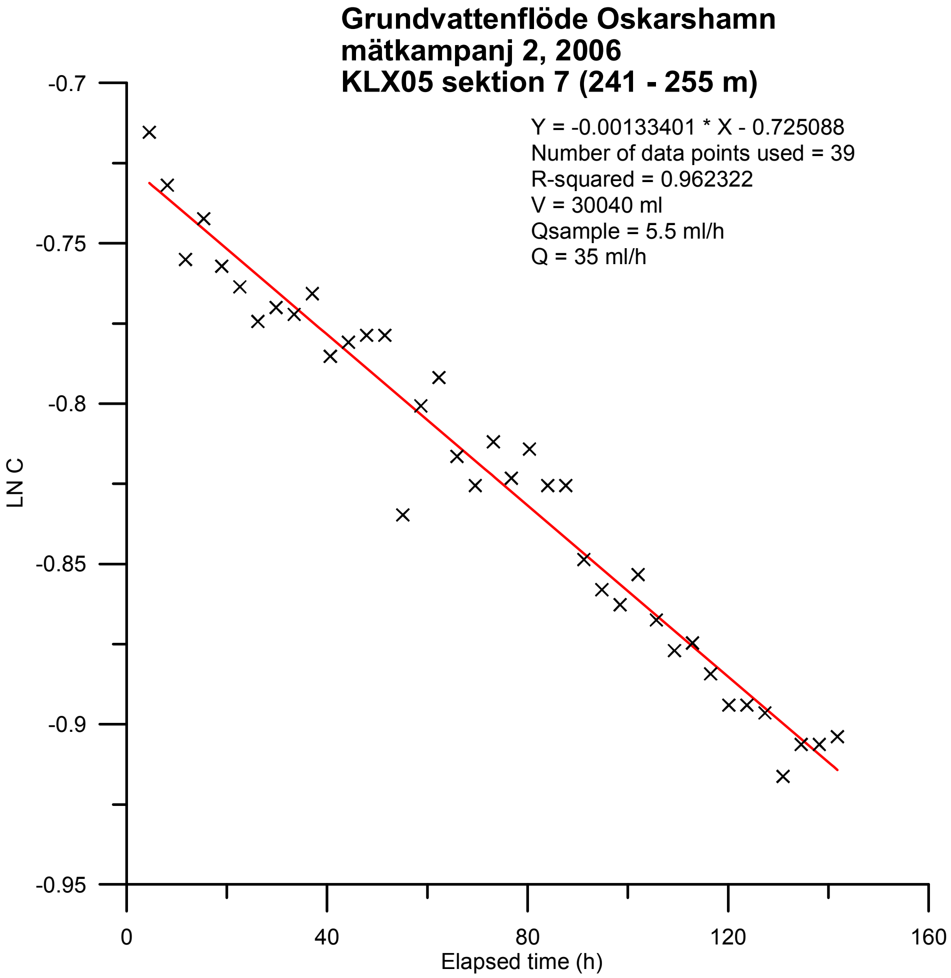

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX03 sektion 1 (965 - 971 m)
Y = -0.00094844 * X - 0.438802
Number of data points used = 13
R-squared = 0.588744
V = 65600 ml
Qsample = 6 ml/h
Q = 56 ml/h
LN C
-0.44
-0.48
-0.52
-0.56
-0.6
-0.64
0
40
80
120
160
200
Elapsed time (h)


Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX04 sektion 5 (507 - 530 m)
Y = -0.00073421 * X - 0.622542
Number of data points used = 36
R-squared = 0.847551
V = 54120 ml
Qsample = 7 ml/h
Q = 33 ml/h
LN C
-0.56
-0.6
-0.64
-0.68
-0.72
-0.76
0
40
80
120
160
Elapsed time (h)

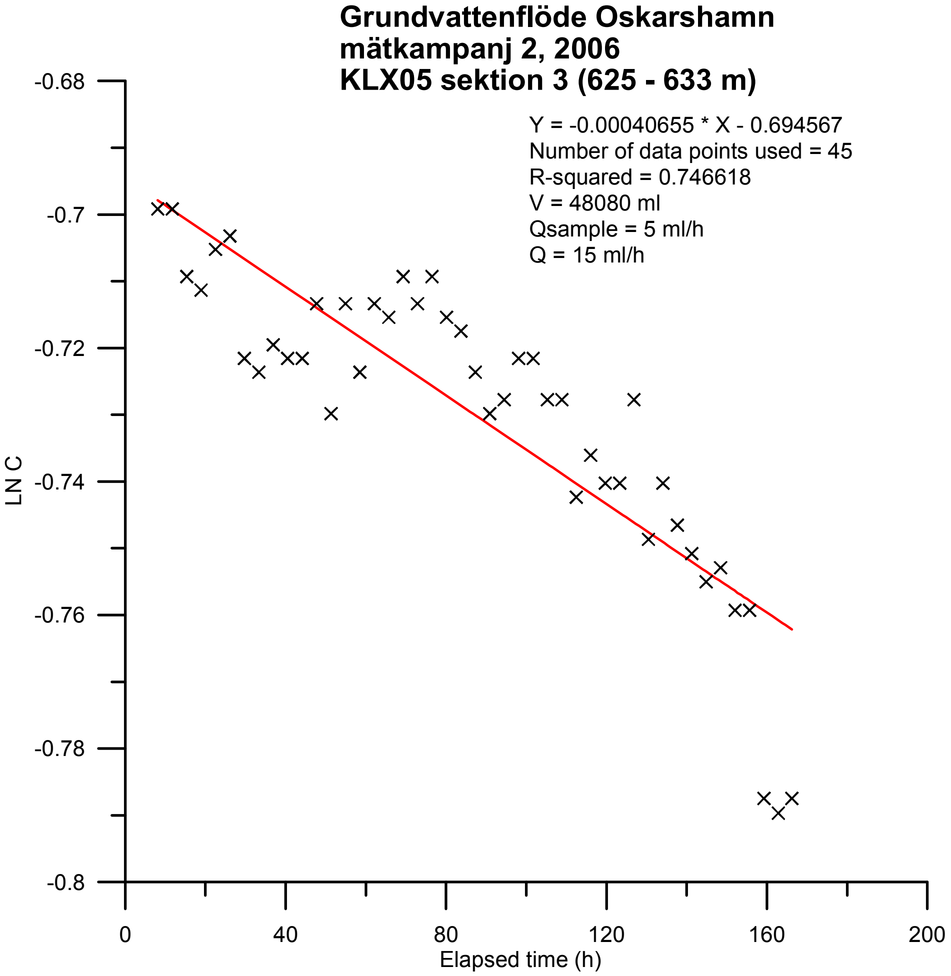

Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KLX04 sektion 5 (507 - 530 m)
Y = -0.00084658 * X - 0.897727
Number of data points used = 37
R-squared = 0.96505
V = 54120 ml
Qsample = 6 ml/h
Q = 40 ml/h
LN C
-0.88
-0.92
-0.96
-1
-1.04
0
40
80
120
160
Elapsed time (h)

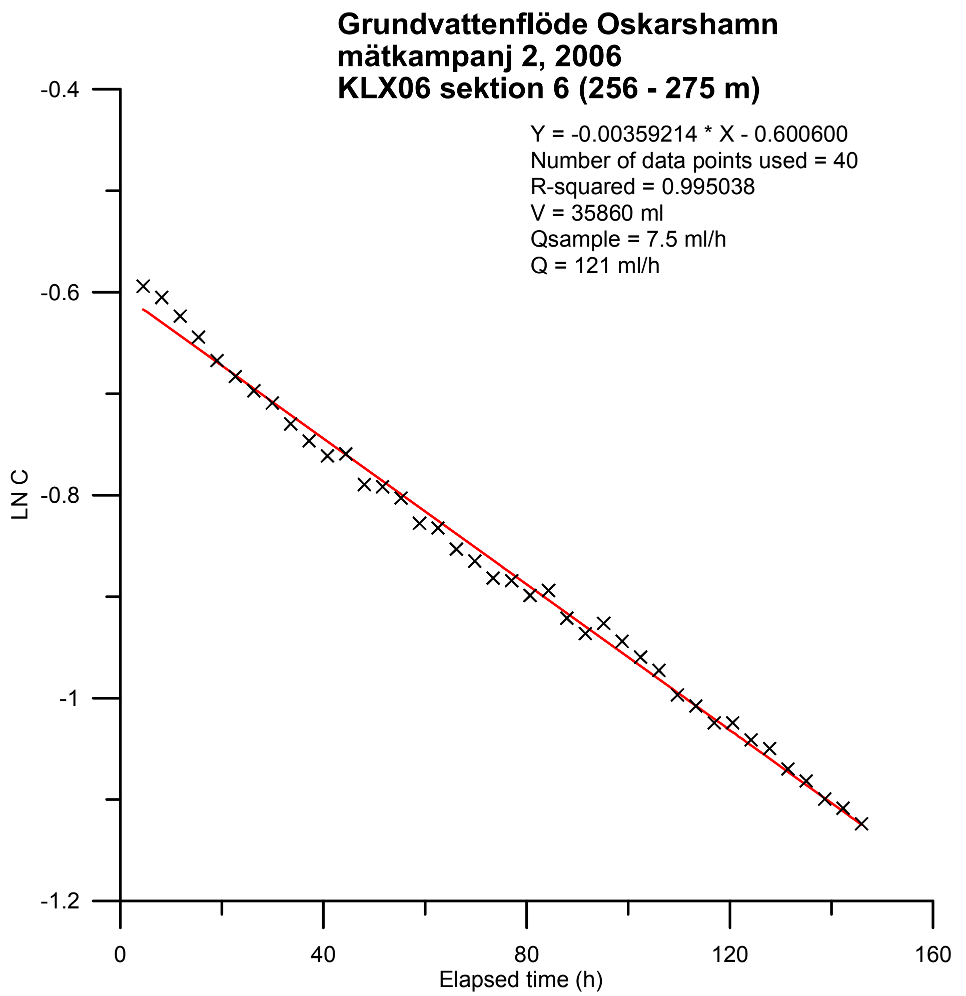

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX04 sektion 2 (870 - 897 m)
Y = -0.00055997 * X - 0.524902
Number of data points used = 24
R-squared = 0.860467
V = 83340 ml
Qsample = 5 ml/h
Q = 42 ml/h
LN C
Elapsed time (h)

