Working Report 2007-37

Hydraulic Conductivity Measurements with HTU at Eurajoki, Olkiluoto, Drillholes OL-KR28 and OL-KR39 in 2006

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May 2007

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ABSTRACT

As a part of the site investigations for the disposal of spent nuclear fuel, hydraulic conductivity measurements were carried out in drillholes OL-KR28 and OL-KR39 at Eurajoki, Olkiluoto. The objective was to investigate the distribution of the hydraulic conductivity in the surrounding bedrock volume. Measurements were carried out during summer 2006.

The total length of the borehole OL-KR28 is 656,33 m, 352 m of which was covered by 176 standard tests with 2 m packer separation as specified in the measurement plan. Respectively, OL-KR39 is 502,97 m deep and 101 similar tests were made in it covering 202 m of the hole. The measured sections are around the depths of the planned repository. Double-packer constant-head method was used throughout with nominal 200 kPa overpressure. Injection stage lasted normally 20 minutes and fall-off stage 10 minutes. The tests were often shortened if there were clear indications that the hydraulic conductivity is below the measuring range of the system. The pressure in the test section was let to stabilise at least 5 min before injection. In some test sections the test stage times were extended. Two transient (Horner and 1/Q) interpretations and one stationary-state (Moye) interpretation were made in-situ immediately after the test.

The Hydraulic Testing Unit (HTU-system) is owned by Posiva Oy and it was operated by Geopros Oy.

Keywords: HTU, hydraulic conductivity, constant head test, hydraulic injection test

VEDENJOHTAVUUDEN MITTAUKSET HTU-LAITTEELLA EURAJOEN OLKILUODON KAIRANREI'ISSÄ OL-KR28 JA OL-KR39 VUONNA 2006

TIIVISTELMÄ

Varmentaviin ydinjätteen loppusijoituspaikkatutkimuksiin liittyen Posiva Oy:n tutkimusalueella Eurajoen Olkiluodossa mitattiin kallioperän vedenjohtavuutta kairanrei'issä OL-KR28 ja OL-KR39 kesällä 2006. OL-KR28:n syvyys on 656,33 m, josta mitattiin tutkimussuunnitelman mukaan 2 m testivälillä 352 m, yhteensä 176 täydellistä mittausta. Vastaavasti OL-KR39:ssä tehtiin 101 mittausta kattaen 202 m reiän 502,97 m:n syvyydestä. Mitatut osuudet ovat suunnitellun loppusijoitustilan syvyydellä. Mittaukset tehtiin kaksoistulppa- ja vakiopainemenetelmällä käyttäen 200 kPa ylipainetta. Injektio kesti tavallisesti 20 min ja paineenlaskuvaihe 10 min, mutta ajat vaihtelivat tilanteen mukaan ollen paikoin huomattavasti pidempiäkin. Mikäli testin aikana kävi ilmeiseksi, että vedenjohtavuus alittaa mittausalueen alarajan, sitä lyhennettiin huomattavasti. Paineen annettiin tasoittua luonnolliseen tasoonsa ennen injektiota vähintään 5 min. Vedenjohtavuudet tulkittiin välittömästi käyttäen kahta transientti- (Horner ja 1/Q) ja yhtä stationääritilan (Moye) tulkintaa.

Mittauksissa käytettiin Posivan omistamaa HTU-järjestelmää (Hydraulic Testing Unit). Mittaukset suoritti Geopros Oy:n henkilökunta.

Avainsanat: HTU, vedenjohtavuus, vakiopainekoe, vesimenekkikoe

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1 INTRODUCTION

Posiva Oy has made investigations of the suitability of bedrock for final disposal of spent nuclear fuel at five locations. The first phase was Preliminary Site Investigations, which were performed 1987-1992. After the first phase, Romuvaara at Kuhmo, Kivetty at Äänekoski and Olkiluoto at Eurajoki were selected for further study. The fieldwork of the following phase, Detailed Site Investigations, started in spring 1993. Hästholmen at Loviisa was included in the selection in the beginning of the year 1997. Olkiluoto at Eurajoki was chosen as the location for the repository in 2000, and more detailed and confirmative site investigations were continued there.

The HTU-system was developed to measure the hydraulic conductivity in situ from drillholes. In the early stages all drillholes were measured systematically with the HTU-system with 30 m packer separation. Later, when more detailed information was needed for modelling of the rock structure and hydrological conditions, emphasis has been on smaller scale studies with higher spatial resolution, and the mostly used packer separation has been 2 m. Advantages of the HTU-system are it's wide measuring range and good resolution compared with other methods for measuring the hydraulic conductivity. Improvement of the resolution and widening the measurement range towards lower hydraulic conductivities has been one of the focus areas in the continuous development of the system. Another focus has been improving the determination of the accuracy of the test section depth to get a better correlation between results from different types of measurements accomplished in the same drillhole.

The tests described in this report were aimed to produce detailed data on the hydraulic conductivity of the bedrock from drillholes OL-KR28 and OL-KR39 around the depth of the planned repository. The studies will improve the understanding of groundwater movement and produce data on smaller fractures in the area.

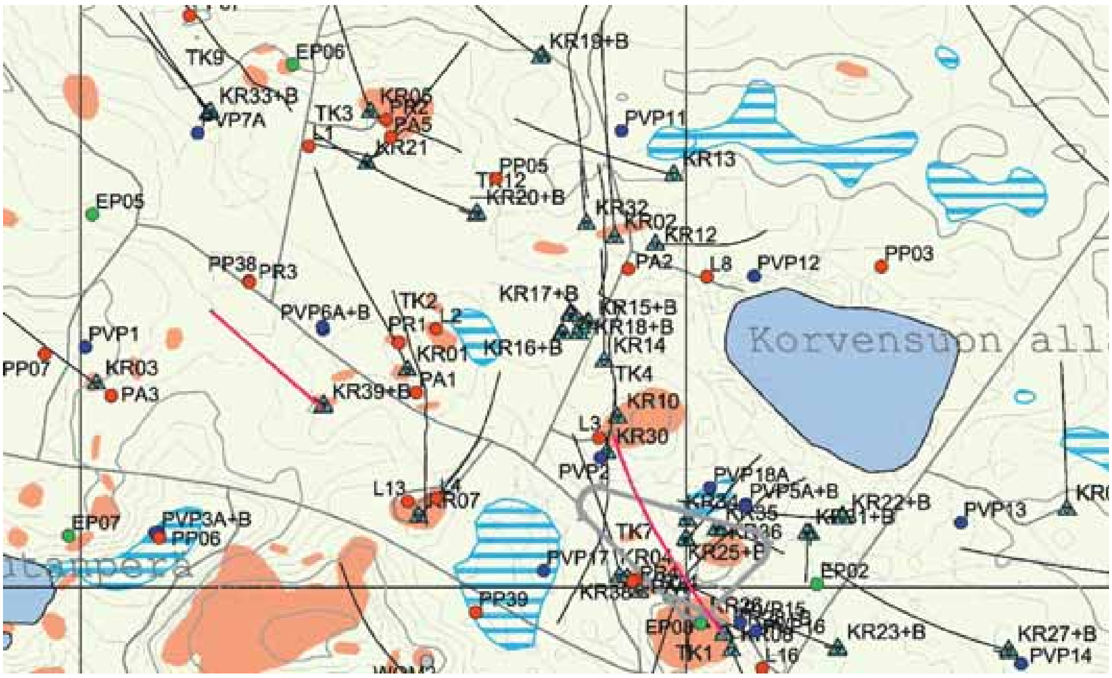

Figure 1. *Location of the holes.*

OL-KR28 was drilled in 2003 to the depth of 656,33 m, and it is located near the entrance of ONKALO. The start inclination of the hole is 54,5º. A 134 mm diameter casing has been installed in the upper part of the hole down to 40,02 m depth. The respective information on OL-KR39 is as follows: Drilled in autumn 2005, depth 502,97 m, start inclination 65,4º and similar casing. The nominal diameter of both holes is 75,7 mm.

Most of the fractures in OL-KR28 are reported to be tight or tight filled, with only a few fractures over 1 mm thick filling and four open fractures. Tight and tight filled fractures are hardly aquifers at all, they cause normally conductivities around 10^{-11} m/s, even if abundant. Dominant fracture orientation is horizontal. Average fracture frequency is 1,5/m.

The fracturing of OL-KR39 is very similar to OL-KR28, the widest filling of over 20 mm is included to the measured section at 418,48 m. Only one open fracture was found inspecting the cores. Fracture dips between horizontal and 35º prevail, but there is great variation and also vertical ones exist. Average fracture frequency is 1,7/m. Strongly fractured zones in both holes are outside the measurement plan in the upper parts of the hole.

Measurements were done in one shift by a single operator. The responsible contractor was Geopros Oy. The operators were Heikki Hämäläinen and Raimo Para from Geopros Oy. Aimo Hiironen from Posiva Oy supervised the fieldwork. This report is written by Heikki Hämäläinen from Geopros Oy.

2 MEASUREMENTS

HTU-trailer was transported to OL-KR28 4.5.2006 for ONKALO monitoring measurements performed in upper parts of the hole. The measurements described here were started 25.5.2006 continuing directly after the monitoring tests. They cover completely the planned sections, altogether 352,00 m of the length of the hole. The total number of tests started is 183 of which 176 were completed successfully. The last test was finished 20.6.2006 and the downhole equipment was lifted from the hole logging the Single Point Resistivity on the way. According to the test plan, the systematic tests with 2 m intervals started from 298,30 m and continued systematically downwards to 650,30 m.

After completion of measurements in OL-KR28 the trailer was moved to OL-KR39 on 26.6.2006, and tests started the following day. 103 tests were initiated and 101 of them were completed successfully, 2 were repeated for technical reasons. Also here, all planned tests were carried out, covering 202,00 m of the total length of the hole.

Reports from interrupted or repeated tests are not included in the Appendix 4. As they may occasionally contain useful information, the table listing all initiated tests is included in the Appendix 1b. It contains slightly different data from the list of completed tests presented in the Appendix 1a. In this case little useful data is retrievable from the repeated tests. The distribution of hydraulic conductivities by Moye-interpretation are shown as a diagram in Appendix 2. The table "Completed tests", Appendix 1a, contains the results of all three in-situ interpretations. The operator's comments in each test report explain if there was a special purpose for the test or any deviation from the normal conditions or sequence of phases during the test.

There are no significant cavities in the walls of either hole in the measured sections, and no deviations from the planned test locations were necessary to avoid bursting of the packers. No significant technical problems were encountered during the tests, except that SP-logging didn't succeed at all in OL-KR39 due to a broken wire in the SP-module. The SP log of OL- KR28 is presented in Appendix 5. There were also minor apparently hardware related problems in logging the SP in OL-KR28. Because of these 25 m of SP-data from the bottom of the hole is useless. As the depth is believed to be accurately definable in these holes because the observed conductive fractures coincide with the results of other types of measurements, no further action was taken with SP-logs.

The comparison between the K-values by Difference flowmeter and HTU show some peculiarities in OL-KR28. In several locations Difference flowmeter indicated values around 10^{-6} m/s, where HTU measured only 10^{-8} m/s, and at 442,3 m – 444,3 m barely 10^{-11} m/s. No valid explanation has been found this far for the difference, as there is no apparent reason to suspect the validity of these HTU-measurements. Experience shows that the hydraulic conductivity of aquifers tends to decrease with time, but there are not many years between the HTU- and Flowmeter measurements. This discrepancy applies only to these high hydraulic conductivities measured with Difference Flowmeter. In OL-KR39 the interpreted K-values of both systems were very coherent.

No new fracture searches based directly on the hydraulic conductivity to confirm the reliability of the depth corrections were made in these holes. The cable stretch can be considered to be known in these circumstances, although the new cable still needs some confirmative observations. The table in Appendix 3 contains data from all these checks in various drillholes logged previously. The description of the mathematical model used to calculate the depth correction is also in the appendix 3. The tension of the cable is measured in the beginning of every test before inflation of the packers and it is used as a parameter in the mathematical model.

3 EQUIPMENT

3.1 General description

The equipment is described in detail in its documentation (Hämäläinen, H. 2005), in Finnish). The system consists of a pair of inflatable packers, a downhole tool, a borehole cable and a trailer, where the surface equipment is installed.

The downhole tool contains pressure sensors to record the pressures in the test section, below packers and above packers, and a temperature sensor. Also, sensors for observation of eventual water leakage etc. are installed. An active pressure regulator with position indication is fitted to the injection line. The injection line opens to the test section and at higher conductivities the constant overpressure is kept by regulating the flow. There is also a bypass valve over the upper packer to equalise the pressure difference during inflation of the packers. All sensors are connected to a microprocessor controlled electronics unit, which has also got a sine wave output for the Single Point Resistance electrode. The digital data transfer between the tool and surface is in serial RS-485 format. The upper packer is attached to the tool and the lower packer is connected to it with aluminium rods. The borehole cable is custom built for this purpose. It contains polyamide hoses for injection and packer inflation and the necessary copper wire conductors. The stress member is a Kevlar webbing below the outer polyurethane jacket.

The trailer is built on the chassis of a log carriage. The body is of GRP sandwich construction with polyurethane foam inner acting also as thermal insulation. A bulkhead divides the space in control and winch rooms. The controller PC, data logger, printers and power supplies are located in the control room, while the cable winch, majority of measurement and control appliances and actuators together with service facilities are in the winch room. The cable is fed to the borehole through a hatch in the floor. A hydraulic power supply, a compressor and a 500 l pressure vessel are installed below the floor. The trailer is equipped with electric heating which is capable to keep the system operational also in severe winter conditions.