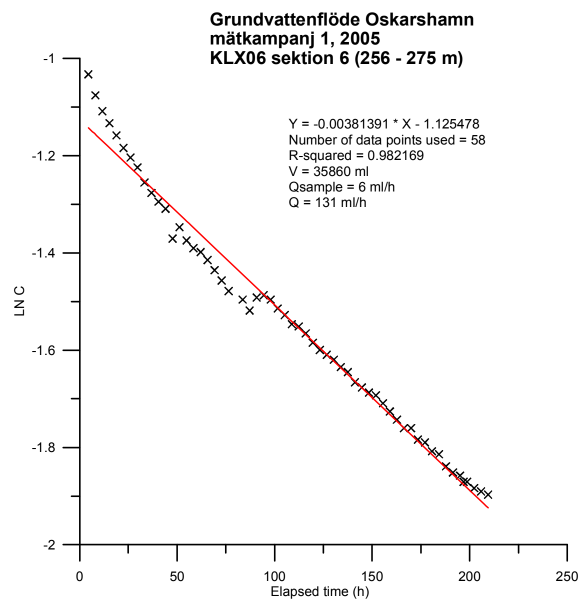

Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KLX04 sektion 2 (870 - 897 m)
Y = -0.00059085 * X - 0.852485
Number of data points used = 26
R-squared = 0.856129
V = 83340 ml
Qsample = 5 ml/h
Q = 44 ml/h
LN C
Elapsed time (h)

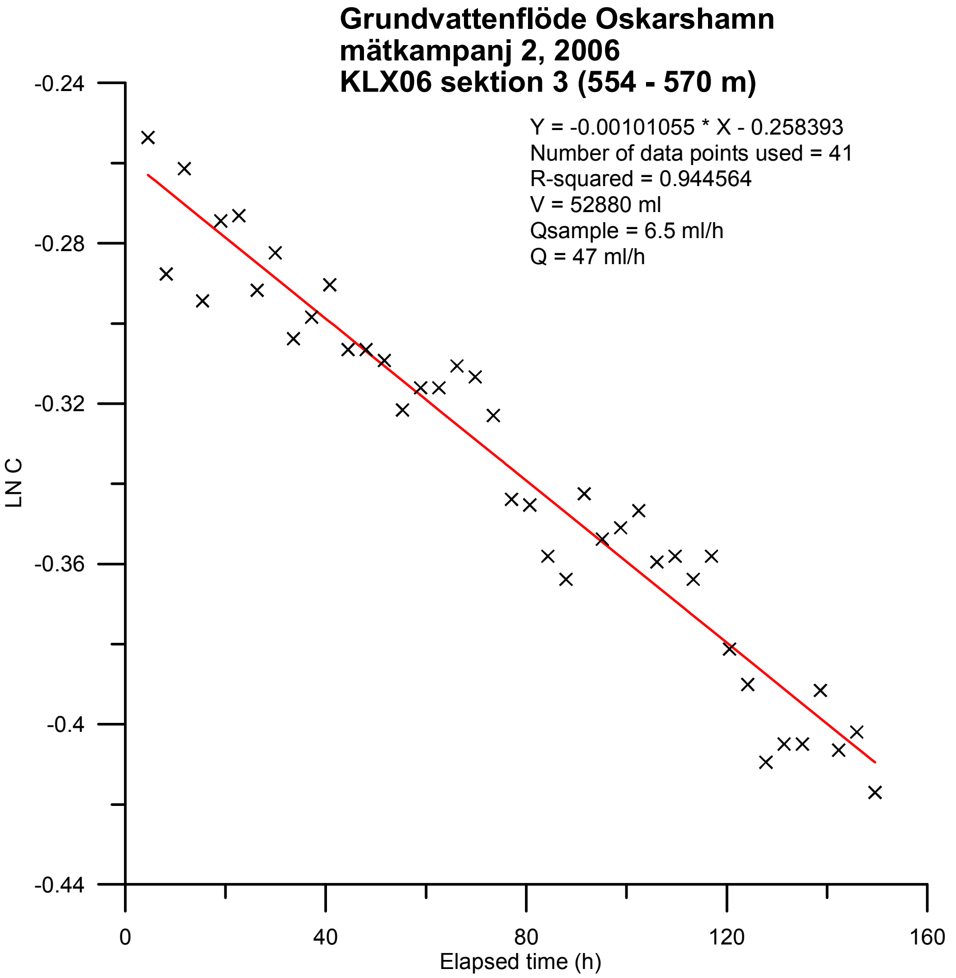


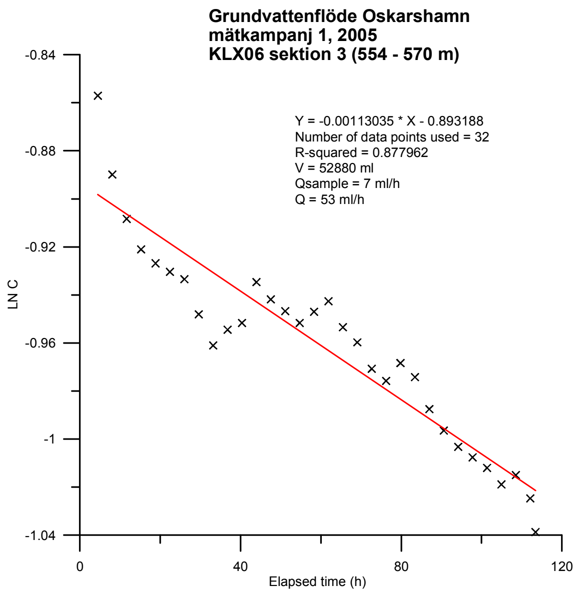
Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX05 sektion 7 (241 - 255 m)
Y = -0.00133401 * X - 0.725088
Number of data points used = 39
R-squared = 0.962322
V = 30040 ml
Qsample = 5.5 ml/h
Q = 35 ml/h
-0.7
-0.75
-0.8
-0.85
-0.9
-0.95
LN C
0
40
80
120
160
Elapsed time (h)

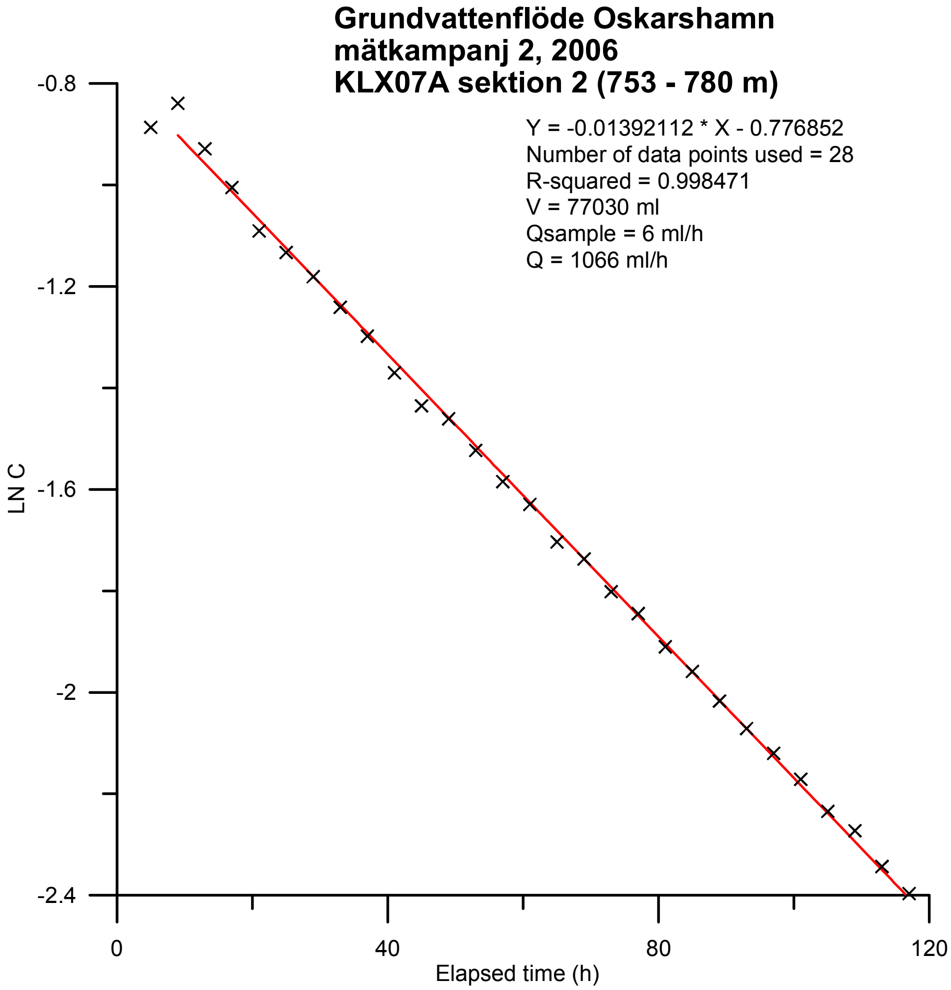

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX05 sektion 3 (625 - 633 m)
Y = -0.00040655 * X - 0.694567
Number of data points used = 45
R-squared = 0.746618
V = 48080 ml
Qsample = 5 ml/h
Q = 15 ml/h
-0.68
-0.7
-0.72
-0.74
-0.76
-0.78
-0.8
LN C
0
40
80
120
160
200
Elapsed time (h)


Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX06 sektion 6 (256 - 275 m)
Y = -0.00359214 * X - 0.600600
Number of data points used = 40
R-squared = 0.995038
V = 35860 ml
Qsample = 7.5 ml/h
Q = 121 ml/h
LN C
-0.4
-0.6
-0.8
-1
-1.2
0
40
80
120
160
Elapsed time (h)