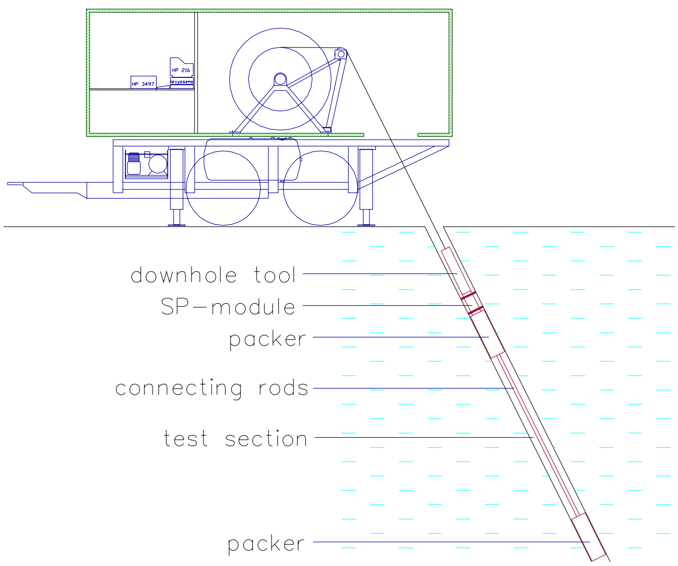

Figure 2. *System configuration.*

3.2 Functional description

The system is primarily designed for constant head injection tests, but several other types of tests are possible with minor software modifications. The tool and the cable are dimensioned for operation down to 1020 m depth. The minimum hole diameter is 56 mm, and wider holes just need a suitable set of packers. The measurement range is $1*10^{-4}$ to 1*10-[11] m/s based on Moye interpretation and 2 m packer separation. The range of the flow measurement is 0,001 – 130 ml/s (3,6 ml/h to 468 l/h) using five auto-ranging transducers.

Interpretation and evaluation of results can be done on site during operation. Data is stored on the hard disk of the PC and a removable backup disk. Test reports containing the preliminary interpretations are printed on the site. The record interval can be selected by the operator to suit both fast transients and long-term observation. Most functions, including operation of the winch, are software controllable. Detailed description of the software is in Appendix 2 of the system documentation (Hämäläinen, H. 2005).

All components in contact with injection water are either stainless steel or plastics to prevent contamination of the groundwater. The pressurised air driving the injection water is filtered mechanically and active coal filters are used to remove the oil contamination from the compressor. There is a coarse filter in the filling line of water tank and a finer (50 μ) between the tank and the flow transducers.

The packer separation is adjusted by the number of aluminium connecting rods between the packers. The standard rods are 2 m long, and there are adaptors for different packer sizes to adjust the separation to even metres and one 1 m long rod. In addition to the rods there is also a safety wire between the packers. It is also used together with a manually operated winch in deploying and lifting the packer system, which can get too heavy to be handled by bare hands if the packer separation is large. Packer connections have breakpoints for possible jamming situations. Both the packers and the tool are equipped with receptacles for a drilling rig in case retrieving of a jammed tool or packer is necessary.

3.3 Technical Specifications

3.3.1 Dimensions

Trailer	Length	7,5 m
	Width	2,5 m
	Height	3,6 m
	Weight	~ 6 t
Tool	Ø	53 mm
	Length	1 580 mm
	Weight	9,5 kg
Cable	Length	1 080 m
	Ø	34,4 mm
	Weight	
	in air	936 kg
	in water	slightly buoyant
Power requirements	minimum	8 kW 380 V 3-phase

3.3.2 Digital accuracy

During a test both the raw data and the calibrated values are stored on the hard disk of the controller PC. The accuracy of the calibrated values depends mainly on the quality of the mathematical model used to convert the raw data to calibrated data. Raw data can always be reprocessed afterwards, if necessary. Data from the tool sensors is digitised by an A/D converter in the tool, which uses 18 bit accuracy for all data utilised in the interpretation of the hydraulic conductivity. Pressures measured on the surface come as 0 – 10 V analogue signals to the data logger from the sensor electronics. A-D conversion is made with 100 µV resolution, which equals better than 0,01 % full scale accuracy. Flow from the electromechanical transducers is recorded directly as pulse counts. The accuracy of the heat-pulse transducers used to measure the lowest flows is more difficult to define, because the resolution of the pulse time varies from 50 ms to 500 ms depending on the duration of the heat pulse cycle. Generally the resolution is more than adequate compared to the accuracy of calibration. Temperatures are measured using PT100 sensors fed with the 1 mA constant current supply of the HP 3497 data logger. The accuracy of the constant current supply is 125 nA at 1 mA output level and the output voltage is measured with 1 µV resolution. Practical resolution is about 10 mΩ, which equals 0,025ºC.

Based on facts presented above, errors caused by data conversions and storage are negligible compared with the accuracy of the sensors.

3.3.3 Pressure sensors

Variable	Type	Linearity + hysteresis	resol.	repeatabil.
Test section P1	Keller PD-14-10	± 5 kPa	10 Pa	± 1 kPa
Above upper packer P2	Keller PA-14-100	±50 kPa	100 Pa	±10 kPa
Below lower packer P8	Keller PA-14-100	±50 kPa	100 Pa	±10 kPa
Water table level P3	Keller PA-14-,5	± 1 kPa	2 Pa	± 2 hPa
Atmospheric press P7	Vaisala PTB101C	±0.28 hPa	1 Pa	±0.1 hPa

All except the atmospheric pressure sensor are manufactured by Keller AG and based on a piezoresistive bridge fed by a constant current source.

3.3.4 Flow Transducers

Type	Range (ml/s)	Cal. accuracy % of reading	Repeatability % of reading
GP 04-T1	0,001-0,03	± 5 %	± 2 %
GP 04-T2	0,02-0,075	± 5 %	± 2 %
FTO N-1-LJS	0,06-4,7	± 0,05 %	± 0,1 %
FTO N-3-LJS	0,44-25,2	± 0,05 %	± 0,1 %
FTO N-5-LJS	1,89-126,2	± 0,05 %	± 0,1 %

The manufacturer of the FTO-transducers is Flow Technology Inc. They are of electromechanical construction and based on a rotor, whose movement is sensed electromagnetically. The GP 04 transducer is heat pulse type and made by Geopros Oy. It has a set of three heating thermistors and two receiving thermistors. There is also one reference thermistor to compensate the drift. Its accuracy is affected by changes in the ambient temperature and possible minor mechanical shocks. Thus the accuracy is difficult to define, but generally it is not as good as with the rotor-transducers. However, the main source of error is the calibration, which is difficult and very time consuming especially in the lower end of the measuring range. With the lowest measurable flows the accuracy is not within the specification above, maybe only ±30 %. The measuring period is long, varying from 15 s to 500 s, which causes steps in the flow graphs of the test reports.

In practice the accuracy of flow measurements is limited by the fact that measurements are made on surface and there is the large and unstable volume of the cable (about 80 l) between the transducer and the test section. The cable expands about 0,5 l/Mpa. This error is minimised by starting the injection with pressurised cable and returning to the same state after injection. Also changes in the water tank pressure during injection are avoided. The reservoir effect of the cable is an important source of error at low hydraulic conductivities when also the flow is small. Therefore a measurement of a flow close to the lower detection limit requires plenty of time (reaching the stationary state after depressurisation of the cable takes about 1 hr) and a careful operator. At higher flows the volume change of the cable becomes negligible compared to the volume of water injected into the bedrock. The magnitude of the error due to the reservoir effect of the cable is hard to estimate as it varies with pressure and flow.

3.3.5 Temperature sensors

PT100 sensors are used on surface and a PT1000 in the tool. The accuracy of a PT100 is 0,3 º C and 0,4 º for PT1000 by DIN 43760 B standard within the temperature range in use. The software uses measured temperatures as parameters in various corrections, but the absolute values are not of great importance to the system. Therefore no individual calibration is made for single sensors.

3.3.6 Cable Tension

The cable tension is measured with a spring-scale and the value is used in the calculation of the stretch correction. The resolution of the scale is 2 kg and accuracy is approximately ±4 kg. The tension is not even along the cable because of the friction between the cable and the wall of the hole, which depends on the inclination of the hole. Due to the friction the tension depends also on the direction of the previous movement of the cable. Therefore the tension correction is only approximate, but this does not introduce large errors, as due to the nearly neutral buoyancy of the cable the tension correction is relatively small at all depths.

3.3.7 Test section Depth

The depth is controlled by markings on the cable jacket at 1 m intervals. There are also markings with enhanced visibility at 25 m intervals and a bogie wheel counter. The wheel is located in a place where the cable runs straight to avoid errors due to bending or askew direction. The resolution of the counter is 1 cm. The zero-offset is reset at the bogie wheel at least every 25 m in systematically advancing testing.

The cable is slightly buoyant, which makes the stretch non-linear with depth. Consequently the stretch starts to decrease at higher depths. In addition the weight of the packer system, the inclination of the hole and the density (salinity) of the ground water affect the tension and stretch. To calibrate the stretch a few known conductive fractures have been accurately located in almost all surveyed boreholes and results from these observations have been collected to a database. The mathematical model used for the stretch correction is based on this database (Appendix 3). The accuracy of the model depends on the amount of data supporting the model, which varies depending on the hole diameter and inclination.

The reported test section depths are based on the length of the cable in the borehole corrected with the equation (3). The equation consists of a linear component *V* and a non-linear component *K*. *V* depends on the cable length and tension. *K* depends only on the cable length and corrects the non-linearity of the stretch. Because of their differing weight, each packer size and section length combination has its own specific set of coefficients used to calculate *V* and *K*.

$$K = Aa + Bb \times d + Cc \times \left(Ln(d) - Dd\right) + \frac{Ee \times d}{\left(d - Ff\right)^2} \tag{1}$$

$$V = Gg \times d \times \left(t + Hh\right) \tag{2}$$

$$Depth = d - (K + V) \tag{3}$$

d = depth according to the markings in the cable [m]
K = non-linear correction, depends on depth only
V = linear correction which depends on depth and tension
t = cable tension [kp]
Aa, Bb, Cc, Dd, Ee, Ff, Gg, Hh = model coefficients, coefficients *Gg* and *Hh* depend on the packer size and separation, see Appendix 3

The applied cable length correction can be found in the beginning of the Event Log printout on the third page of each test report. No other corrections have been applied afterwards. Based on the experience from previous boreholes the current cable model is expected to be quite accurate. A summary of all fracture searches done previously is in Appendix 3 together with the coefficients of the current cable model (model 1298). All depths presented in this report are believed to be at least within 1 m error margin, highly probably better than ±0,5 m

3.3.8 Pressure control

The test section pressure should be maintained as constant as possible during injection. This is done using two different methods depending on the properties of the aquifers crossing the test section. There is an active flow regulator in the tool, which controls the pressure drop over the regulator. It works accurately at medium and high hydraulic conductivities when there is enough flow through the regulator. If the pressure drop is too large, the control becomes unstable. The most important parameter is the selection of the pressure in the water tank, which feeds the water into the test section. It should be high enough to compensate the pressure drop in the cable and leave a suitable reserve for the regulator, but low enough to keep the control stable.

The tank pressure is selected before the start of test. Therefore it is inevitably based on estimation. Major pressure changes are avoided during test as explained in the previous chapter. In many cases the behaviour of the test section pressure during stabilisation gives an indication of the hydraulic conductivity, and the operator can adjust the water tank pressure before the start of injection. Usually the stabilisation time has to be extended in these cases. Occasionally there are test sections with extremely large amplitude flow transient. Then it may be necessary to change the water tank pressure during injection, which normally causes a temporary change in the test section pressure. Also flow transducer changes during injection cause temporary jumps in the test section pressure. However, in almost all cases the pressure can be held constant within ±2 % accuracy, and normally the accuracy is within ±0,5 %.

At low hydraulic conductivities the flow is small and the pressure drop in the cable is not significant. The control can then rely only on the tank pressure with the regulator in the tool in a steady position. Then the pressure can be maintained within ±0,5 % or better. If the value of K is larger than approximately 10^{-9} m/s, active control of the regulator in the tool is needed. With K-values >10^{-7} m/s the pressure drop in the cable increases so much that the nominal 200 kPa overpressure cannot be maintained in the test section. The test is then carried out using a lower pressure, which does not necessarily degrade the accuracy of measurement, as the absolute accuracy of the control is improved. The lowest controllable pressure within these error limits is less than 1 kPa at high flows. Several experiments have proved that the magnitude of the overpressure can be varied within a wide range without any noticeable effect on the measured K-value.

3.3.9 Single Point Resistance

The Single Point Resistance sensor was roughly calibrated to show kΩ. The absolute values are not especially important, as only the shapes of distinguishable anomalies are used to locate fractures or other conductors by comparing to similar logs from other sources.

3.4 Measurement range

The measurement range depends on the packer separation and overpressure used. With the accuracy specified to the electromechanical flow transducers the hydraulic conductivity can be measured within the range $1*10^{-4}$ – $2*10^{-12}$ m/s using 30 m packer separation and overpressure between 0,5 kPa and 200 kPa. The lower detection limit with the thermal-pulse transducer is $1*10^{-11}$ m/s with 2 m packer separation and 250 kPa overpressure. The accuracy is determined by the accuracy of the thermal pulse flow sensor, see 3.3.4. These limits are based on the Moye-interpretation.

3.5 Calibration

Pressure- and flow transducers are calibrated annually according to the quality control manual included in the system documents. The last calibration before these measurements was accomplished in September 2006 and January 2005.

4 TEST SEQUENCE

A constant head test consists of 4 stages.

4.1 Inflation

A test starts by inflating the packers with a pressure of app. 800 kpa. The inflation time varies from 4 to 15 min depending on the packer set and the expected duration of the test. Then the inflation valve is closed to prevent disturbances caused by eventual operation of the inflation pump entering the packers. During the inflation the by-pass valve is open to compensate the volume change of the packers and thus levelling the pressure across the upper packer.