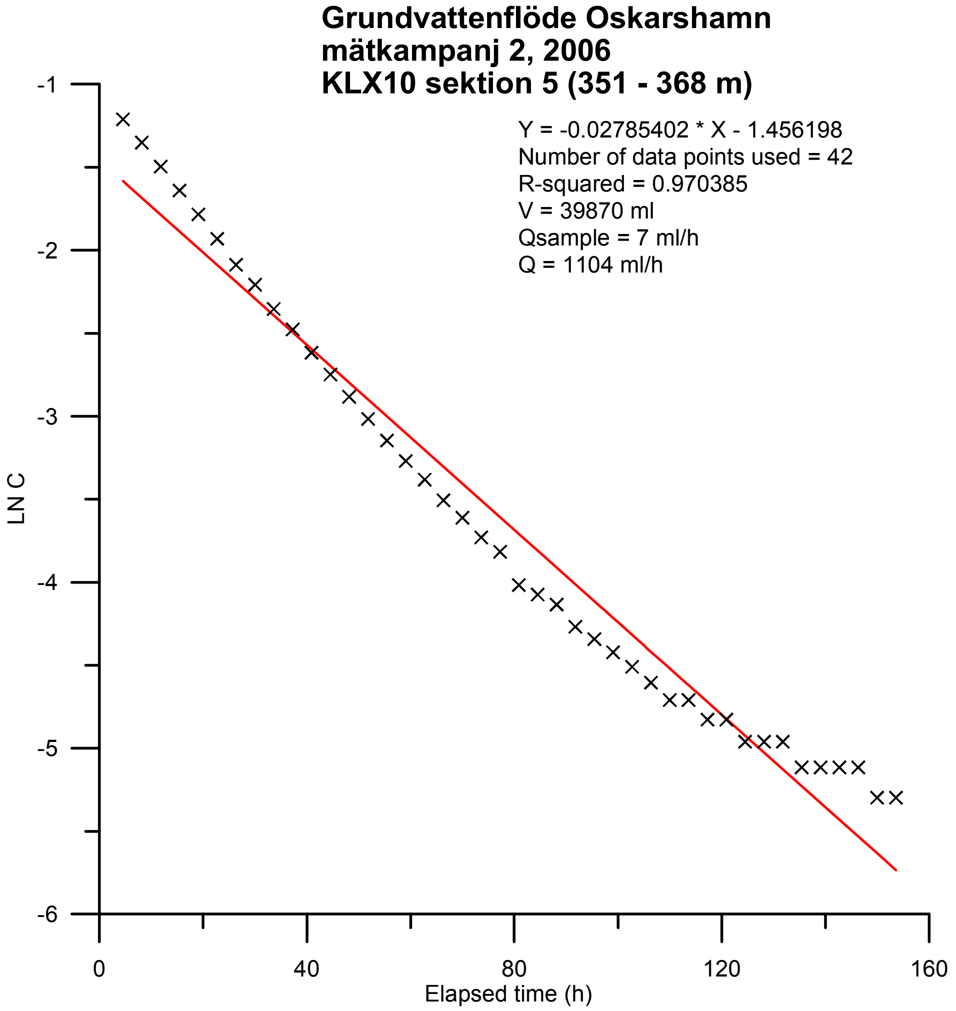

Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KLX06 sektion 6 (256 - 275 m)
Y = -0.00381391 * X - 1.125478
Number of data points used = 58
R-squared = 0.982169
V = 35860 ml
Qsample = 6 ml/h
Q = 131 ml/h
LN C
-1
-1.2
-1.4
-1.6
-1.8
-2
0
50
100
150
200
250
Elapsed time (h)

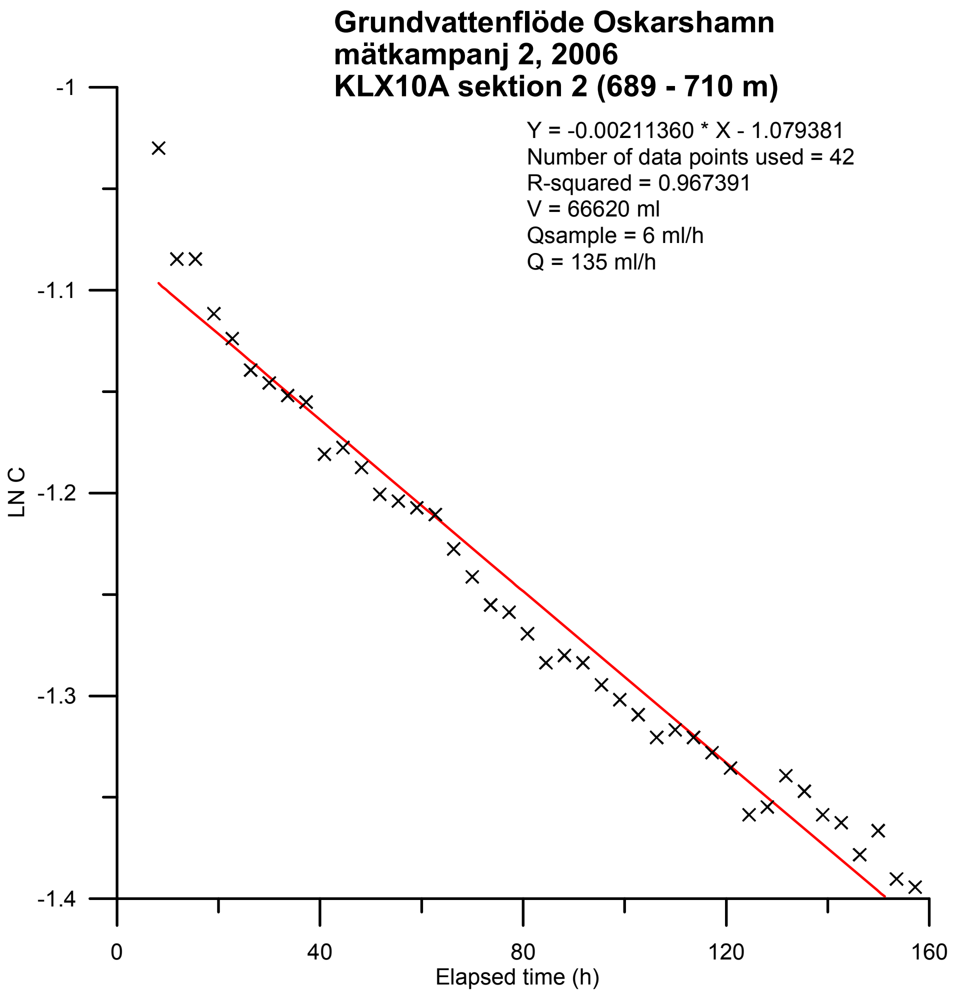

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX06 sektion 3 (554 - 570 m)
Y = -0.00101055 * X - 0.258393
Number of data points used = 41
R-squared = 0.944564
V = 52880 ml
Qsample = 6.5 ml/h
Q = 47 ml/h
LN C
Elapsed time (h)

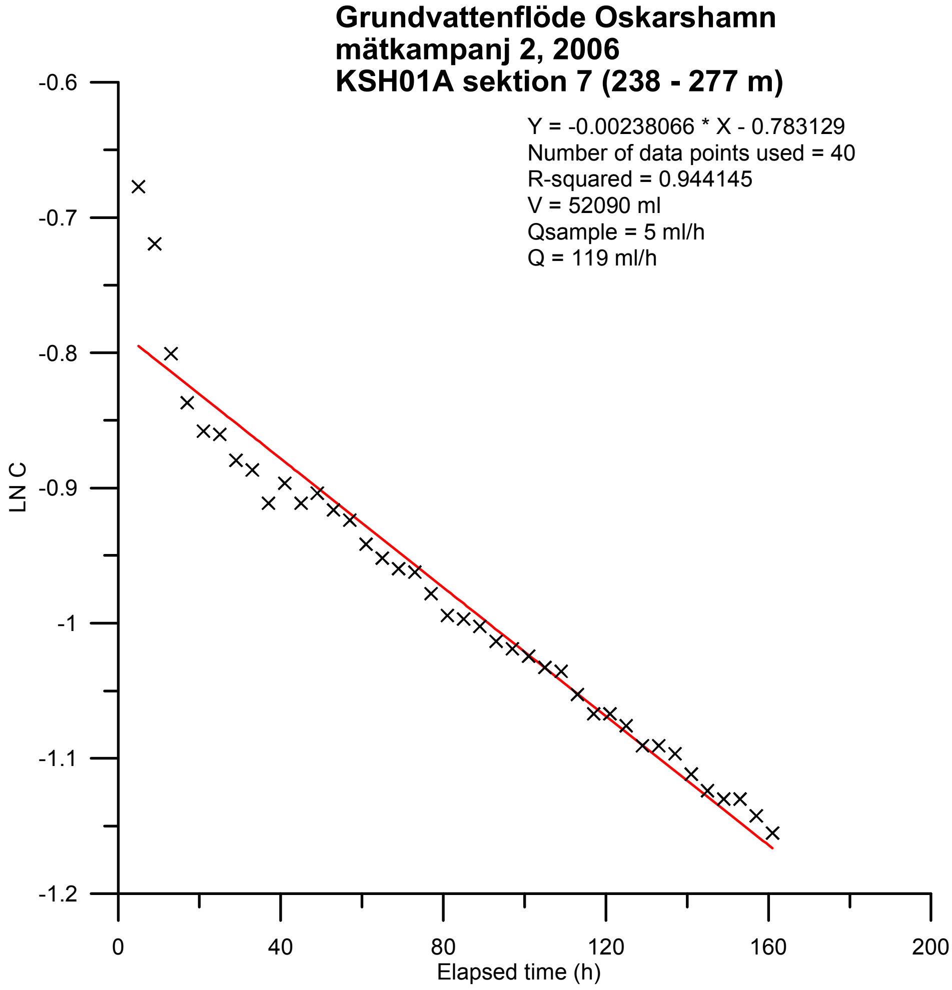

Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KLX06 sektion 3 (554 - 570 m)
Y = -0.00113035 * X - 0.893188
Number of data points used = 32
R-squared = 0.877962
V = 52880 ml
Qsample = 7 ml/h
Q = 53 ml/h
LN C
Elapsed time (h)