4.2 Stabilisation

In the next stage the by-pass valve is closed and the test section is stabilised normally 5 to 10 minutes. During this time the pressure normally reaches a level close to the natural pressure. However, the time needed for the packers to fully accommodate themselves to the inflation pressure is considerably longer. At very low conductivities this very small volume change creates a significant pressure build-up during stabilisation and frequently it would take hours to reach the natural pressure level. In these cases the natural pressure level remains unknown. The pressure build-up gives a clear indication of the hydraulic conductivity of the section, and provides an opportunity to the operator to adjust the water tank pressure accordingly without disturbing the injection stage.

The cable is pressurised with the water tank pressure at the start of stabilisation. Normally this creates a sharp spike in the flow curve. It should be noted that this flow does not go into the rock, but only into the hose inside the cable, which is made of plastics and therefore flexible. The system is returned to the same state after the injection to ensure the best possible accuracy of the total flow measurement and to prepare the cable for the next test. The cumulative sum of all flow measurements during the whole test is printed in the end of the Event Log of the test. The pressure regulator in the tool stays closed until the end of stabilisation.

4.3 Injection

At the start of injection the pressure regulator in the tool is opened to a preset position. Thereafter the control software opens or closes the regulator in short cycles to maintain a constant pressure in the test section. If there is an appropriate feeding pressure in the water tank of the trailer, the set test section pressure is reached within a minute or sooner. If the hydraulic conductivity is high, it may take several minutes to reach the full flow and stable test section pressure. The early part of the flow transient is lost in this case. The record interval of the data is decreased to a minimum for one minute in the beginning of injection in order to record accurately also the often sharp start of the flow transient.

With K-values $<1*10^{-9}$ m/s no active control is needed, and the regulator is left to a steady position. Then the feeding pressure in the water tank holds the test section pressure constant. Standard test section pressure is 200 kPa, but at high hydraulic conductivities a lower value has to be used because of the high pressure loss in the cable. Injection is continued until a stationary flow is reached. The flow is considered stationary when the change is less than 0,5 %/min. The nominal injection time is 20 min, but it varies within a large range depending on the properties of the aquifers.

4.4 Fall-off

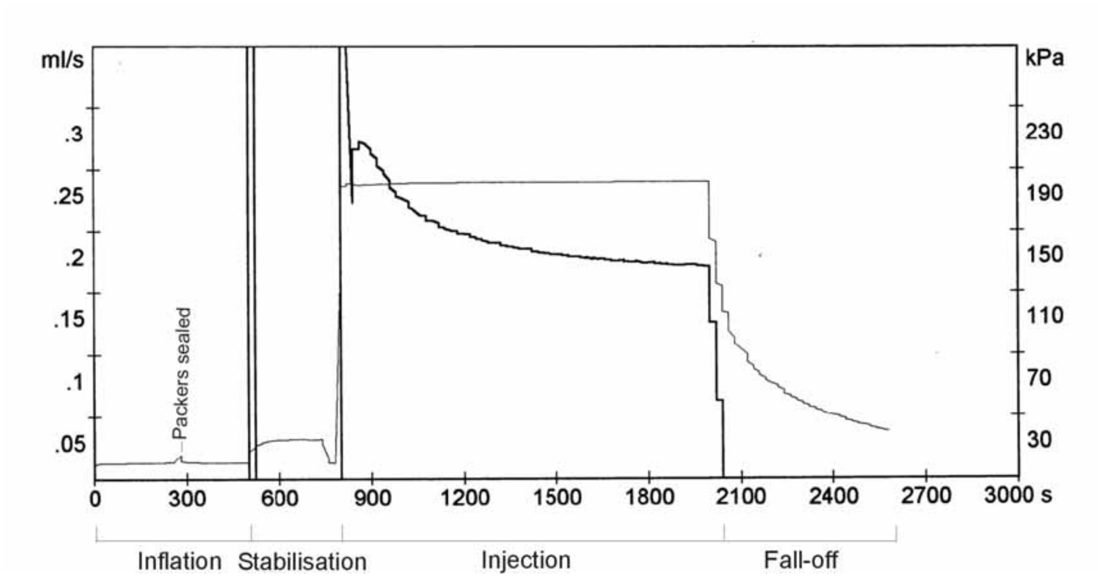

Figure 3. *Stages on a typical P/V-plot, thin line is pressure, bold line flow.*

When the test moves on to fall-off, the regulator is closed and the record interval of the data is decreased to a minimum for one minute to record the start of the pressure transient accurately. The nominal fall-off time is 10 min, after which the packers are deflated. Again the time may vary from 2 min to several hours. When the packers have been released, which takes 5 to 10 min, the tool can be moved to the next location.

4.5 SP-log

Logging the single point resistance is not a standard part of a test. When applicable, ie. in Ø76 mm holes, SP is measured during the movement from one test location to the next. A continuous log from the whole length of the hole is done as a separate procedure. The idea is to pinpoint the depths of fractures or other electrical conductors and to compare them with similar logs from other systems for eventual depth corrections.

SP is measured as resistance between an isolated electrode and the metallic body of the tool and packers. The isolation is achieved by two pairs of polyurethane flaps sliding against the walls. The length of the isolated section is roughly 300 mm, which can be considered as the absolute resolution in depth, though comparing logs accomplished similarly, the accuracy is better. The SP-module is a separate component and attached between the tool and upper packer as necessary (see Fig. 1).

The logging can be done at any time, but normally, as the measurements proceed downwards, the SP-log is combined with the withdrawal of the tool from the bottom. The isolating flaps are asymmetrical and designed to work with upward motion, though usable data is produced also going down. This is utilised especially during the moves between tests, as all other existing SP-data from the hole is presented on the screen parallel to this SP-log. The winch is operated at lowered speed for this purpose, both to decrease the flow past the flaps and to improve the spatial resolution. Especially when there are no aquifers between the tool and the bottom of the hole, the water is forced to flow past the flaps as they act like a piston, providing a path for the electric current and dampening the SP-signal. Because the sampling frequency of the SP-signal is limited, the lower speed also increases the number of data points per meter.

4.6 Recorded variables

The timing of the stages is controlled by the software according to the values set at the initiation of the test. However, the operator can change these values at any time. Also the recording interval is operator controllable. Normal interval is 10 s, and the decreased interval in the beginning of injection and fall-off is about 1 s. Longer times are used in long duration tests, mainly to keep the data files smaller.

The following variables are recorded during a test:

VARIABLE	NAME OF VARIABLE
Real time	-
Test section pressure	P1
Pressure above upper packer	P2
Water table level	P3
Feeding pressure	P5
Packer inflation pressure	P6
Atmospheric pressure	P7
Pressure below lower packer	P8
Test section temperature	T1
Temperature of pressure vessel	T2
Air temperature	T3
Flow	Q
Humidity in the tool	Hm
Regulator position	Ak
Water quantity in the vessel	S2
Record number	RecNr
Code letter of the stage	Stg
Single point resistance	Sp

The values of the recorded variables are saved in data files. Stage durations, interpretation results and Q/A-data shown in the test reports together with other test specific information are stored in a database. A tracer is always added to the injection water. Sodium fluoresine (uranine) is used as the tracer with a calculated concentration of 0,50 mg/l.

5 INTERPRETATION THEORY

5.1 Moye

The Moye-equation is widely used to calculate the hydraulic conductivity from a constant-head test. The equation is:

$$K = \frac{Q \times g \times \rho}{2\pi \times L \times P} \times \left(1 + \ln\left(\frac{L}{2R_w}\right)\right) \qquad (1)$$

The equation applies accurately only to point or radial sources and gives too high K-values with linear sources. A double-packer configuration in a slim hole can be considered as a linear source. The enhanced Moye equation (2) yields more accurate K-values when $L/R_w > 30$, which equals a longer than 0,8 m packer separation in a 56 mm diameter hole, or 1,1 m separation in a 76 mm hole (Ylinen A. 1994)

The enhanced Moye equation is:

$$K = \frac{Q \times g \times \rho}{2\pi \times L \times P} \times \ln\left(\frac{L}{2R_w}\right) \qquad (2)$$

where:

K = hydraulic conductivity	[m/s]
Q = flow	[m^3/s]
g = gravitational acceleration	[m/s^2]
L = test section length	[m]
P = overpressure	[Pa]
Rw =radius of the borehole	[m]
ρ = density of water	[kg/m^3]

The enhanced Moye equation (2) has been used in Moye interpretations presented in this report. The software does the interpretation automatically by using the average of 5 last values of the pressure and flow. If the end of the injection is not suitable due to disturbances etc, the operator selects the time of interpretation manually. Normally he seeks a stretch of injection with a stationary flow. In this case an average of 5 data points on both sides of the selected point is used. With normal 10 s intervals this means an average over 100 s, or respectively 50 s with the automatic interpretation in the end of injection.

5.2 1/Q

In this method a line is fitted to the 1/Q-curve on a semi logarithmic scale and the change of the flow over a logarithmic period of time is calculated. The start of the injection is defined as the moment, when the pressure has reached 70 % of its final value. The period of time over which the line is fitted is operator selectable. He can also decide whether to use the root mean square method for the line fit or manual fitting. If the selected period contains spikes or other disturbances, manual fitting usually gives better results. If there is no proper transient, the 1/Q interpretation is omitted.

The time ranges of injection and line fit are shown in the test report, as well as changes of the pressure and flow over the logarithmic period of time. The interpretation results are the K-value K_{inj} and the skin-factor Z_{inj}, which are also shown on the page 2 of the report. The time scale is in seconds instead of logarithms to improve readability, as the seconds are more easily compared with the other graphs. The hydraulic conductivity is derived directly from the slope with the following equation (Kuusela A. 1986):

$$K = \frac{0{,}183 \times \rho \times g}{P \times L \times \Delta(1/Q)} \qquad (3)$$

where:

ρ = density of water	[kg/m^3]
g = gravitational acceleration	[m/s^2]
P = average overpressure	[Pa]
L = test section length	[m]
$\Delta(1/Q)$ = flow change over a logarithmic period of time	[s/m^3]

The skin effect Z_{inj} is calculated by the equation (Kuusela A. 1986):

$$Z_{inj} = 1{,}15 \times \left(\left(\frac{(1/Q)_t}{\Delta(1/Q)} \right) - \log\left(\frac{K}{R_w^{\,2} \times S_s} \right) - 2{,}13 \right) \qquad (4)$$

where in addition to above:

$(1/Q)_t$ = 1/Q value at the moment t, the beginning of the range of line fit
R_w = radius of the borehole [m]
S_s = specific storage coefficient [1/m]

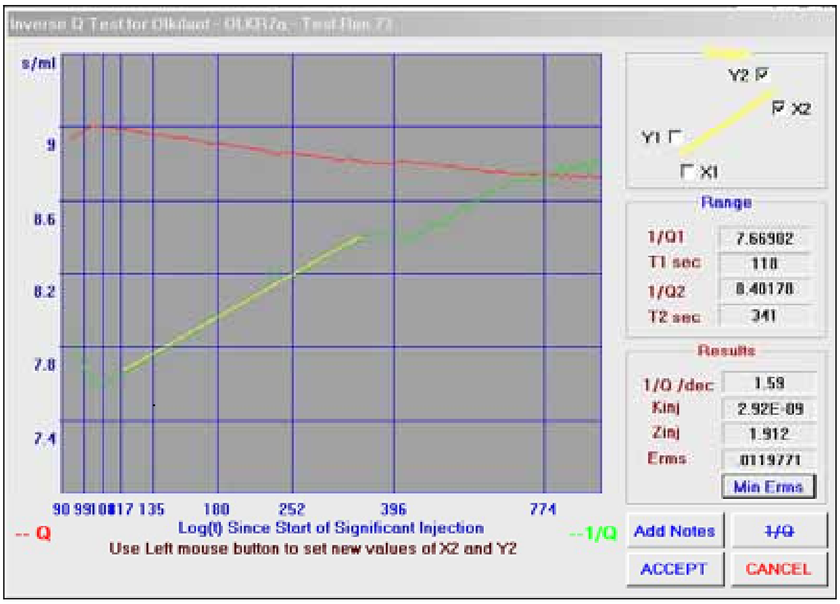

Figure 4. *1/Q interpretation, the operator's view.*

5.3 Horner

The Horner-interpretation is performed on a semi logarithmic coordinate system, where the test section pressure is on the vertical axis and a dimensionless time Log((*t*+*t'*)/*t'*) on the horizontal axis. The dimensionless time is, however, converted to seconds in the notation to ease the comparison of the graphs.

t	= time in seconds from the beginning of injection	[s]
t'	= time in seconds from the beginning of fall-off	[s]

The line fit to the Horner-diagram is accomplished in the same way as in 1/Q-interpretation. The interpretation is again skipped if the transient is not suitable for the purpose. The first (about 5 to 30) seconds are not normally used because of the time needed to close the regulator, which disturbs the beginning of Fall-off.

The hydraulic conductivity is calculated from the slope in the same way as in 1/Q by the following equation (Kuusela 1986):

$$K_{fo} = \frac{0{,}183 \times Q_p \times \rho \times g}{\Delta dP \times L} \qquad (5)$$

where in addition to variables defined in 5.3:

ΔdP	= change of the pressure on a logarithmic time range	[Pa]
Q_p	= flow in the end of injection	[m^3/s]

Like in 1/Q method, the skin effect Z_{fo} is calculated by the equation (Kuusela 1986):

$$Z_{fo} = 1{,}15 \times \left(\frac{dP_t}{\Delta dP} - \log\left(\frac{K_{fo}}{R_w{}^2 \times S_s} \right) - 2{,}13 \right) \qquad (6)$$

where in addition to variables defined above:

dP_t = pressure in the test section at the moment t, the starting point of the range of the line fit

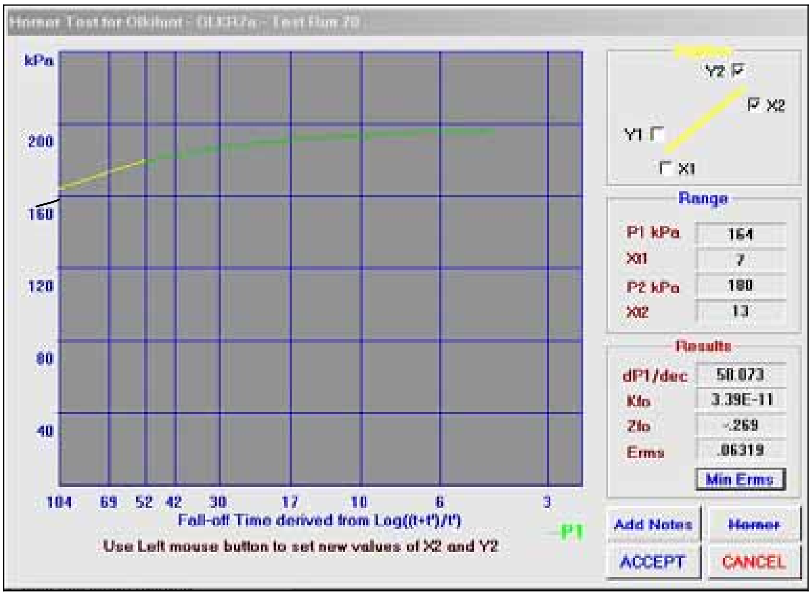

Figure 5. *Horner interpretation, the operator's view.*

5.4 Sources of interpretation errors

Three interpretations are always done, when possible. A Moye-interpretation is calculated every time from the stationary state. The software does this automatically from the end of injection. If there is no measurable flow, the 0,0 m/s value is stored. The operator can override this by selecting the time of interpretation on the Pressure/Flow Graph by cursor, if he considers that the data in the end of injection is disturbed or does not represent the real hydraulic conductivity. Both transient interpretations are done by the operator. He may skip them by arbitration, if a transient is not suitable for interpretation.

Following factors affecting the pressure and flow measurements ought to be kept in mind when evaluating the results. If the hydraulic conductivity is very low, small volume changes of the packer system can have strong effects on the pressure. The shaping of the packers causes a volume change, which continues a long time after the inflation stage has ended building up the pressure in the test section. This build-up can continue for hours and go up to hundreds of kPa:s. The reference (zero value) of the test section pressure is read immediately before the inflation begins to prevent this effect to disturb the interpretation. On the other hand, also high natural pressures are sometimes found, or at least cases, which can't be explained by the packer behaviour. The packer influence and possible high natural pressure are impossible to distinguish without extremely long measuring periods.

With K-values around 10^{-11} m/s the flow is very low, and the volume change of the packers can be large enough to cause an error to the measured flow and the shape of the flow transient. A typical consequence is that there is no flow transient, or it is inverted. The volume change of the packers decreases with time, and the end of injection is usually free of this error provided that sufficiently long time has elapsed since the inflation of packers was started.

Another possible source of error is introduced if the piezometric pressure differs significantly from the hydrostatic pressure. The operator can detect this if the stabilisation stage is long enough and compensate it by altering the pressure offset measured before the beginning of the inflation. In practice this compensation becomes really important with K-values above $1*10^{-6}$ m/s, when the obtainable test section overpressure may be limited to a few kPa. In these cases the offset correction can be even greater than the overpressure and if it is left uncorrected gross errors in the interpretation may result. With the normal overpressure around 200 kPa the possible error is usually not significant. High contrasts in the local topography or manmade underground cavities are apt to provoke this phenomenon.

Opening of the regulator takes some time at the start of inflation, which disturbs the beginning of the flow transient. Opening time varies between 5 and 30 s depending on the pre-set regulator position. This time is recorded in the Event Log to assist the interpreter in evaluation of the beginning of the undisturbed portion of 1/Q. Another error source in 1/Q interpretation is that at high K-values reaching a stable pressure level may take several minutes at the start of injection. When this happens, it causes severe distortion in the shape of the early part of the flow transient. Closing of the regulator takes some time, too, and it disturbs the beginning of fall-off. Also closing time is recorded in the Event Log to inform the interpreter about the length of disturbance.

6 CONTENTS OF THE TEST REPORT

6.1 Test information and results

HEADER

The header contains the 8 characters long name of the test, where the first 6 characters form an ID of the hole, followed by a serial number of the test in two characters, separated by a dash (e.g. OLK15a-12). The 6 character hole ID is formatted as **aarrnx**, where:

aa = area code according to the naming practice of Posiva Oy
rr = type of the hole (KR, EP…)
n = number of the hole
x = additional ID, an alphabetical character

The HTU software creates the names of the data files from a hole ID (6 characters) and a running number of the test (2 characters). If more than 99 tests are carried out in one hole, a new logic hole has to be created. The logical holes are distinguished by the additional ID **x**. In areas with more than 9 holes, 2 characters are needed for the hole number. In this case the type of the hole is expressed by one character only and the hole ID is formatted as **aarnnx**.

Below the header there are the name of the hole in the format used by Posiva Oy and the location of the test section. The location is the distance from ground level along the borehole with all known corrections applied. Next comes an illustration of the hole, where the relative location of the test section is marked. Also the most significant fractures and fracture zones are presented, if known at the time of creation of the hole record in the database.

DATA FILES

In the following section are the names of all data files related to the test. Regarding an eventual post processing the most important files are the file containing the calibrated values with the suffix **.PRO** and an Event Log file with the suffix **.EVT**. All essential events, which may have an effect on the results are logged in the event file and time tagged. The calibration coefficients are in the **.CAL** file. The raw data with no calibration applied is in the file with the suffix **.RAW**. The structure of the **.PRO** file is described in detail in chapter 7.

The filenames are like the test name described in 6.1, but without the dash. The name of the event log file has the running number of the test as the first 2 characters and the rest is coded information based on the time of creation of the file. The name of the calibration file begins with characters “**HT**” and continues with the date of its creation in the format **ddmmyy.** As an additional information there are the initials of the operator and the number of records in the data files.

TEST SECTION DATA

Section length	distance between packers	[m]
hole Ø	diameter of the hole	[mm]
water table after stabilisation	water table depth from the ground level	[m]

TIMES

date	date of the start of the test	[pvm]
start of test	time of the start of the test	[hh:mm:ss]
end of test	time of the finish of the test	[hh:mm:ss]
reprocesses	number of re-processes, incremented every time a new interpretation is written into the database	
duration	duration of the whole test	[s]
stabilisation	duration of the stabilisation stage	[s]
injection	duration of the injection stage	[s]
fall-off	duration of the fall-off stage	[s]

RESULTS

last flow	flow value used in the automatic Moye-interpretation	[ml/s]
volume	volume of water used during injection, calculated by integrating measured flow values during injection	[l]
last pressure	pressure used in the automatic Moye-interpretation	[kPa]
start pressure	test section pressure before the injection	[kPa]
final pressure	test section pressure in the end of fall-off	[kPa]

HYDRAULIC CONDUCTIVITIES

Moye	conductivity calculated by the enhanced Moye-equation	[m/s]
Horner	conductivity by Horner-method	[m/s]
1/Q	conductivity by 1/Q-method	[m/s]

Q/A

The intention of the Q/A data is to gather momentary and derivative values with significance in evaluation of the quality of the results. The information is classified into 3 groups timed to the ends of stabilisation-, injection- and fall-off stages. Below is a brief description of the Q/A-values and their use.

END OF STABILISATION:

P1 change — The change of the test-section pressure during stabilisation [kPa]
Needed, if the difference between hydrostatic and piezometric pressures has to be compensated. Indicates also a pressure rise due to the packers at a low hydraulic conductivity, and helps in predicting the hydraulic conductivity before the start of injection

P1 rate of chg — The rate of test-section pressure change [kPa/min]
Correlates to the reliability of the indicated piezometric pressure. Also helps to predict the hydraulic conductivity before start of injection. Thus the injection parameters can be optimised beforehand.

P8 change — The change of the pressure below the lower packer [kPa]
Indicates leaks past the lower packer. In some cases also indicates the magnitude of the hydraulic conductivity of the whole borehole below the test section, if the small volume change caused by the packers can be seen as a rise of this pressure.

P6 packer press.	Packer inflation pressure This is to check that the inflation pressure was sufficient to seal the test-section. The magnitude of overpressure used in the injection should be taken into account.	[kPa]
END OF INJECTION:		
P1 mean dev.	The standard deviation of overpressure during injection Shows how accurately the constant pressure has been kept during injection	[%]
P1 mean error	The mean deviation of the overpressure from the set P1 value during injection Another measure for the success of the pressure control.	[kPa]
rate of flow chg	The rate of change of flow at the end of injection Indicates the degree of stationary state of the flow. The target is normally a value below 0,5 %/min	[(%)/min]
watertable chg	The change of the groundwater level during injection A change in the groundwater level changes the reference pressure of the test-section pressure sensor. The software uses the water table data to compensate it. This value indicates the magnitude of applied correction.	[m]
END OF FALL-OFF:		
P1 change	The pressure difference in the test-section between the start and end of the test Indicates how close to the original the test section pressure has been restored during fall-off.	[kPa]
P1 rate of chg	The rate of pressure change at the end of fall-off Used to estimate a reasonable duration for the fall-off stage.	[kPa/min]
P8 change	The pressure change below the lower packer from the start of injection In case of low hydraulic conductivity between the test-section and the bottom of the hole a rise of this value shows possible leaks past the lower packer, or fractures joining the test section to the bottom part of the hole.	[kPa]
stages	The number of completed test stages 1 = Packer inflation completed 2 = Packer inflation and stabilisation completed 3 = Packer inflation, stabilisation and injection completed 4 = Packer inflation, stabilisation, injection and fall-off completed, normally a fully completed test 5 = A completed, but for some reason repeated test 6 = A special test 7 = The test belongs to a series of tests in the same location 8 = A test to record the piezometric pressure	

TEST COMMENTS
These are operator's notes on the events and irregularities, which happened during the test. Usually also possible reasons to these have been written down. The test comments are stored to a file **FinalNN.CMT**, where **NN** is the number of the test.

INTERPRETATION COMMENTS
The operator's comments about the interpretations are under this headline. The interpretation comments are stored to a file **IntpreNN.CMT**, where **NN** is the number of the test.

6.2 Diagrams

The second page contains three graphical presentations. The first shows the test-section pressure and flow from the entire duration of the test (P1 and V Plot). The next two are the 1/Q and Horner-interpretations, where only the time range chosen for the interpretation by the operator is shown.

P1 and V PLOT
The thinner line represents the pressure in the test-section and the flow is drawn with a bold line. The software scales the diagrams by the max values of the variables (a possible spike in the beginning of injection is omitted in the scaling of flow). The linear time scale is the time in seconds from the beginning of the test. When the heat pulse flow transducer has been in use, the flow diagram consists of steps, because the value is updated only at 15 – 500 s intervals. The flow value is calculated at the end of each heat pulse cycle, and therefore the front edge of a step represents the flow best. Even that is delayed, as the instant, which would best represent the flow value measured by the heat pulse sensor, is the middle of the previous cycle. In addition to the diagram, the values of following variables are shown:

Moye K	The result of the Moye-interpretation	[m/s]
time	The moment of interpretation in seconds from the beginning of the test	[s]
pressure	Test-section pressure at the moment of interpretation, the average of 5 or 10 nearest values (normally 50 or 100 s)	[kPa]
flow	Flow at the moment of interpretation, the average of 5 or 10 nearest values (normally 50 or 100 s)	[ml/s]

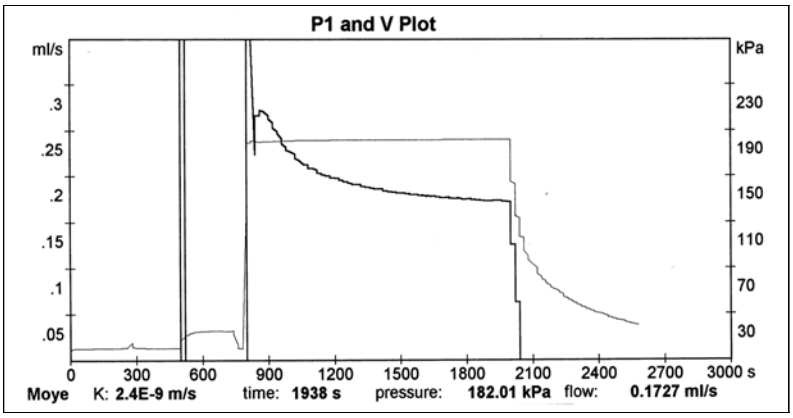

Figure 6 . *P/V plot as presented in test reports with values used for the Moye-interpretation, thin line is pressure, bold line flow.*

1/Q PLOT

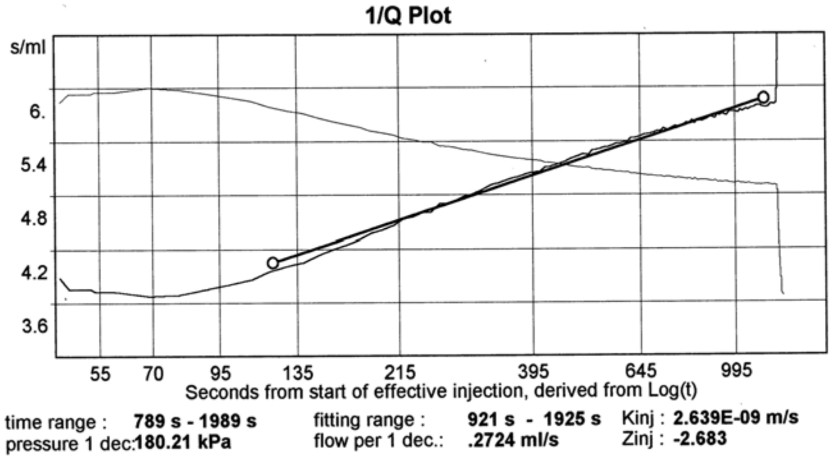

Figure 7. *1/Q-plot as presented in the test reports with values used for the 1/Q interpretation.*

In 1/Q-diagram the thin line represents the flow and the bold line its inverted value. The time scale is logarithmic and the unit is seconds from the effective start of injection. The effective injection is considered to start, when the test-section pressure has reached 70 % of the target value. The annotation of the time axis cannot be directly bound to the P-V diagram, but both injection and line fit ranges are given numerically to ease its outlining.