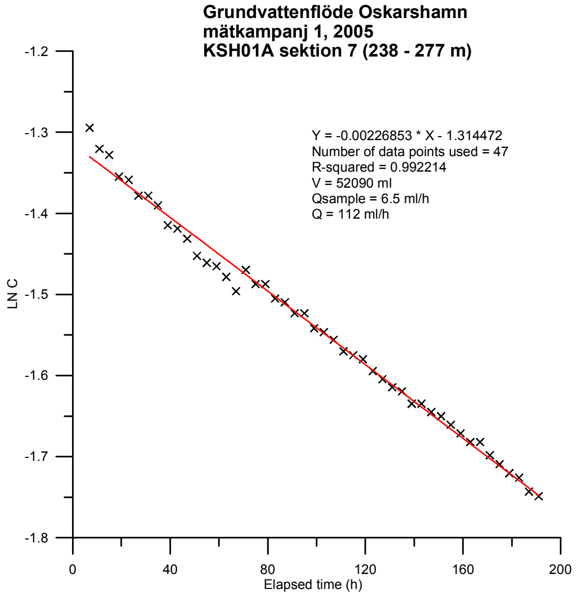


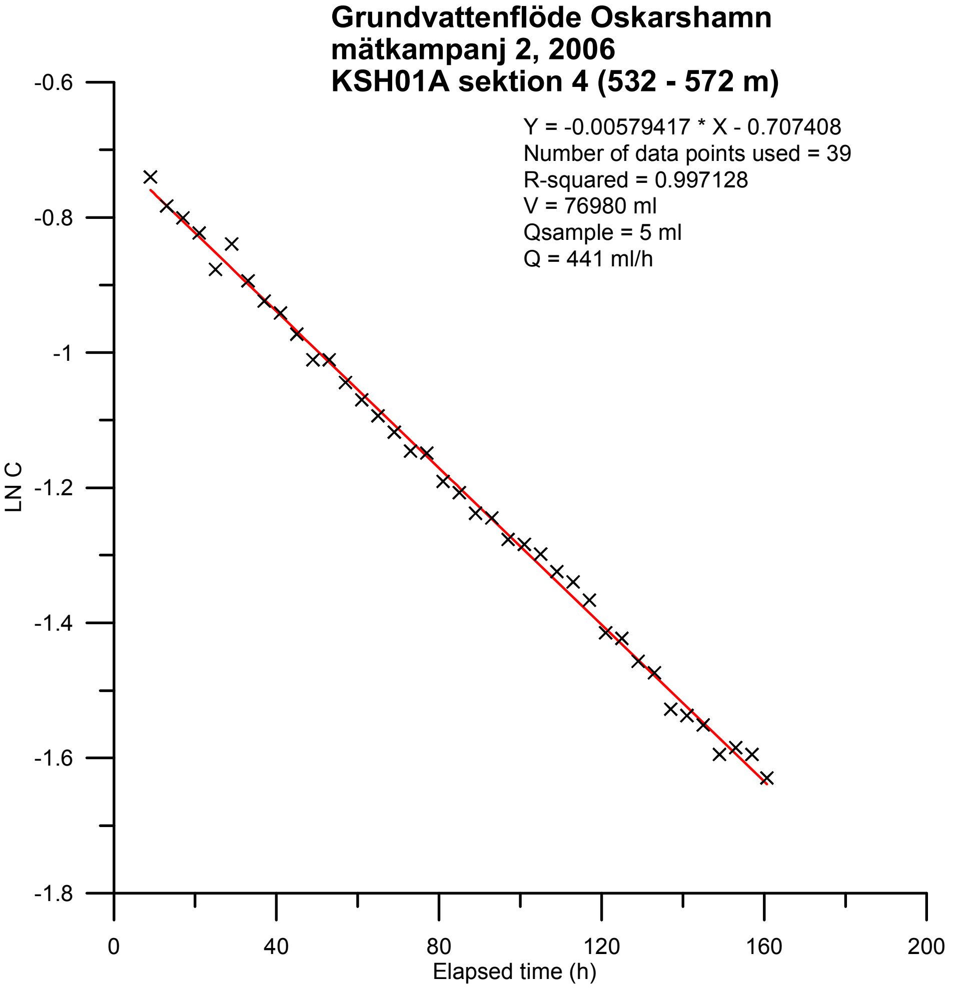
Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX07A sektion 2 (753 - 780 m)
Y = -0.01392112 * X - 0.776852
Number of data points used = 28
R-squared = 0.998471
V = 77030 ml
Qsample = 6 ml/h
Q = 1066 ml/h
-0.8
-1.2
-1.6
-2
-2.4
LN C
0
40
80
120
Elapsed time (h)

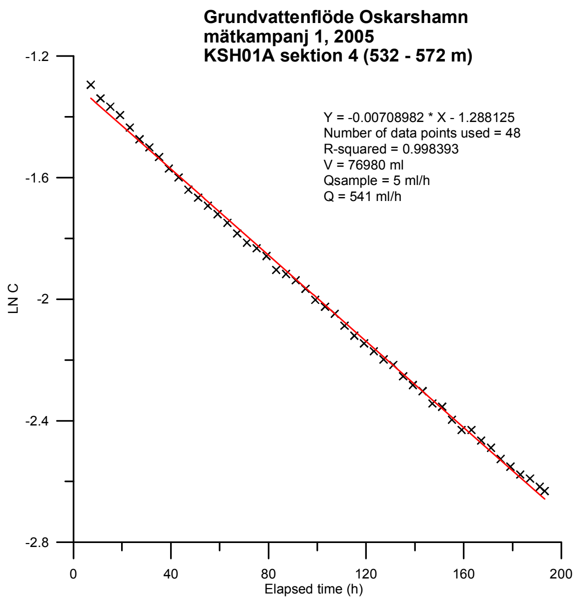

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX10 sektion 5 (351 - 368 m)
Y = -0.02785402 * X - 1.456198
Number of data points used = 42
R-squared = 0.970385
V = 39870 ml
Qsample = 7 ml/h
Q = 1104 ml/h
-1
-2
-3
-4
-5
-6
LN C
0
40
80
120
160
Elapsed time (h)

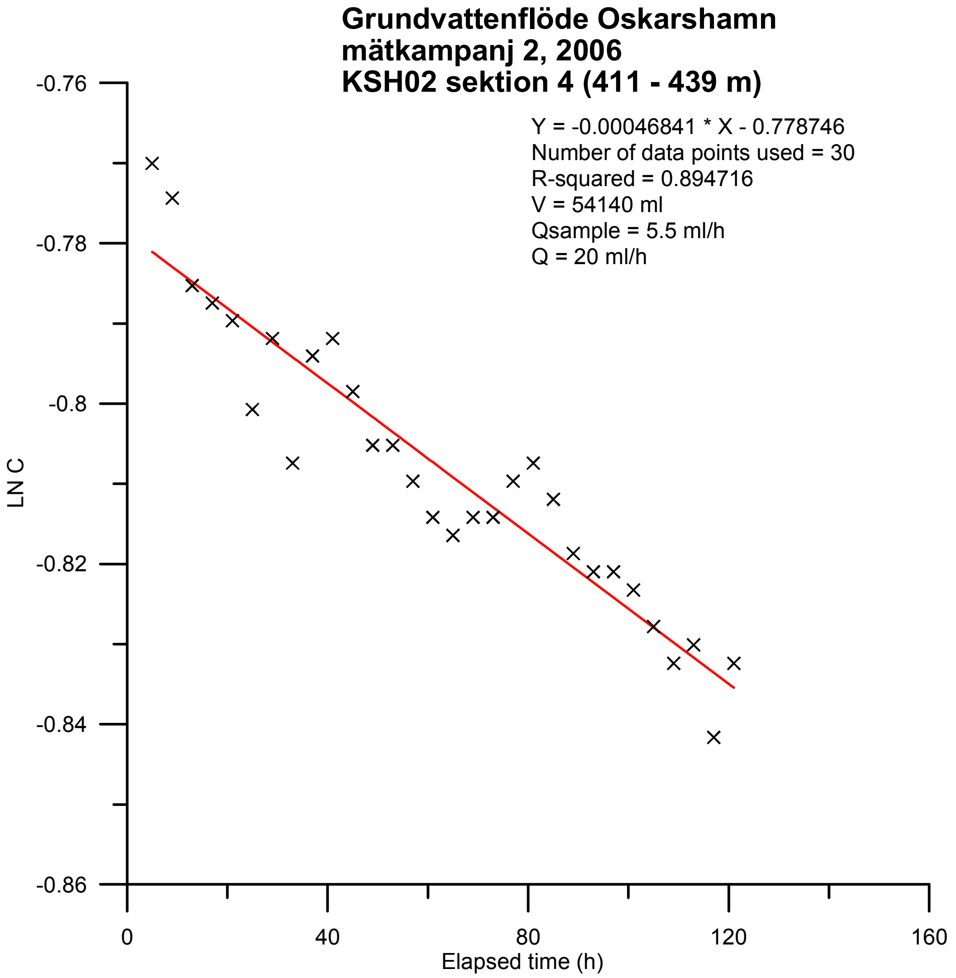

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KLX10A sektion 2 (689 - 710 m)
Y = -0.00211360 * X - 1.079381
Number of data points used = 42
R-squared = 0.967391
V = 66620 ml
Qsample = 6 ml/h
Q = 135 ml/h
-1
-1.1
-1.2
-1.3
-1.4
LN C
0
40
80
120
160
Elapsed time (h)

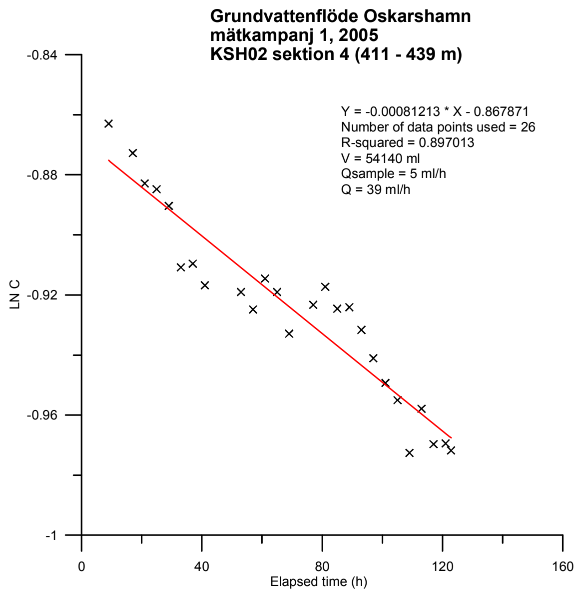

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KSH01A sektion 7 (238 - 277 m)
Y = -0.00238066 * X - 0.783129
Number of data points used = 40
R-squared = 0.944145
V = 52090 ml
Qsample = 5 ml/h
Q = 119 ml/h
LN C
-0.6
-0.7
-0.8
-0.9
-1
-1.1
-1.2
0
40
80
120
160
200
Elapsed time (h)

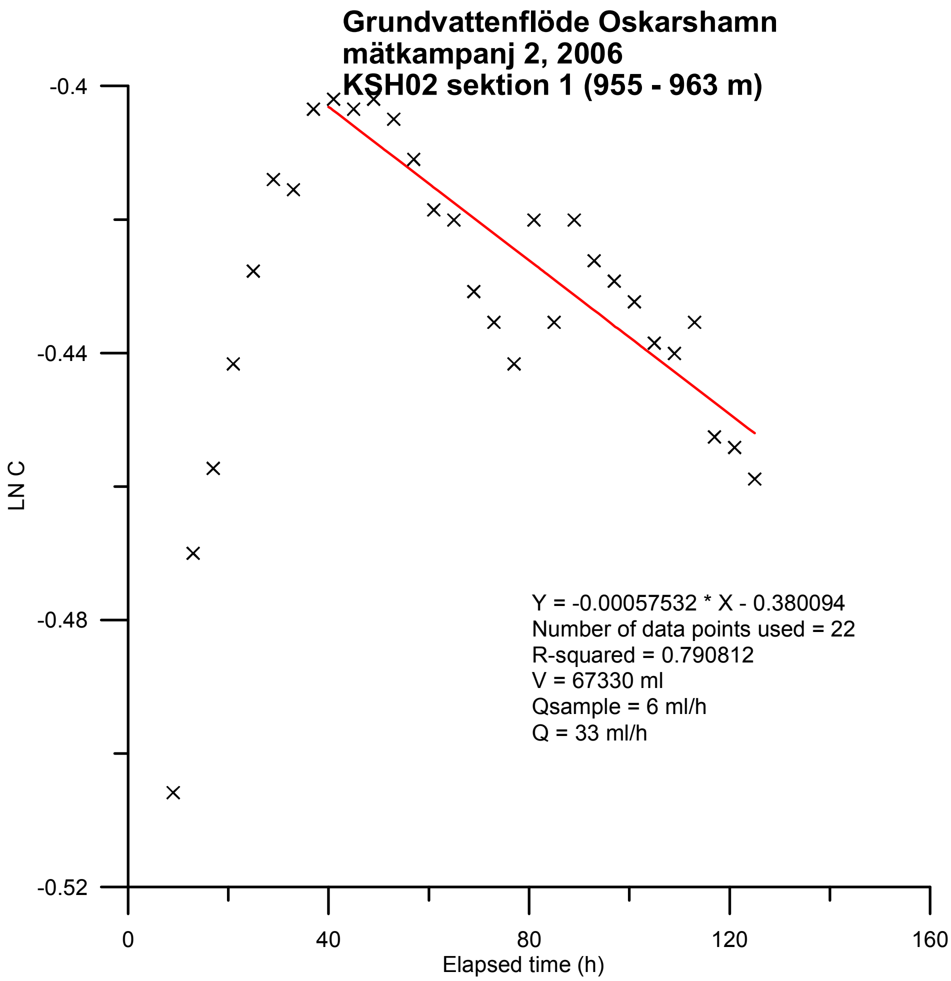

Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KSH01A sektion 7 (238 - 277 m)
Y = -0.00226853 * X - 1.314472
Number of data points used = 47
R-squared = 0.992214
V = 52090 ml
Qsample = 6.5 ml/h
Q = 112 ml/h
LN C
-1.2
-1.3
-1.4
-1.5
-1.6
-1.7
-1.8
0
40
80
120
160
200
Elapsed time (h)

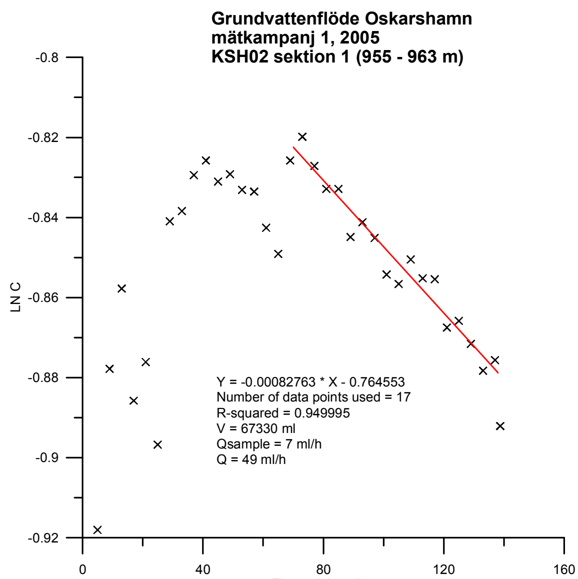

Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KSH01A sektion 4 (532 - 572 m)
Y = -0.00579417 * X - 0.707408
Number of data points used = 39
R-squared = 0.997128
V = 76980 ml
Qsample = 5 ml
Q = 441 ml/h
LN C
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
0
40
80
120
160
200
Elapsed time (h)


Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KSH01A sektion 4 (532 - 572 m)
Y = -0.00708982 * X - 1.288125
Number of data points used = 48
R-squared = 0.998393
V = 76980 ml
Qsample = 5 ml/h
Q = 541 ml/h
LN C
-1.2
-1.6
-2
-2.4
-2.8
0
40
80
120
160
200
Elapsed time (h)


Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KSH02 sektion 4 (411 - 439 m)
Y = -0.00046841 * X - 0.778746
Number of data points used = 30
R-squared = 0.894716
V = 54140 ml
Qsample = 5.5 ml/h
Q = 20 ml/h
-0.76
-0.78
-0.8
-0.82
-0.84
-0.86
LN C
0
40
80
120
160
Elapsed time (h)

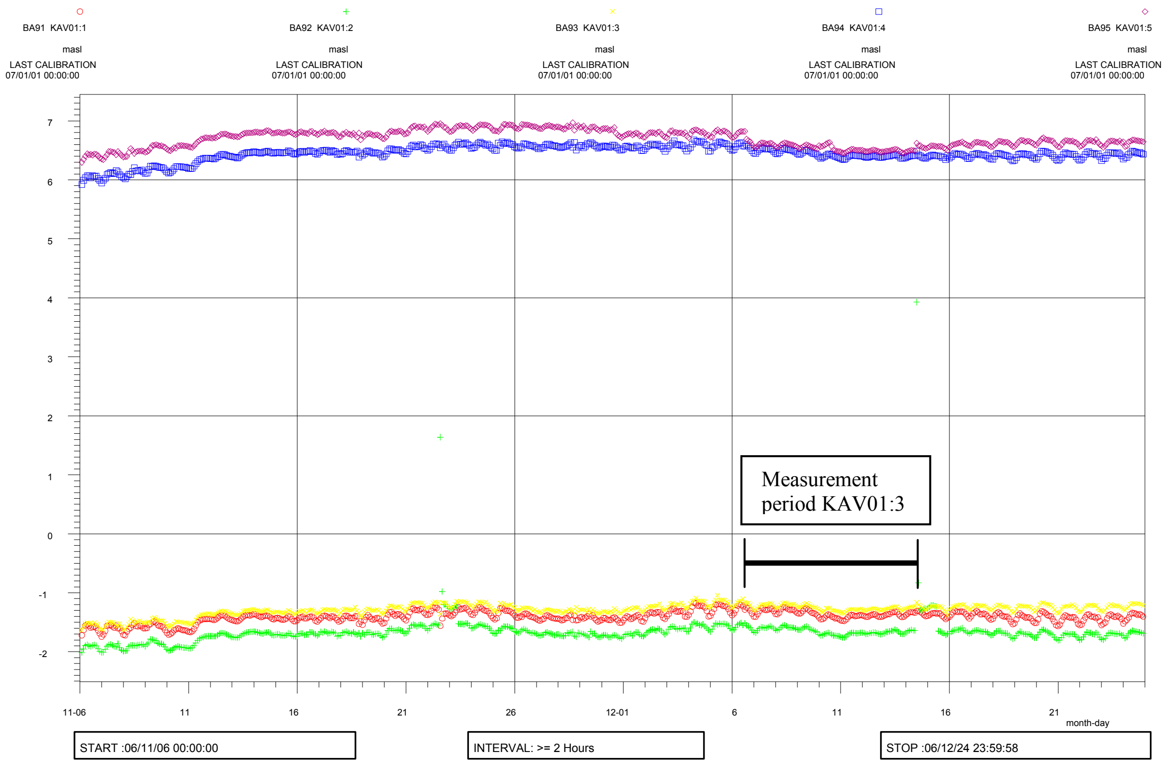

Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KSH02 sektion 4 (411 - 439 m)
Y = -0.00081213 * X - 0.867871
Number of data points used = 26
R-squared = 0.897013
V = 54140 ml
Qsample = 5 ml/h
Q = 39 ml/h
-0.84
-0.88
-0.92
-0.96
-1
LN C
0
40
80
120
160
Elapsed time (h)


Grundvattenflöde Oskarshamn
mätkampanj 2, 2006
KSH02 sektion 1 (955 - 963 m)
-0.4
-0.44
-0.48
-0.52
LN C
0
40
80
120
160
Elapsed time (h)
Y = -0.00057532 * X - 0.380094
Number of data points used = 22
R-squared = 0.790812
V = 67330 ml
Qsample = 6 ml/h
Q = 33 ml/h