The following variables are printed adjacent to the diagram:

Time range	The injection period, in seconds from the beginning of the test	[s]
fitting range	The time range of the line fitted on the curve, in seconds from the beginning of the test	[s]
pressure 1 dec	The change of pressure over a logarithmic period of time	[kPa]
flow per 1 dec	The change of flow over a logarithmic period of time	[ml/s]
K_{inj}	Hydraulic conductivity by 1/Q-interpretation	[m/s]
Z_{inj}	Skin effect by 1/Q-interpretation	

HORNER-DIAGRAM

The thin line in the Horner-diagram represents the pressure in the test section after the end of injection. Actual interpretation is accomplished in dimensionless time Log((t+t')/t'), where t = time in seconds from the beginning of the injection and t' = time in seconds from the beginning of the fall-off. As this is a very unillustrative way to present the time, the time axis is annotated in seconds from the beginning of the fall-off. This way it is easier to understand the physical placing of the line on the pressure curve. Due to the above mentioned background, the time increases from right to left on the horizontal axis, which adds the difficulty of visualising it. The following variables are printed adjacent to the diagram:

Time range	Fall-off period in seconds from the beginning of the test	[s]
Fitting range	Fitting range of the line	[s]

K_{fo}	Hydraulic conductivity by Horner-interpretation	[m/s]
Z_{fo}	Skin effect by Horner-interpretation	

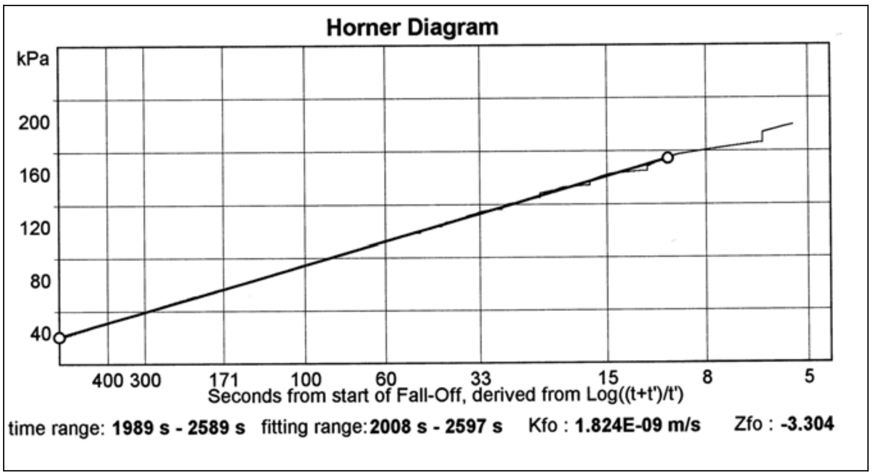

Figure 8. *Horner diagram as presented in test reports with values used for the Horner-interpretation.*

6.3 Event log

The third and possibly fourth page contains a printout of the log file created during the test. There are all events with time stamps detected by the software, like error messages, variable deflections higher than set limits etc, which exceed a pre-set severity limit. The software classifies the events to categories from 1 to 9 by their severity. Only events ranked over class 4 are written to the log, the rest are shown on the screen only as information to the operator. The time stamp has got two parts. The first is the clock time and the second is the time from the beginning of the test in seconds. This makes correlation of the events with the diagrams on page 2 easy.

In addition to the error messages, a number of informative messages are included in the log. They may help to explain possible anomalies and to correct errors noticed afterwards. As an example, these include the identification of the mathematical model used to calculate the cable stretch, cable tension, starting- and set points of some pressures and values of internal pressure and humidity of the tool at the start of test. Also exact times of stage changes, flow transducer changes and opening and closing times of the pressure regulator are saved to the Event Log file. The regulator opening and closing times enable evaluation of how long the regulator operations affect the start of injection and fall-off. In the end there is the overall total flow, which includes the volume of water used for pressurisation of the cable during stabilisation and fall-off and possible leaks, while the total flow presented on page 1 is the time integral of flow measurements during injection.

7 DATAFILE CONFIGURATION

The data is stored in the **.PRO** files in ASCII format. The length of records is 121 characters and the contents is described by the variable definition borrowed from the software and presented below. For future use there are 11 blanks in the end of the record. The last character is an EOR (ASCII13) to ease postprocessing of the data in other applications. The EOR character was added 1995, so it is lacking only from tests accomplished in Romuvaara 1994 – 1995. The length of the record has not been altered, but a few changes to the contents have been introduced during the past 10 years. Relevant hole reports should be consulted if old data is to be reprocessed.

```
Type ProcData                    'used to store processed data records
   TimeDate As String * 12       'time stamp, format ddmmyyhhmmss
   p1 As String * 8              'test section pressure [kPa], format ####.###
   p2 As String * 7              'pressure over upper packer [MPa], format ###.###
   p3 As String * 8              'water table depth in [m], format ###.####
   Hm As String * 2              'moisture inside the tool [digits 0-99], format ##
   p8 As String * 7              'pressure below lower packer [MPa], format ####.##
   t1 As String * 6              'test section temperature [C]
   t2 As String * 6              'injection water temperature in tank [C]
   t3 As String * 6              'outside air temperature [C]
   s2 As String * 3              'water level in tank [l], format ###
   Ak As String * 5              'control valve pos. in [%=percentage of open], format ##.##
   Flow  As String * 9           'water flow [ml/s], format ####.####
   Stg As String * 1             'stage code [code letter], format #
   RecNr As String * 5           'number of the raw data record [digits 1-9999], format ####
   p5 As String * 8              'p5 in kPa, format ####.###
   p7 As String * 6              'p7 in millibars
   p6 As String * 5              'p6 in kPa, format ####.#
   Sp As String * 5              'Scaled single point resistivity signal #.###
   Spare2 As String * 11         'spare 11 ch space
   EOR As String * 1             'End Of Record, separator char "CR"
End Type
```

"Stage code" is the third character in the words “pre-start”, "inflation", "stabilisation", "injection" and "fall-off", i.e. “e”, “f”, “a”, “j” or “l”. The time is in the format "ddmmyyhhmmss". Groundwater level (p3) is measured with a sensor below the water table in the borehole and converted to metres from ground. In cases where p3 signal is not available, p2 pressure is used instead, which is much more inaccurate.

Below is an example of the contents of a .PRO-file (tabs have been added for better readability in the printout).

```
time         p1     p2    p3      Hm  p8  t1     t2     t3    s2   Mm    flow   stg Rec  p5     p7    p6    Sp    Spare
141102093413 65.161 3.073 -5.9863 55  3.18.736   8.415  -5.6  406  30.55 2.8706 j   87   27.517 1002. 825.6 4.067______
141102093414 65.966 3.073 -5.9864 55  3.18.733   8.415  -5.6  406  27.15 2.6444 j   88   27.506 1002. 825.4 4.067______
141102093415 66.168 3.073 -5.9864 55  3.18.733   8.415  -5.6  406  27.15 2.6444 j   89   27.501 1002. 825.4 3.907______
141102093417 66.266 3.073 -5.9862 55  3.18.733   8.415  -5.6  406  19.13 2.6444 j   90   27.5   1002. 825.4 3.907______
141102093418 66.426 3.074 -5.9862 55  3.18.732   8.415  -5.6  406  14.39 2.6444 j   91   27.495 1002. 825.4 3.068______
141102093419 66.509 3.074 -5.9862 55  3.18.729   8.415  -5.6  406  12.18 2.6444 j   92   27.49  1002. 825.3 3.068______
```

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Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
298.3 - 300.3	25.5.2006	OLK28b54	5438862	2.4E-11	4.6E-12	2.6E-11	1.0E-10
300.3 - 302.3	25.5.2006	OLK28b55	5538862	0.0E+00			1.0E-10
302.3 - 304.3	25.5.2006	OLK28b56	5638862	0.0E+00			1.0E-10
304.3 - 306.3	25.5.2006	OLK28b57	5738862	0.0E+00			1.0E-10
306.3 - 308.3	26.5.2006	OLK28b58	5838863	0.0E+00			1.0E-10
308.3 - 310.3	26.5.2006	OLK28b59	5938863	2.7E-11	5.3E-12		1.0E-10
310.3 - 312.3	26.5.2006	OLK28b60	6038863	0.0E+00			1.1E-10
312.3 - 314.3	26.5.2006	OLK28b61	6138863	0.0E+00			1.1E-10
314.3 - 316.3	26.5.2006	OLK28b62	6238863	0.0E+00			1.1E-10
316.3 - 318.3	26.5.2006	OLK28b63	6338863	0.0E+00			1.1E-10
318.3 - 320.3	26.5.2006	OLK28b64	6438863	0.0E+00			1.1E-10
320.3 - 322.3	26.5.2006	OLK28b65	6538863	1.6E-11			1.1E-10
322.3 - 324.3	26.5.2006	OLK28b66	6638863	6.6E-11		3.7E-11	1.1E-10
324.3 - 326.3	26.5.2006	OLK28b67	6738863	2.6E-11	6.3E-12		1.1E-10
326.3 - 328.3	26.5.2006	OLK28b68	6838863	0.0E+00			1.1E-10
328.3 - 330.3	26.5.2006	OLK28b69	6938863	0.0E+00			1.1E-10
330.3 - 332.3	27.5.2006	OLK28b70	7038864	0.0E+00			1.1E-10
332.3 - 334.3	27.5.2006	OLK28b71	7138864	0.0E+00			1.1E-10
334.3 - 336.3	27.5.2006	OLK28b72	7238864	6.8E-08	1.8E-07	4.8E-07	1.1E-10
336.3 - 338.3	27.5.2006	OLK28b73	7338864	1.1E-10		6.9E-11	1.1E-10
338.3 - 340.3	27.5.2006	OLK28b74	7438864	0.0E+00			1.1E-10
340.3 - 342.3	27.5.2006	OLK28b75	7538864	0.0E+00			1.1E-10
342.3 - 344.3	27.5.2006	OLK28b76	7638864	0.0E+00			1.1E-10
344.3 - 346.3	27.5.2006	OLK28b77	7738864	0.0E+00			1.1E-10

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
346.3 - 348.3	27.5.2006	OLK28b78	7838864	1.7E-11	3.6E-12		1.1E-10
348.3 - 350.3	27.5.2006	OLK28b79	7938864	0.0E+00			1.1E-10
350.3 - 352.3	27.5.2006	OLK28b80	8038864	0.0E+00			1.1E-10
352.3 - 354.3	27.5.2006	OLK28b81	8138864	0.0E+00			1.1E-10
354.3 - 356.3	29.5.2006	OLK28b82	8238866	0.0E+00	0.0E+00		1.0E-10
356.3 - 358.3	29.5.2006	OLK28b83	8338866	0.0E+00	0.0E+00		1.0E-10
358.3 - 360.3	29.5.2006	OLK28b84	8438866	2.7E-11	7.6E-12	3.2E-11	1.0E-10
360.3 - 362.3	29.5.2006	OLK28b85	8538866	2.1E-10	7.3E-10	9.3E-11	1.0E-10
362.3 - 364.3	29.5.2006	OLK28b86	8638866	0.0E+00	0.0E+00		1.0E-10
364.3 - 366.3	29.5.2006	OLK28b87	8738866	2.5E-11	5.9E-12	0.0E+00	1.0E-10
366.3 - 368.3	29.5.2006	OLK28b88	8838866	0.0E+00	0.0E+00		1.0E-10
368.3 - 370.3	29.5.2006	OLK28b89	8938866	0.0E+00	0.0E+00		1.0E-10
370.3 - 372.3	30.5.2006	OLK28b90	9038867	5.2E-10	8.8E-11	7.7E-10	1.0E-10
372.3 - 374.3	30.5.2006	OLK28b91	9138867	5.4E-11	1.1E-11	4.4E-11	1.0E-10
374.3 - 376.3	30.5.2006	OLK28b92	9238867	2.9E-11	6.7E-12	2.2E-10	1.0E-10
376.3 - 378.3	30.5.2006	OLK28b93	9338867	8.8E-12	6.9E-12		1.0E-10
378.3 - 380.3	30.5.2006	OLK28b94	9438867	2.3E-11	6.2E-12		1.0E-10
380.3 - 382.3	31.5.2006	OLK28b95	9538868	6.7E-09	7.2E-09	6.9E-08	2.5E-08
382.3 - 384.3	31.5.2006	OLK28b96	9638868	5.0E-11	1.5E-11	2.0E-11	1.0E-10
384.3 - 386.3	31.5.2006	OLK28b97	9738868	2.2E-10	0.0E+00	1.1E-10	1.0E-11
386.3 - 388.3	31.5.2006	OLK28b98	9838868	1.4E-09	9.3E-10	4.5E-09	1.0E-10
388.3 - 390.3	31.5.2006	OLK28b99	9938868	2.2E-08	3.2E-08	6.4E-08	8.7E-06
390.3 - 392.3	31.5.2006	OLK28c01	0138868	1.6E-04	0.0E+00		1.0E-10
392.3 - 394.3	31.5.2006	OLK28c02	0238868	0.0E+00			1.0E-10
394.3 - 396.3	31.5.2006	OLK28c03	0338868	0.0E+00			1.0E-10
396.3 - 398.3	31.5.2006	OLK28c04	0438868	0.0E+00			1.1E-10

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
398.3 - 400.3	31.5.2006	OLK28c05	0538868	0.0E+00			1.0E-10
400.3 - 402.3	1.6.2006	OLK28c06	0638869	0.0E+00			1.1E-10
402.3 - 404.3	1.6.2006	OLK28c07	0738869	0.0E+00			1.1E-09
404.3 - 406.3	1.6.2006	OLK28c08	0838869	2.5E-11	6.4E-12	1.4E-11	1.1E-09
406.3 - 408.3	1.6.2006	OLK28c09	0938869	7.3E-11	3.6E-11	3.7E-11	1.0E-10
408.3 - 410.3	1.6.2006	OLK28c10	1038869	0.0E+00			0.0E+00
410.3 - 412.3	1.6.2006	OLK28c11	1138869	0.0E+00			1.0E-10
412.3 - 414.3	1.6.2006	OLK28c12	1238869	2.4E-11		3.1E-11	1.1E-09
414.3 - 416.3	1.6.2006	OLK28c13	1338869	1.8E-11			0.0E+00
416.3 - 418.3	1.6.2006	OLK28c14	1438869	0.0E+00			0.0E+00
418.3 - 420.3	1.6.2006	OLK28c15	1538869	0.0E+00			1.0E-10
420.3 - 422.3	1.6.2006	OLK28c16	1638869	3.5E-11		3.6E-11	1.0E-10
422.3 - 424.3	2.6.2006	OLK28c17	1738870	7.3E-11		7.8E-11	1.1E-10
424.3 - 426.3	2.6.2006	OLK28c18	1838870	0.0E+00			1.1E-10
426.3 - 428.3	2.6.2006	OLK28c19	1938870	0.0E+00			1.1E-10
428.3 - 430.3	2.6.2006	OLK28c20	2038870	3.4E-11		5.4E-11	0.0E+00
430.3 - 432.3	2.6.2006	OLK28c21	2138870	4.7E-11		5.6E-11	1.0E-10
432.3 - 434.3	2.6.2006	OLK28c22	2238870	0.0E+00			1.0E-10
434.3 - 436.3	2.6.2006	OLK28c23	2338870	0.0E+00			1.0E-10
436.3 - 438.3	2.6.2006	OLK28c24	2438870	0.0E+00			1.0E-10
438.3 - 440.3	2.6.2006	OLK28c25	2538870	0.0E+00			1.0E-10
440.3 - 442.3	2.6.2006	OLK28c26	2638870	1.4E-10		6.7E-11	1.1E-09
442.3 - 444.3	6.6.2006	OLK28c27	2738874	6.3E-11	1.4E-11	3.6E-11	2.8E-06
444.3 - 446.3	6.6.2006	OLK28c28	2838874	3.5E-06			1.0E-10
446.3 - 448.3	6.6.2006	OLK28c29	2938874	2.8E-08	4.4E-08		4.0E-08
448.3 - 450.3	6.6.2006	OLK28c30	3038874	5.2E-11	0.0E+00	4.3E-11	1.0E-10

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
450.3 - 452.3	6.6.2006	OLK28c31	3138874	1.1E-11		1.3E-11	1.0E-10
452.3 - 454.3	6.6.2006	OLK28c32	3238874	3.0E-11		2.4E-11	1.0E-10
454.3 - 456.3	6.6.2006	OLK28c33	3338874	0.0E+00			1.0E-12
456.3 - 458.3	6.6.2006	OLK28c34	3438874	0.0E+00			1.0E-10
458.3 - 460.3	6.6.2006	OLK28c35	3538874	0.0E+00			1.0E-10
460.3 - 462.3	6.6.2006	OLK28c36	3638874	0.0E+00			1.0E-10
462.3 - 464.3	6.6.2006	OLK28c37	3738874	0.0E+00			1.0E-10
464.3 - 466.3	6.6.2006	OLK28c38	3838874	0.0E+00			1.0E-10
466.3 - 468.3	6.6.2006	OLK28c39	3938874	0.0E+00			1.0E-10
468.3 - 470.3	7.6.2006	OLK28c40	4038875	0.0E+00			1.0E-10
470.3 - 472.3	7.6.2006	OLK28c41	4138875	0.0E+00			1.0E-10
472.3 - 474.3	7.6.2006	OLK28c42	4238875	0.0E+00			1.0E-10
474.3 - 476.3	7.6.2006	OLK28c43	4338875	0.0E+00			1.0E-10
476.3 - 478.3	7.6.2006	OLK28c44	4438875	0.0E+00			1.0E-10
478.3 - 480.3	7.6.2006	OLK28c45	4538875	0.0E+00			1.0E-10
480.3 - 482.3	7.6.2006	OLK28c46	4638875	0.0E+00			1.0E-10
482.3 - 484.3	7.6.2006	OLK28c47	4738875	0.0E+00			1.0E-10
484.3 - 486.3	7.6.2006	OLK28c48	4838875	1.2E-11			1.0E-10
486.3 - 488.3	7.6.2006	OLK28c49	4938875	0.0E+00			1.0E-10
488.3 - 490.3	7.6.2006	OLK28c50	5038875	0.0E+00			1.0E-10
490.3 - 492.3	7.6.2006	OLK28c51	5138875	0.0E+00			1.0E-10
492.3 - 494.3	7.6.2006	OLK28c52	5238875	0.0E+00			1.0E-10
494.3 - 496.3	8.6.2006	OLK28c53	5338876	0.0E+00			0.0E+00
496.3 - 498.3	8.6.2006	OLK28c54	5438876	0.0E+00			1.0E-10
498.3 - 500.3	8.6.2006	OLK28c55	5538876	0.0E+00			1.0E-10
500.3 - 502.3	8.6.2006	OLK28c56	5638876	0.0E+00			1.0E-10

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
502.3 - 504.3	8.6.2006	OLK28c57	5738876	0.0E+00			1.0E-10
504.3 - 506.3	8.6.2006	OLK28c58	5838876	0.0E+00			1.0E-10
506.3 - 508.3	8.6.2006	OLK28c59	5938876	0.0E+00			1.0E-10
508.3 - 510.3	8.6.2006	OLK28c60	6038876	0.0E+00			1.0E-10
510.3 - 512.3	8.6.2006	OLK28c61	6138876	0.0E+00			1.0E-10
512.3 - 514.3	8.6.2006	OLK28c62	6238876	1.5E-11			1.0E-10
514.3 - 516.3	8.6.2006	OLK28c63	6338876	0.0E+00			1.0E-10
516.3 - 518.3	8.6.2006	OLK28c64	6438876	0.0E+00			1.0E-10
518.3 - 520.3	8.6.2006	OLK28c65	6538876	0.0E+00			1.0E-10
520.3 - 522.3	9.6.2006	OLK28c66	6638877	3.2E-08	5.8E-08	2.6E-07	2.3E-08
522.3 - 524.3	12.6.2006	OLK28c69	6938880	1.4E-07	7.7E-08	1.4E-07	1.0E-10
524.3 - 526.3	12.6.2006	OLK28c70	7038880	3.8E-09	0.0E+00	1.2E-08	1.0E-10
526.3 - 528.3	13.6.2006	OLK28c71	7138881	3.2E-09	1.9E-08	1.9E-08	1.0E-10
528.3 - 530.3	13.6.2006	OLK28c72	7238881	4.1E-10	7.3E-10	8.2E-10	1.0E-10
530.3 - 532.3	13.6.2006	OLK28c73	7338881	5.6E-10	0.0E+00	7.9E-10	1.0E-10
532.3 - 534.3	13.6.2006	OLK28c74	7438881	0.0E+00			1.0E-10
534.3 - 536.3	13.6.2006	OLK28c75	7538881	0.0E+00			1.0E-10
536.3 - 538.3	13.6.2006	OLK28c76	7638881	0.0E+00			1.0E-10
538.3 - 540.3	13.6.2006	OLK28c77	7738881	0.0E+00			1.0E-10
540.3 - 542.3	13.6.2006	OLK28c78	7838881	0.0E+00			1.0E-10
542.3 - 544.3	13.6.2006	OLK28c80	8038881	3.6E-10	2.1E-10	2.6E-10	2.3E-10
544.3 - 546.3	13.6.2006	OLK28c81	8138881	1.1E-09	7.6E-11	1.0E-09	1.0E-10
546.3 - 548.3	14.6.2006	OLK28c82	8238882	1.5E-10	5.2E-11	7.7E-11	0.0E+00
548.3 - 550.3	14.6.2006	OLK28c84	8438882	6.2E-11	0.0E+00	6.3E-11	1.0E-10
550.3 - 552.3	14.6.2006	OLK28c85	8538882	1.3E-10	3.1E-11	2.1E-10	1.0E-10
552.3 - 554.3	14.6.2006	OLK28c86	8638882	0.0E+00			1.0E-10

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
554.3 - 556.3	14.6.2006	OLK28c87	8738882	0.0E+00			1.0E-10
556.3 - 558.3	14.6.2006	OLK28c88	8838882	0.0E+00			1.0E-10
558.3 - 560.3	14.6.2006	OLK28c89	8938882	0.0E+00			1.0E-10
560.3 - 562.3	14.6.2006	OLK28c90	9038882	0.0E+00			1.0E-10
562.3 - 564.3	14.6.2006	OLK28c91	9138882	0.0E+00			1.0E-10
564.3 - 566.3	14.6.2006	OLK28c92	9238882	0.0E+00			1.0E-10
566.3 - 568.3	14.6.2006	OLK28c93	9338882	2.4E-10	8.5E-11	2.1E-10	1.0E-10
568.3 - 570.3	15.6.2006	OLK28c96	9638883	4.3E-09	1.7E-09	4.0E-09	1.0E-09
570.3 - 572.3	15.6.2006	OLK28c97	9738883	0.0E+00			1.0E-10
572.3 - 574.3	15.6.2006	OLK28c98	9838883	1.6E-11			1.0E-10
574.3 - 576.3	15.6.2006	OLK28c99	9938883	0.0E+00			1.0E-10
576.3 - 578.3	15.6.2006	OLK28d01	0138883	0.0E+00			0.0E+00
578.3 - 580.3	15.6.2006	OLK28d02	0238883	0.0E+00			1.0E-10
580.3 - 582.3	15.6.2006	OLK28d03	0338883	0.0E+00			0.0E+00
582.3 - 584.3	15.6.2006	OLK28d04	0438883	0.0E+00			1.0E-10
584.3 - 586.3	15.6.2006	OLK28d05	0538883	0.0E+00			0.0E+00
586.3 - 588.3	15.6.2006	OLK28d06	0638883	0.0E+00			1.0E-10
588.3 - 590.3	15.6.2006	OLK28d07	0738883	0.0E+00			1.0E-10
590.3 - 592.3	16.6.2006	OLK28d08	0838884	0.0E+00			1.0E-10
592.3 - 594.3	16.6.2006	OLK28d09	0938884	0.0E+00			1.0E-10
594.3 - 596.3	16.6.2006	OLK28d10	1038884	1.5E-11			1.0E-10
596.3 - 598.3	16.6.2006	OLK28d11	1138884	0.0E+00			1.0E-10
598.3 - 600.3	16.6.2006	OLK28d12	1238884	3.3E-10	1.4E-10	2.6E-10	2.3E-10
600.3 - 602.3	16.6.2006	OLK28d13	1338884	0.0E+00			1.0E-10
602.3 - 604.3	16.6.2006	OLK28d14	1438884	0.0E+00			1.0E-10
604.3 - 606.3	16.6.2006	OLK28d15	1538884	0.0E+00			1.0E-10

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
606.3 - 608.3	19.6.2006	OLK28d16	1638887	9.9E-11	5.0E-11	4.6E-11	1.0E-10
608.3 - 610.3	19.6.2006	OLK28d17	1738887	5.2E-11		3.5E-11	1.0E-10
610.3 - 612.3	19.6.2006	OLK28d18	1838887	0.0E+00			1.0E-10
612.3 - 614.3	19.6.2006	OLK28d19	1938887	0.0E+00			1.0E-10
614.3 - 616.3	19.6.2006	OLK28d20	2038887	0.0E+00			1.0E-10
616.3 - 618.3	19.6.2006	OLK28d21	2138887	0.0E+00			1.0E-10
618.3 - 620.3	19.6.2006	OLK28d22	2238887	0.0E+00			1.0E-10
620.3 - 622.3	19.6.2006	OLK28d23	2338887	0.0E+00			1.0E-10
622.3 - 624.3	19.6.2006	OLK28d25	2538887	0.0E+00			1.0E-10
624.3 - 626.3	19.6.2006	OLK28d26	2638887	0.0E+00			1.0E-10
626.3 - 628.3	20.6.2006	OLK28d27	2738888	0.0E+00			1.0E-10
628.3 - 630.3	20.6.2006	OLK28d28	2838888	0.0E+00			1.0E-10
630.3 - 632.3	20.6.2006	OLK28d29	2938888	0.0E+00			1.0E-10
632.3 - 634.3	20.6.2006	OLK28d30	3038888	0.0E+00			1.0E-10
634.3 - 636.3	20.6.2006	OLK28d31	3138888	0.0E+00			1.0E-10
636.3 - 638.3	20.6.2006	OLK28d32	3238888	0.0E+00			1.0E-10
638.3 - 640.3	20.6.2006	OLK28d33	3338888	0.0E+00			1.0E-10
640.3 - 642.3	20.6.2006	OLK28d34	3438888	0.0E+00			1.0E-10
642.3 - 644.3	20.6.2006	OLK28d35	3538888	0.0E+00			1.0E-10
644.3 - 646.3	20.6.2006	OLK28d36	3638888	9.2E-11		5.5E-11	4.5E-10
646.3 - 648.3	20.6.2006	OLK28d37	3738888	1.6E-10		1.0E-10	1.0E-10
648.3 - 650.3	20.6.2006	OLK28d38	3838888	5.1E-11		3.7E-11	1.0E-10