Grundvattenflöde Oskarshamn
mätkampanj 1, 2005
KSH02 sektion 1 (955 - 963 m)
-0.8
-0.82
-0.84
-0.86
-0.88
-0.9
-0.92
LN C
0
40
80
120
160
Elapsed time (h)
Y = -0.00082763 * X - 0.764553
Number of data points used = 17
R-squared = 0.949995
V = 67330 ml
Qsample = 7 ml/h
Q = 49 ml/h

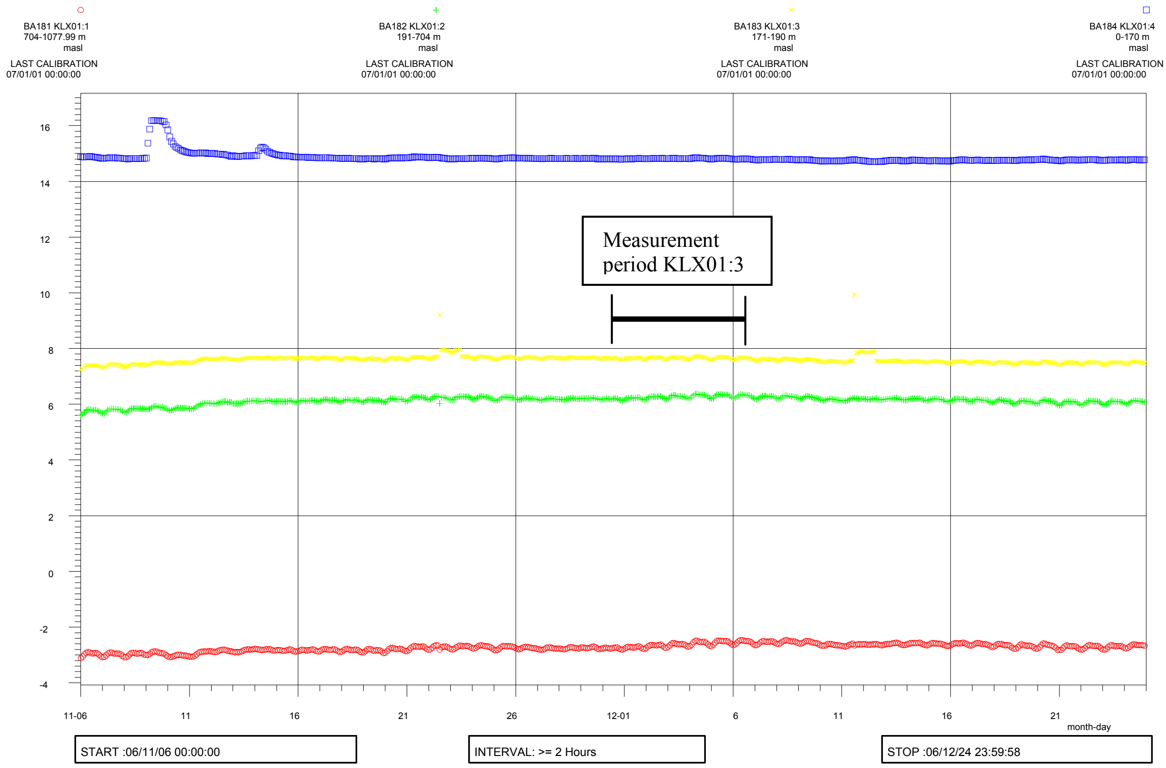
Groundwater level (m.a.s.l.)

KAV01



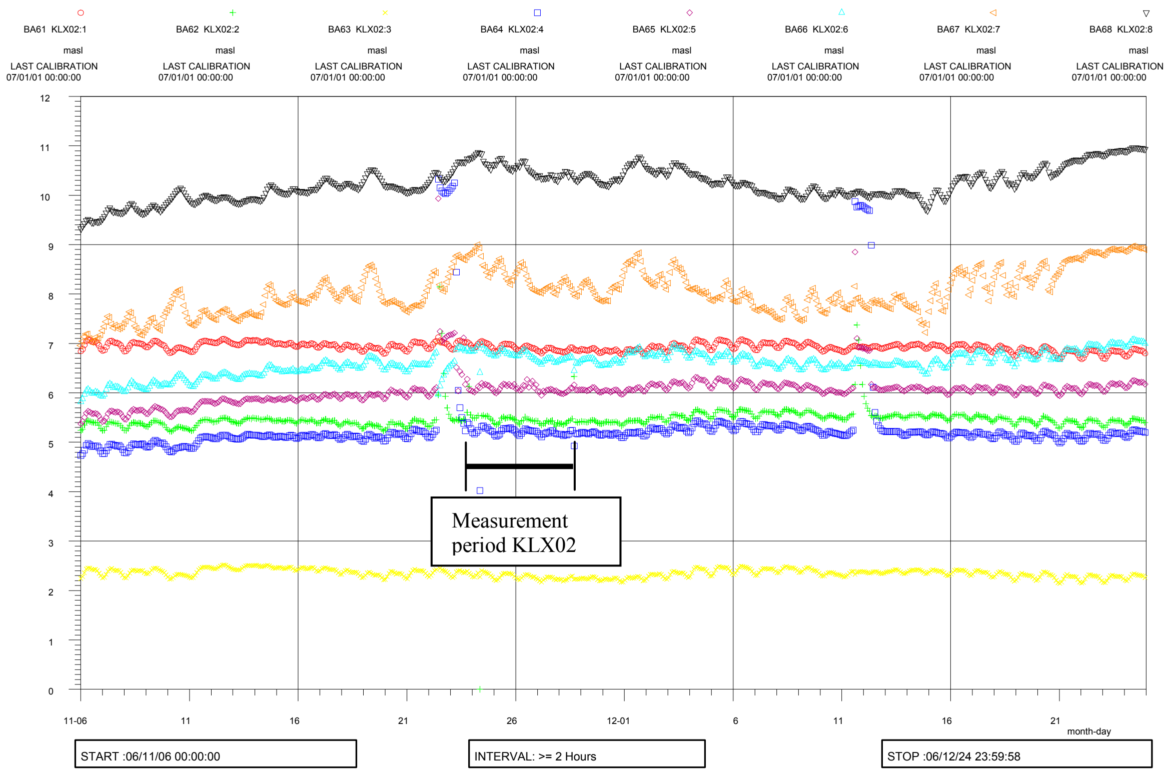
Measured section: KAV01:3 (yellow)

KLX01



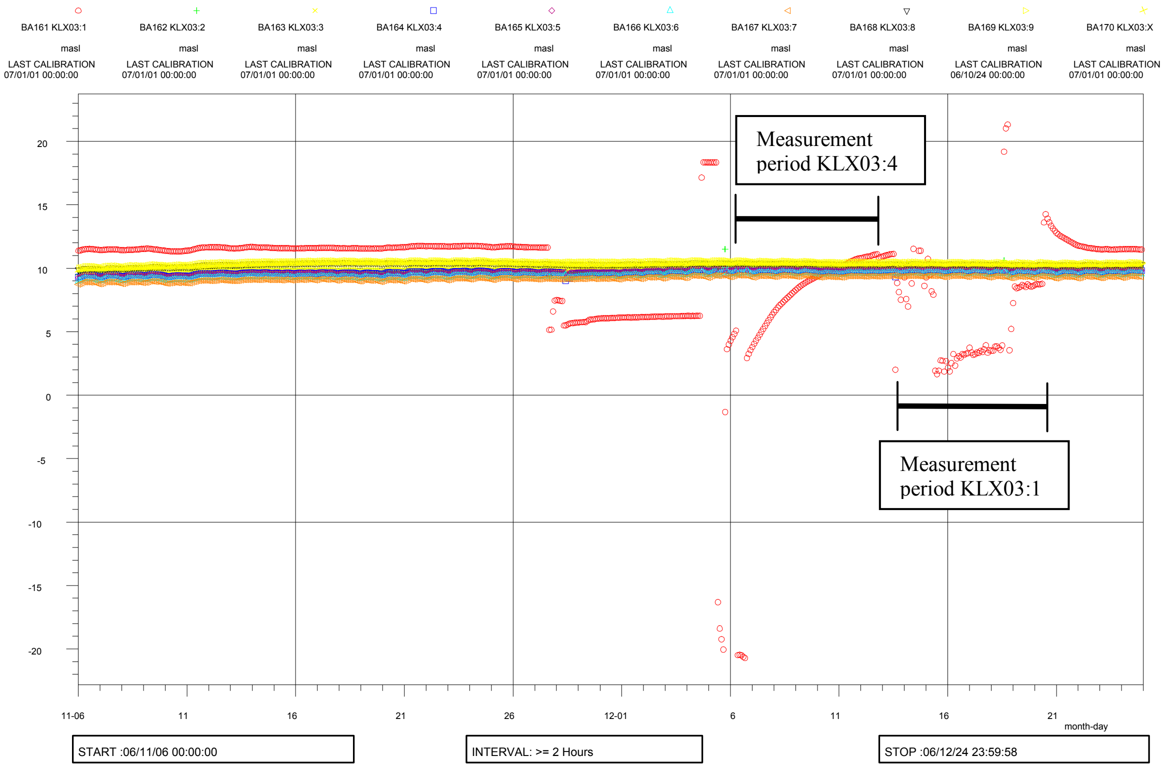
Measured section: KLX01:3 (yellow)