Total 176

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
101.15 - 103.15	27.6.2006	OLK39a01	0138895	5.1E-09			0.0E+00
299.15 - 301.15	27.6.2006	OLK39a02	0238895	3.0E-11		4.0E-11	1.0E-10
301.15 - 303.15	27.6.2006	OLK39a03	0338895	0.0E+00			1.0E-10
303.15 - 305.15	27.6.2006	OLK39a04	0438895	0.0E+00			1.0E-10
305.15 - 307.15	28.6.2006	OLK39a05	0538896	0.0E+00	0.0E+00		1.0E-10
307.15 - 309.15	28.6.2006	OLK39a06	0638896	0.0E+00			1.0E-10
309.15 - 311.15	28.6.2006	OLK39a07	0738896	3.6E-11			1.0E-10
311.15 - 313.15	28.6.2006	OLK39a08	0838896	0.0E+00			0.0E+00
313.15 - 315.15	28.6.2006	OLK39a09	0938896	0.0E+00			1.0E-10
315.15 - 317.15	28.6.2006	OLK39a10	1038896	0.0E+00			1.0E-10
317.15 - 319.15	28.6.2006	OLK39a11	1138896	1.7E-11			1.0E-10
319.15 - 321.15	28.6.2006	OLK39a12	1238896	1.8E-11			1.0E-10
321.15 - 323.15	28.6.2006	OLK39a13	1338896	1.4E-11			1.0E-10
323.15 - 325.15	28.6.2006	OLK39a14	1438896	9.8E-12			1.0E-10
325.15 - 327.15	28.6.2006	OLK39a15	1538896	0.0E+00			1.0E-10
327.15 - 329.15	29.6.2006	OLK39a16	1638897	4.4E-11			1.0E-10
329.15 - 331.15	29.6.2006	OLK39a17	1738897	3.0E-11			1.0E-10
331.15 - 333.15	29.6.2006	OLK39a18	1838897	1.2E-11			1.0E-10
333.15 - 335.15	29.6.2006	OLK39a19	1938897	0.0E+00			1.0E-10
335.15 - 337.15	29.6.2006	OLK39a20	2038897	0.0E+00			1.0E-10
337.15 - 339.15	29.6.2006	OLK39a21	2138897	0.0E+00			1.0E-10
339.15 - 341.15	29.6.2006	OLK39a22	2238897	0.0E+00			1.0E-10
341.15 - 343.15	29.6.2006	OLK39a23	2338897	0.0E+00			1.0E-10
343.15 - 345.15	29.6.2006	OLK39a24	2438897	0.0E+00			1.0E-10

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
345.15 - 347.15	30.6.2006	OLK39a25	2538898	1.6E-11		2.1E-11	2.0E-09
347.15 - 349.15	30.6.2006	OLK39a26	2638898	2.9E-09	9.9E-10	1.6E-09	1.0E-10
349.15 - 351.15	30.6.2006	OLK39a27	2738898	0.0E+00			0.0E+00
351.15 - 353.15	30.6.2006	OLK39a28	2838898	0.0E+00			0.0E+00
353.15 - 355.15	3.7.2006	OLK39a29	2938901	1.0E-10			1.0E-10
355.15 - 357.15	3.7.2006	OLK39a30	3038901	1.1E-11			1.0E-10
357.15 - 359.15	3.7.2006	OLK39a31	3138901	3.2E-11			1.0E-10
359.15 - 361.15	3.7.2006	OLK39a32	3238901	2.2E-11		3.5E-11	1.0E-10
361.15 - 363.15	3.7.2006	OLK39a33	3338901	0.0E+00			1.0E-10
363.15 - 365.15	3.7.2006	OLK39a34	3438901	0.0E+00			1.0E-10
365.15 - 367.15	3.7.2006	OLK39a37	3738901	5.7E-11			1.0E-10
367.15 - 369.15	3.7.2006	OLK39a38	3838901	2.7E-11			1.0E-10
369.15 - 371.15	4.7.2006	OLK39a39	3938902	6.4E-11			1.0E-10
371.15 - 373.15	4.7.2006	OLK39a40	4038902	0.0E+00			1.0E-10
373.15 - 375.15	4.7.2006	OLK39a41	4138902	0.0E+00			1.0E-10
375.15 - 377.15	4.7.2006	OLK39a42	4238902	3.6E-10		3.4E-10	1.0E-10
377.15 - 379.15	4.7.2006	OLK39a43	4338902	3.0E-09	3.0E-09	2.3E-09	2.6E+00
379.15 - 381.15	4.7.2006	OLK39a44	4438902	2.1E-10		8.9E-11	1.0E-10
381.15 - 383.15	4.7.2006	OLK39a45	4538902	7.6E-11		2.9E-11	4.5E-09
383.15 - 385.15	4.7.2006	OLK39a46	4638902	2.8E-09	3.4E-09	2.9E-09	1.0E-10
385.15 - 387.15	4.7.2006	OLK39a48	4838902	0.0E+00			1.0E-10
387.15 - 389.15	5.7.2006	OLK39a49	4938903	0.0E+00			1.0E-10
389.15 - 391.15	5.7.2006	OLK39a50	5038903	0.0E+00			1.0E-10
391.15 - 393.15	5.7.2006	OLK39a51	5138903	2.5E-11			1.0E-10
393.15 - 395.15	5.7.2006	OLK39a52	5238903	0.0E+00			1.0E-10
395.15 - 397.15	5.7.2006	OLK39a53	5338903	0.0E+00			1.0E-10

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
397.15 - 399.15	5.7.2006	OLK39a54	5438903	8.6E-11		2.8E-11	1.1E-09
399.15 - 401.15	5.7.2006	OLK39a55	5538903	6.4E-10	1.1E-09	1.0E-09	1.9E-09
401.15 - 403.15	5.7.2006	OLK39a56	5638903	1.3E-09	1.9E-09	4.1E-09	1.0E-10
403.15 - 405.15	5.7.2006	OLK39a57	5738903	4.4E-10	2.8E-10	5.9E-10	4.8E-09
405.15 - 407.15	5.7.2006	OLK39a58	5838903	2.5E-09	3.7E-09	3.3E-09	1.0E-10
407.15 - 409.15	6.7.2006	OLK39a59	5938904	0.0E+00			1.0E-10
409.15 - 411.15	6.7.2006	OLK39a60	6038904	4.7E-11			1.0E-10
411.15 - 413.15	6.7.2006	OLK39a61	6138904	2.4E-11		3.1E-11	1.0E-10
413.15 - 415.15	6.7.2006	OLK39a62	6238904	0.0E+00			1.0E-10
415.15 - 417.15	6.7.2006	OLK39a63	6338904	1.5E-11			1.0E-10
417.15 - 419.15	6.7.2006	OLK39a64	6438904	4.8E-11		5.5E-11	1.0E-10
419.15 - 421.15	6.7.2006	OLK39a65	6538904	5.0E-11		3.3E-11	1.0E-10
421.15 - 423.15	6.7.2006	OLK39a66	6638904	3.2E-11		7.6E-11	1.0E-10
423.15 - 425.15	7.7.2006	OLK39a67	6738905	6.6E-11			1.0E-10
425.15 - 427.15	7.7.2006	OLK39a68	6838905	0.0E+00			1.0E-10
427.15 - 429.15	7.7.2006	OLK39a69	6938905	3.4E-11		7.2E-11	1.0E-10
429.15 - 431.15	7.7.2006	OLK39a70	7038905	1.1E-11			1.0E-10
431.15 - 433.15	7.7.2006	OLK39a71	7138905	0.0E+00			1.0E-10
433.15 - 435.15	7.7.2006	OLK39a72	7238905	2.2E-11			1.0E-10
435.15 - 437.15	7.7.2006	OLK39a73	7338905	0.0E+00			1.0E-10
437.15 - 439.15	11.7.2006	OLK39a74	7438909	2.9E-11			1.0E-10
439.15 - 441.15	11.7.2006	OLK39a75	7538909	0.0E+00			1.0E-10
441.15 - 443.15	11.7.2006	OLK39a76	7638909	2.8E-11			1.0E-10
443.15 - 445.15	11.7.2006	OLK39a77	7738909	3.8E-11			1.0E-10
445.15 - 447.15	11.7.2006	OLK39a78	7838909	3.3E-11			1.0E-10
447.15 - 449.15	11.7.2006	OLK39a79	7938909	4.8E-11			1.0E-10

Test section [m]	Date	Datafile (.PRO)	Logfile (.EVT)	Moye [m/s]	1/Q [m/s]	Horner [m/s]	Difference Flow Meas. [m/s]
449.15 - 451.15	11.7.2006	OLK39a80	8038909	1.3E-10		1.3E-10	1.0E-10
451.15 - 453.15	11.7.2006	OLK39a81	8138909	3.2E-11		4.4E-11	1.0E-10
453.15 - 455.15	11.7.2006	OLK39a82	8238909	3.2E-11		3.2E-11	1.0E-10
455.15 - 457.15	11.7.2006	OLK39a83	8338909	2.1E-11			1.0E-10
457.15 - 459.15	12.7.2006	OLK39a84	8438910	0.0E+00			1.0E-10
459.15 - 461.15	12.7.2006	OLK39a85	8538910	2.8E-11			1.0E-10
461.15 - 463.15	12.7.2006	OLK39a86	8638910	2.3E-11			1.0E-10
463.15 - 465.15	12.7.2006	OLK39a87	8738910	6.4E-11		5.7E-11	1.0E-10
465.15 - 467.15	12.7.2006	OLK39a88	8838910	0.0E+00			1.0E-10
467.15 - 469.15	12.7.2006	OLK39a89	8938910	0.0E+00			1.0E-10
469.15 - 471.15	12.7.2006	OLK39a90	9038910	0.0E+00			1.0E-10
471.15 - 473.15	12.7.2006	OLK39a91	9138910	0.0E+00			1.0E-10
473.15 - 475.15	12.7.2006	OLK39a92	9238910	2.0E-11			1.0E-10
475.15 - 477.15	12.7.2006	OLK39a93	9338910	0.0E+00			1.0E-10
477.15 - 479.15	12.7.2006	OLK39a94	9438910	2.5E-11			1.0E-10
479.15 - 481.15	12.7.2006	OLK39a95	9538910	0.0E+00			1.0E-10
481.15 - 483.15	12.7.2006	OLK39a96	9638910	0.0E+00			1.0E-10
483.15 - 485.15	13.7.2006	OLK39a97	9738911	8.3E-11			1.0E-10
485.15 - 487.15	13.7.2006	OLK39a98	9838911	0.0E+00			1.0E-10
487.15 - 489.15	13.7.2006	OLK39a99	9938911	0.0E+00			1.0E-10
489.15 - 491.15	13.7.2006	OLK39b01	0138911	0.0E+00			1.0E-10
491.15 - 493.15	13.7.2006	OLK39b02	0238911	0.0E+00			1.0E-10
493.15 - 495.15	13.7.2006	OLK39b03	0338911	0.0E+00			1.0E-10
495.15 - 497.15	13.7.2006	OLK39b04	0438911	0.0E+00			1.0E-10
497.15 - 499.15	13.7.2006	OLK39b05	0538911	0.0E+00			1.0E-10