KLX02



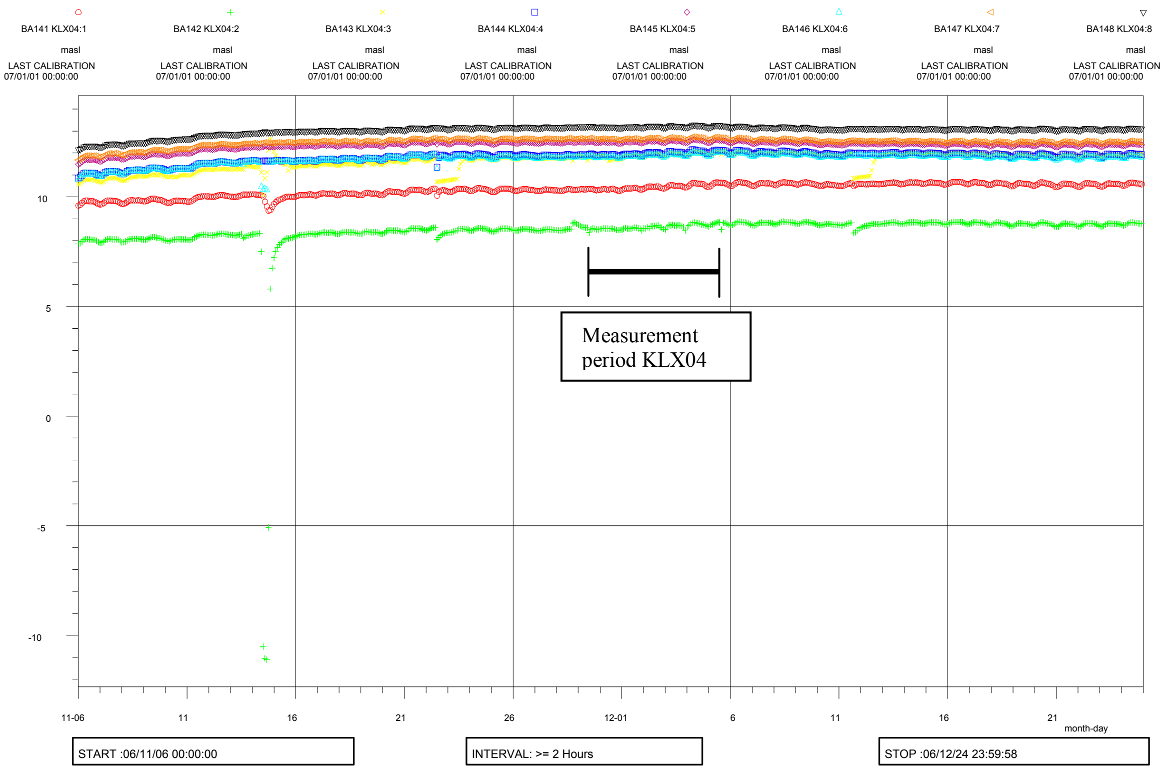
Measured sections: KLX02:5 (mauve) and KLX02:2 (green)

KLX03



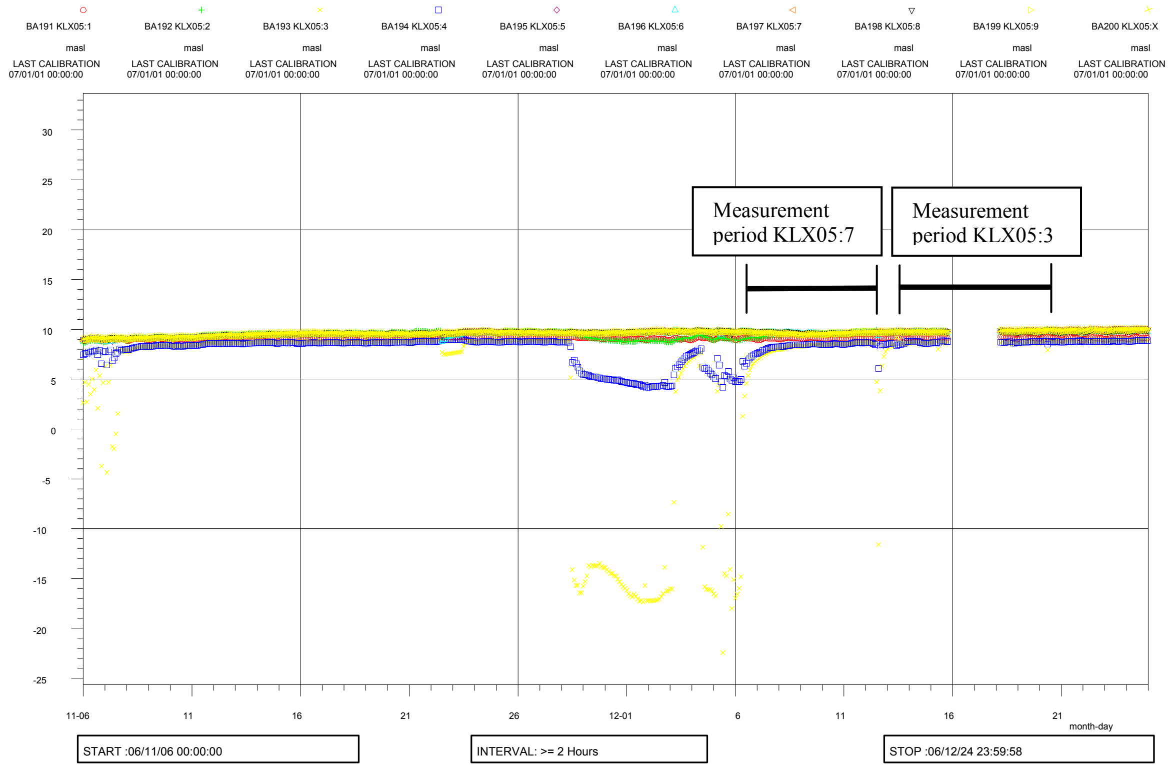
Measured sections: KLX03:4 (blue) and KLX03:1 (red)

KLX04



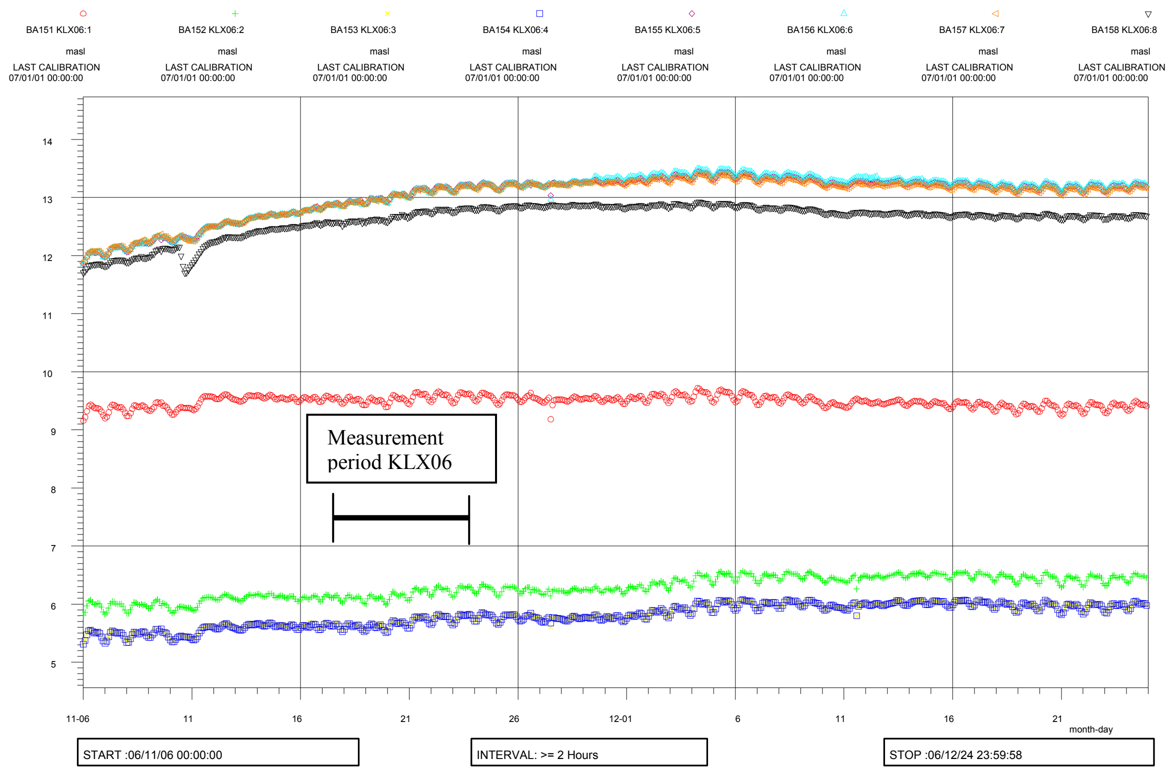
Measured sections: KLX04:5 (mauve) and KLX04:2 (green).

KLX05



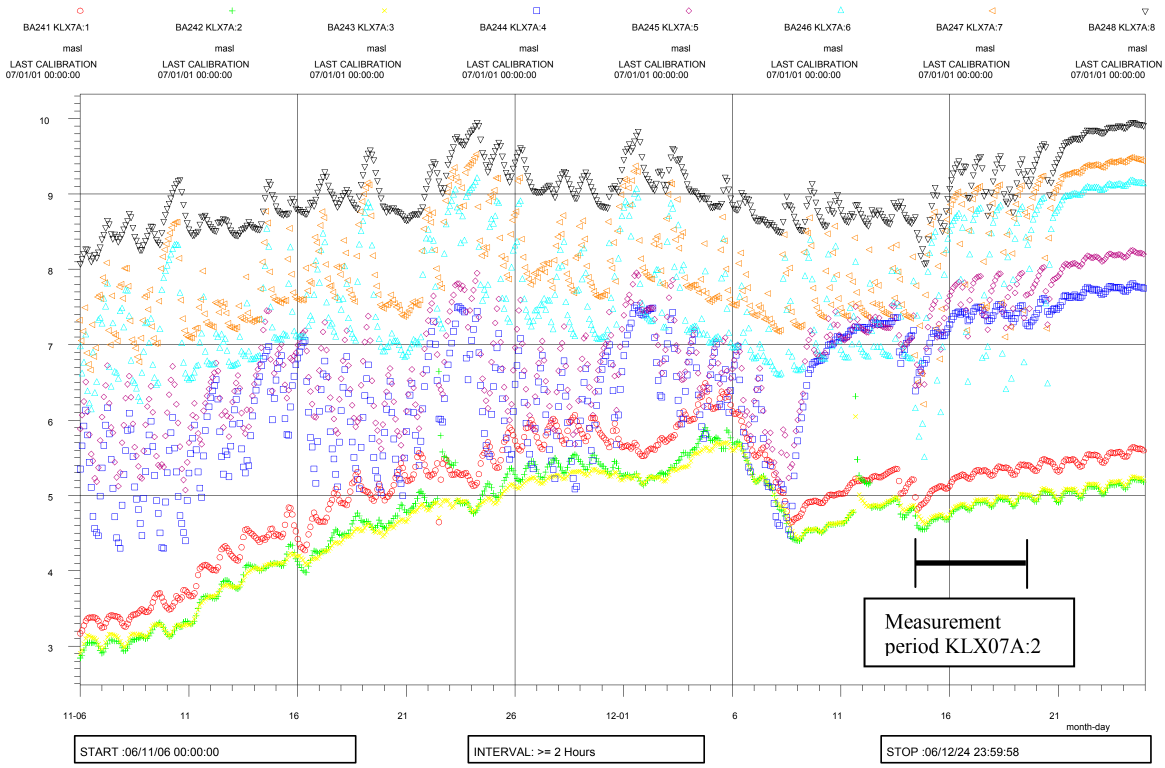
Measured sections: KLX05:7 (orange) and KLX05:3 (yellow).

KLX06



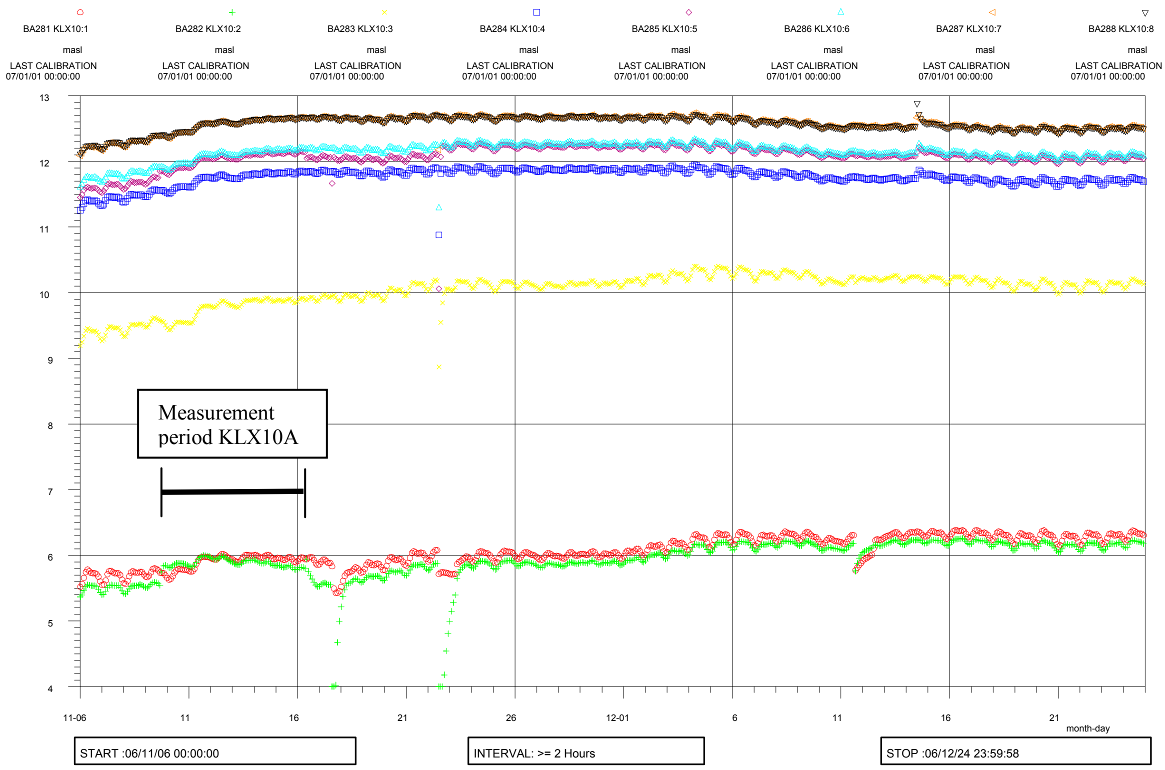
Measured sections: KLX06:6 (light blue) and KLX06:3 (yellow).

KLX07A



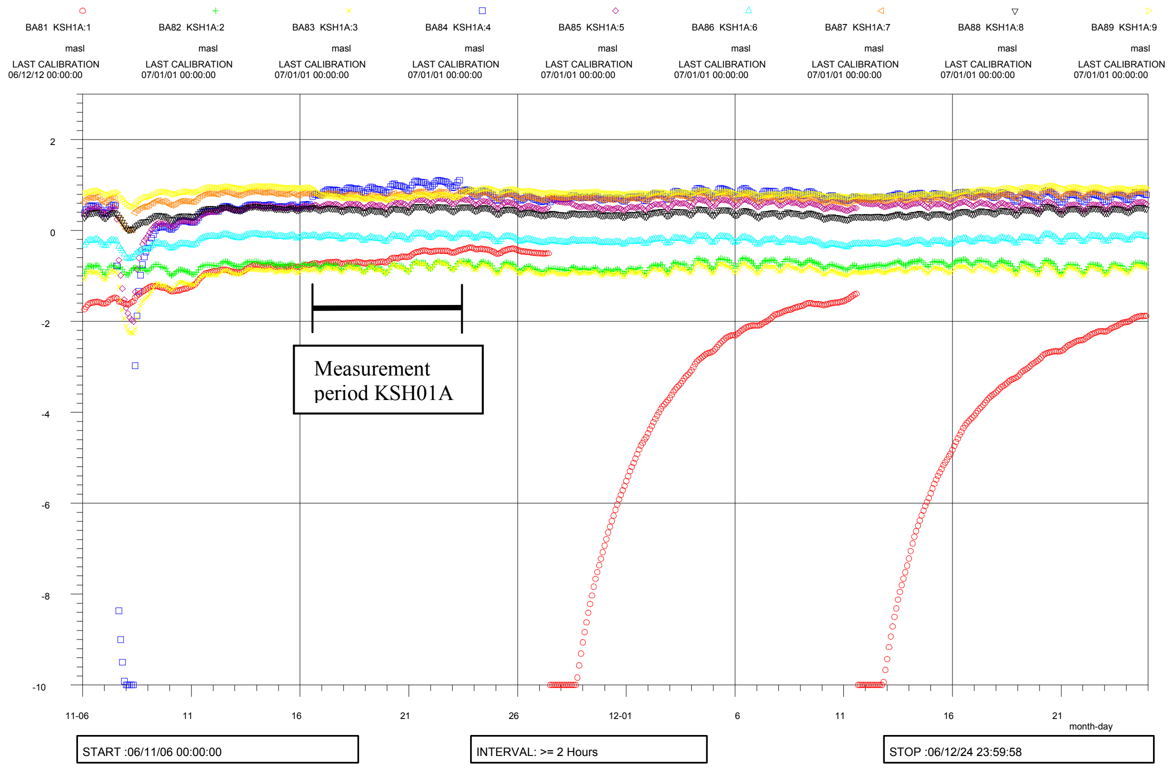
Measured sections: KLX07A:2 (green).

KLX10A



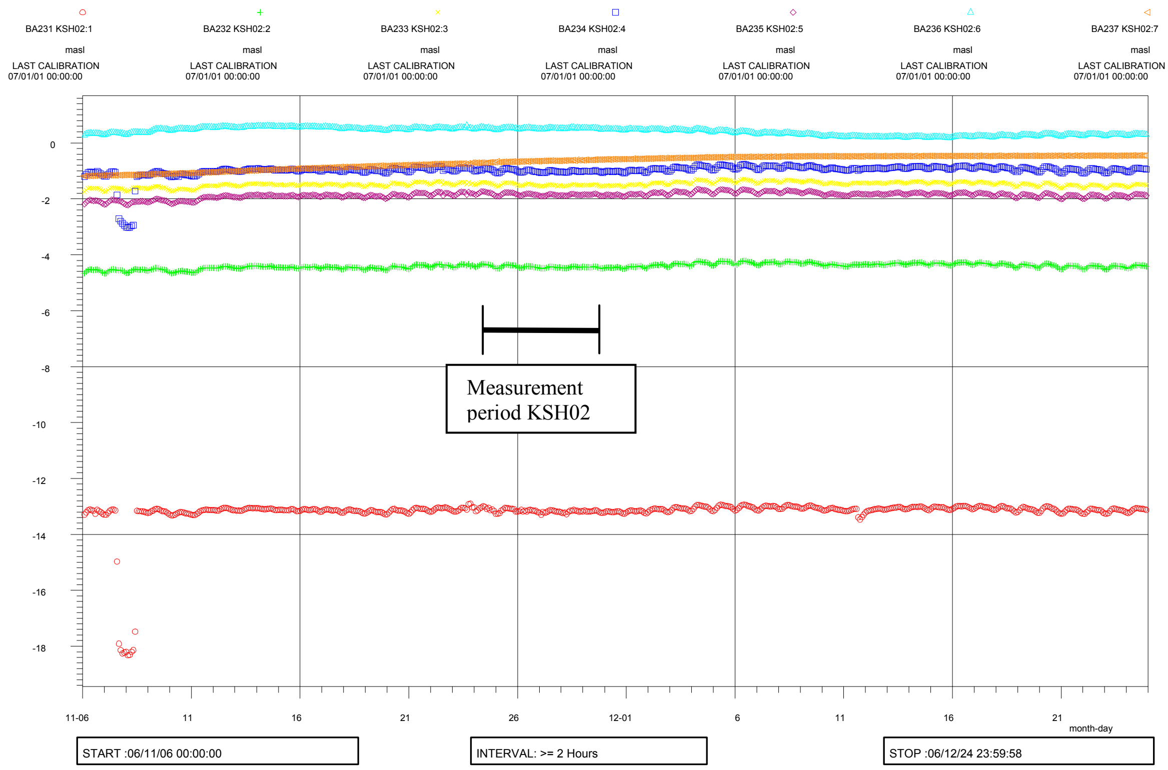
Measured sections: KLX10A:5 (mauve) and KLX10A:2 (green).

KSH01A



Measured sections: KSH01A:7 (orange) and KSH01A:4 (blue).

KSH02



Measured sections: KSH02:4 (blue) and KSH02:1 (red).