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Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
298.3	2	OLK28b54	25.5.2006	299	1160	900	
300.3	2	OLK28b55	25.5.2006	300	1169	241	
302.3	2	OLK28b56	25.5.2006	301	750	240	
304.3	2	OLK28b57	25.5.2006	300	750	180	
306.3	2	OLK28b58	26.5.2006	301	720	300	
308.3	2	OLK28b59	26.5.2006	300	1109	481	
310.3	2	OLK28b60	26.5.2006	301	750	299	
312.3	2	OLK28b61	26.5.2006	300	750	300	
314.3	2	OLK28b62	26.5.2006	300	750	300	
316.3	2	OLK28b63	26.5.2006	300	1021	300	
318.3	2	OLK28b64	26.5.2006	300	751	420	
320.3	2	OLK28b65	26.5.2006	300	1179	301	
322.3	2	OLK28b66	26.5.2006	300	1090	900	
324.3	2	OLK28b67	26.5.2006	300	1290	300	
326.3	2	OLK28b68	26.5.2006	300	840	300	
328.3	2	OLK28b69	26.5.2006	300	840	300	
330.3	2	OLK28b70	27.5.2006	300	750	300	
332.3	2	OLK28b71	27.5.2006	301	1370	300	
334.3	2	OLK28b72	27.5.2006	300	1499	601	
336.3	2	OLK28b73	27.5.2006	300	1270	909	
338.3	2	OLK28b74	27.5.2006	299	751	299	
340.3	2	OLK28b75	27.5.2006	299	770	300	
342.3	2	OLK28b76	27.5.2006	301	759	300	
344.3	2	OLK28b77	27.5.2006	299	750	300	
346.3	2	OLK28b78	27.5.2006	300	1449	301	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
348.3	2	OLK28b79	27.5.2006	300	750	299	
350.3	2	OLK28b80	27.5.2006	300	750	119	
352.3	2	OLK28b81	27.5.2006	300	740	240	
354.3	2	OLK28b82	29.5.2006	299	771	300	
356.3	2	OLK28b83	29.5.2006	301	530	315	
358.3	2	OLK28b84	29.5.2006	300	2690	3000	
360.3	2	OLK28b85	29.5.2006	300	1280	900	
362.3	2	OLK28b86	29.5.2006	301	1459	901	
364.3	2	OLK28b87	29.5.2006	299	1531	899	
366.3	2	OLK28b88	29.5.2006	300	750	300	
368.3	2	OLK28b89	29.5.2006	300	1690	899	
370.3	2	OLK28b90	30.5.2006	300	1270	900	
372.3	2	OLK28b91	30.5.2006	359	1202	901	
374.3	2	OLK28b92	30.5.2006	300	1311	600	
376.3	2	OLK28b93	30.5.2006	299	2761	3000	
378.3	2	OLK28b94	30.5.2006	299	1551	599	
380.3	2	OLK28b95	31.5.2006	299	1200	361	
382.3	2	OLK28b96	31.5.2006	301	1320	900	
384.3	2	OLK28b97	31.5.2006	300	1250	899	
386.3	2	OLK28b98	31.5.2006	301	1500	360	Warning: 85.5 mm void at 389.65 m depth, damage risk for lower packer.
388.3	2	OLK28b99	31.5.2006	300	1201	779	Warning: 85.5 mm void at 389.65 m depth, damage risk for upper packer.
390.3	2	OLK28c01	31.5.2006	299	2100	541	Warning: 85.5 mm void at 389.65 m depth, damage risk for upper packer.
392.3	2	OLK28c02	31.5.2006	301	1050	240	
394.3	2	OLK28c03	31.5.2006	300	560	239	
396.3	2	OLK28c04	31.5.2006	300	779	301	
398.3	2	OLK28c05	31.5.2006	299	781	300	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
400.3	2	OLK28c06	1.6.2006	299	750	301	
402.3	2	OLK28c07	1.6.2006	299	751	300	
404.3	2	OLK28c08	1.6.2006	299	1351	899	
406.3	2	OLK28c09	1.6.2006	300	1240	900	
408.3	2	OLK28c10	1.6.2006	299	780	301	
410.3	2	OLK28c11	1.6.2006	300	780	300	
412.3	2	OLK28c12	1.6.2006	300	1590	900	
414.3	2	OLK28c13	1.6.2006	300	1360	300	
416.3	2	OLK28c14	1.6.2006	300	790	300	
418.3	2	OLK28c15	1.6.2006	300	750	300	
420.3	2	OLK28c16	1.6.2006	300	1220	900	
422.3	2	OLK28c17	2.6.2006	300	1280	899	
424.3	2	OLK28c18	2.6.2006	300	1299	301	
426.3	2	OLK28c19	2.6.2006	300	749	301	
428.3	2	OLK28c20	2.6.2006	300	1350	900	
430.3	2	OLK28c21	2.6.2006	301	1360	900	
432.3	2	OLK28c22	2.6.2006	300	1110	299	
434.3	2	OLK28c23	2.6.2006	299	781	300	
436.3	2	OLK28c24	2.6.2006	300	750	300	
438.3	2	OLK28c25	2.6.2006	301	750	299	
440.3	2	OLK28c26	2.6.2006	299	900	900	
442.3	2	OLK28c27	6.6.2006	299	1260	899	
444.3	2	OLK28c28	6.6.2006	299	2101	240	
446.3	2	OLK28c29	6.6.2006	301	1799	300	
448.3	2	OLK28c30	6.6.2006	301	1349	901	
450.3	2	OLK28c31	6.6.2006	300	1239	900	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
452.3	2	OLK28c32	6.6.2006	310	1391	900	
454.3	2	OLK28c33	6.6.2006	300	750	300	
456.3	2	OLK28c34	6.6.2006	300	749	301	
458.3	2	OLK28c35	6.6.2006	301	790	300	
460.3	2	OLK28c36	6.6.2006	301	780	300	
462.3	2	OLK28c37	6.6.2006	299	751	300	
464.3	2	OLK28c38	6.6.2006	309	751	120	
466.3	2	OLK28c39	6.6.2006	299	750	301	
468.3	2	OLK28c40	7.6.2006	300	1569	300	
470.3	2	OLK28c41	7.6.2006	300	749	300	
472.3	2	OLK28c42	7.6.2006	300	769	300	
474.3	2	OLK28c43	7.6.2006	299	751	299	
476.3	2	OLK28c44	7.6.2006	300	750	300	
478.3	2	OLK28c45	7.6.2006	299	761	300	
480.3	2	OLK28c46	7.6.2006	300	1050	299	
482.3	2	OLK28c47	7.6.2006	309	750	300	
484.3	2	OLK28c48	7.6.2006	300	751	300	
486.3	2	OLK28c49	7.6.2006	299	761	300	
488.3	2	OLK28c50	7.6.2006	300	750	299	
490.3	2	OLK28c51	7.6.2006	300	759	300	
492.3	2	OLK28c52	7.6.2006	300	780	299	
494.3	2	OLK28c53	8.6.2006	299	761	299	
496.3	2	OLK28c54	8.6.2006	301	749	300	
498.3	2	OLK28c55	8.6.2006	301	750	300	
500.3	2	OLK28c56	8.6.2006	309	751	300	
502.3	2	OLK28c57	8.6.2006	300	750	300	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
504.3	2	OLK28c58	8.6.2006	299	790	301	
506.3	2	OLK28c59	8.6.2006	300	750	300	
508.3	2	OLK28c60	8.6.2006	300	780	299	
510.3	2	OLK28c61	8.6.2006	299	781	300	
512.3	2	OLK28c62	8.6.2006	299	1202	434	
514.3	2	OLK28c63	8.6.2006	300	749	301	
516.3	2	OLK28c64	8.6.2006	301	789	301	
518.3	2	OLK28c65	8.6.2006	300	780	310	
520.3	2	OLK28c66	9.6.2006	301	1800	900	
522.3	2	OLK28c69	12.6.2006	300	1800	1199	
522.3	2	OLK28c68	9.6.2006	299	1031	-1E+0	
522.3	2	OLK28c67	9.6.2006	300	1731	-1E+0	
524.3	2	OLK28c70	12.6.2006	300	1200	900	
526.3	2	OLK28c71	13.6.2006	309	1200	900	
528.3	2	OLK28c72	13.6.2006	299	1241	910	
530.3	2	OLK28c73	13.6.2006	300	1259	901	
532.3	2	OLK28c74	13.6.2006	299	1751	299	
534.3	2	OLK28c75	13.6.2006	300	760	300	
536.3	2	OLK28c76	13.6.2006	299	750	301	
538.3	2	OLK28c77	13.6.2006	301	749	300	
540.3	2	OLK28c78	13.6.2006	300	750	300	
542.3	2	OLK28c79	13.6.2006	301	359	-1E+0	
542.3	2	OLK28c80	13.6.2006	299	1271	900	
544.3	2	OLK28c81	13.6.2006	300	1200	901	
546.3	2	OLK28c82	14.6.2006	301	1530	910	
548.3	2	OLK28c83	14.6.2006	-1E+0	-1E+0	-1E+0	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
548.3	2	OLK28c84	14.6.2006	300	1259	901	
550.3	2	OLK28c85	14.6.2006	300	1270	900	
552.3	2	OLK28c86	14.6.2006	300	1279	301	
554.3	2	OLK28c87	14.6.2006	300	760	299	
556.3	2	OLK28c88	14.6.2006	299	780	300	
558.3	2	OLK28c89	14.6.2006	301	750	300	
560.3	2	OLK28c90	14.6.2006	310	760	300	
562.3	2	OLK28c91	14.6.2006	300	760	301	
564.3	2	OLK28c92	14.6.2006	300	780	300	
566.3	2	OLK28c93	14.6.2006	311	1289	900	
568.3	2	OLK28c94	14.6.2006	301	559	-1E+0	
568.3	2	OLK28c95	14.6.2006	299	-1E+0	-1E+0	
568.3	2	OLK28c96	15.6.2006	300	1199	901	
570.3	2	OLK28c97	15.6.2006	309	820	301	
572.3	2	OLK28c98	15.6.2006	301	760	299	
574.3	2	OLK28c99	15.6.2006	300	749	301	
576.3	2	OLK28d01	15.6.2006	301	1200	300	
578.3	2	OLK28d02	15.6.2006	300	750	300	
580.3	2	OLK28d03	15.6.2006	300	760	299	
582.3	2	OLK28d04	15.6.2006	300	1591	300	
584.3	2	OLK28d05	15.6.2006	300	750	300	
586.3	2	OLK28d06	15.6.2006	301	759	301	
588.3	2	OLK28d07	15.6.2006	300	1550	300	
590.3	2	OLK28d08	16.6.2006	301	1469	300	
592.3	2	OLK28d09	16.6.2006	310	1320	299	
594.3	2	OLK28d10	16.6.2006	309	751	299	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
596.3	2	OLK28d11	16.6.2006	300	789	301	
598.3	2	OLK28d12	16.6.2006	300	1290	899	
600.3	2	OLK28d13	16.6.2006	300	790	300	
602.3	2	OLK28d14	16.6.2006	299	780	300	
604.3	2	OLK28d15	16.6.2006	300	749	301	
606.3	2	OLK28d16	19.6.2006	301	1290	899	
608.3	2	OLK28d17	19.6.2006	300	1330	900	
610.3	2	OLK28d18	19.6.2006	301	760	300	
612.3	2	OLK28d19	19.6.2006	300	750	300	
614.3	2	OLK28d20	19.6.2006	310	749	301	
616.3	2	OLK28d21	19.6.2006	301	1689	301	
618.3	2	OLK28d22	19.6.2006	299	750	300	
620.3	2	OLK28d23	19.6.2006	299	790	301	
622.3	2	OLK28d24	19.6.2006	-1E+0	-1E+0	-1E+0	
622.3	2	OLK28d25	19.6.2006	300	760	300	
624.3	2	OLK28d26	19.6.2006	301	1300	240	
626.3	2	OLK28d27	20.6.2006	300	1290	519	
628.3	2	OLK28d28	20.6.2006	299	752	299	
630.3	2	OLK28d29	20.6.2006	301	1759	300	
632.3	2	OLK28d30	20.6.2006	299	791	300	
634.3	2	OLK28d31	20.6.2006	300	749	300	
636.3	2	OLK28d32	20.6.2006	300	749	300	
638.3	2	OLK28d33	20.6.2006	300	749	240	
640.3	2	OLK28d34	20.6.2006	300	750	300	
642.3	2	OLK28d35	20.6.2006	300	750	300	
644.3	2	OLK28d36	20.6.2006	300	1250	900	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
646.3	2	OLK28d37	20.6.2006	310	1290	899	
648.3	2	OLK28d38	20.6.2006	300	1330	900	

Total 183

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
101.15	2	OLK39a01	27.6.2006	299	1200	901	System test
299.15	2	OLK39a02	27.6.2006	299	1570	901	
301.15	2	OLK39a03	27.6.2006	301	850	300	
303.15	2	OLK39a04	27.6.2006	301	1150	300	
305.15	2	OLK39a05	28.6.2006	299	1301	660	
307.15	2	OLK39a06	28.6.2006	300	890	300	
309.15	2	OLK39a07	28.6.2006	299	1291	540	
311.15	2	OLK39a08	28.6.2006	301	1649	300	
313.15	2	OLK39a09	28.6.2006	300	1280	421	
315.15	2	OLK39a10	28.6.2006	300	751	299	
317.15	2	OLK39a11	28.6.2006	300	750	300	Warning: 95.6 mm void at 318.55 m depth, damage risk for lower packer
319.15	2	OLK39a12	28.6.2006	300	1191	300	Warning: 95.6 mm void at 318.55 m depth, damage risk for upper packer
321.15	2	OLK39a13	28.6.2006	300	760	300	
323.15	2	OLK39a14	28.6.2006	300	1590	310	
325.15	2	OLK39a15	28.6.2006	299	671	300	
327.15	2	OLK39a16	29.6.2006	301	1659	301	
329.15	2	OLK39a17	29.6.2006	301	1379	421	
331.15	2	OLK39a18	29.6.2006	300	1570	359	
333.15	2	OLK39a19	29.6.2006	300	749	240	
335.15	2	OLK39a20	29.6.2006	300	760	300	
337.15	2	OLK39a21	29.6.2006	300	750	301	
339.15	2	OLK39a22	29.6.2006	309	1160	300	
341.15	2	OLK39a23	29.6.2006	309	1300	301	
343.15	2	OLK39a24	29.6.2006	301	840	299	
345.15	2	OLK39a25	30.6.2006	309	1731	900	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
347.15	2	OLK39a26	30.6.2006	300	1199	900	
349.15	2	OLK39a27	30.6.2006	311	1300	300	
351.15	2	OLK39a28	30.6.2006	299	1251	299	
353.15	2	OLK39a29	3.7.2006	299	741	330	
355.15	2	OLK39a30	3.7.2006	301	790	300	
357.15	2	OLK39a31	3.7.2006	299	1370	300	
359.15	2	OLK39a32	3.7.2006	301	1510	899	
361.15	2	OLK39a33	3.7.2006	299	1290	301	
363.15	2	OLK39a34	3.7.2006	300	790	300	
365.15	2	OLK39a35	3.7.2006	300	-1E+0	-1E+0	
365.15	2	OLK39a37	3.7.2006	301	1319	480	
367.15	2	OLK39a38	3.7.2006	299	1241	479	
369.15	2	OLK39a39	4.7.2006	300	1019	301	
371.15	2	OLK39a40	4.7.2006	301	770	300	
373.15	2	OLK39a41	4.7.2006	300	781	299	
375.15	2	OLK39a42	4.7.2006	300	1250	900	
377.15	2	OLK39a43	4.7.2006	300	1201	909	
379.15	2	OLK39a44	4.7.2006	300	1270	899	
381.15	2	OLK39a45	4.7.2006	300	1279	901	
383.15	2	OLK39a46	4.7.2006	300	1200	900	
385.15	2	OLK39a47	4.7.2006	300	670	-1E+0	Warning: 95.7 mm void at 387.19 m depth, damage risk for lower packer.
385.15	2	OLK39a48	4.7.2006	299	880	301	Warning: 95.7 mm void at 387.19 m depth, damage risk for lower packer
387.15	2	OLK39a49	5.7.2006	301	659	300	Warning: 95.7 mm void at 387.19 m depth, damage risk for upper packer
389.15	2	OLK39a50	5.7.2006	300	770	299	
391.15	2	OLK39a51	5.7.2006	299	781	300	
393.15	2	OLK39a52	5.7.2006	299	781	299	

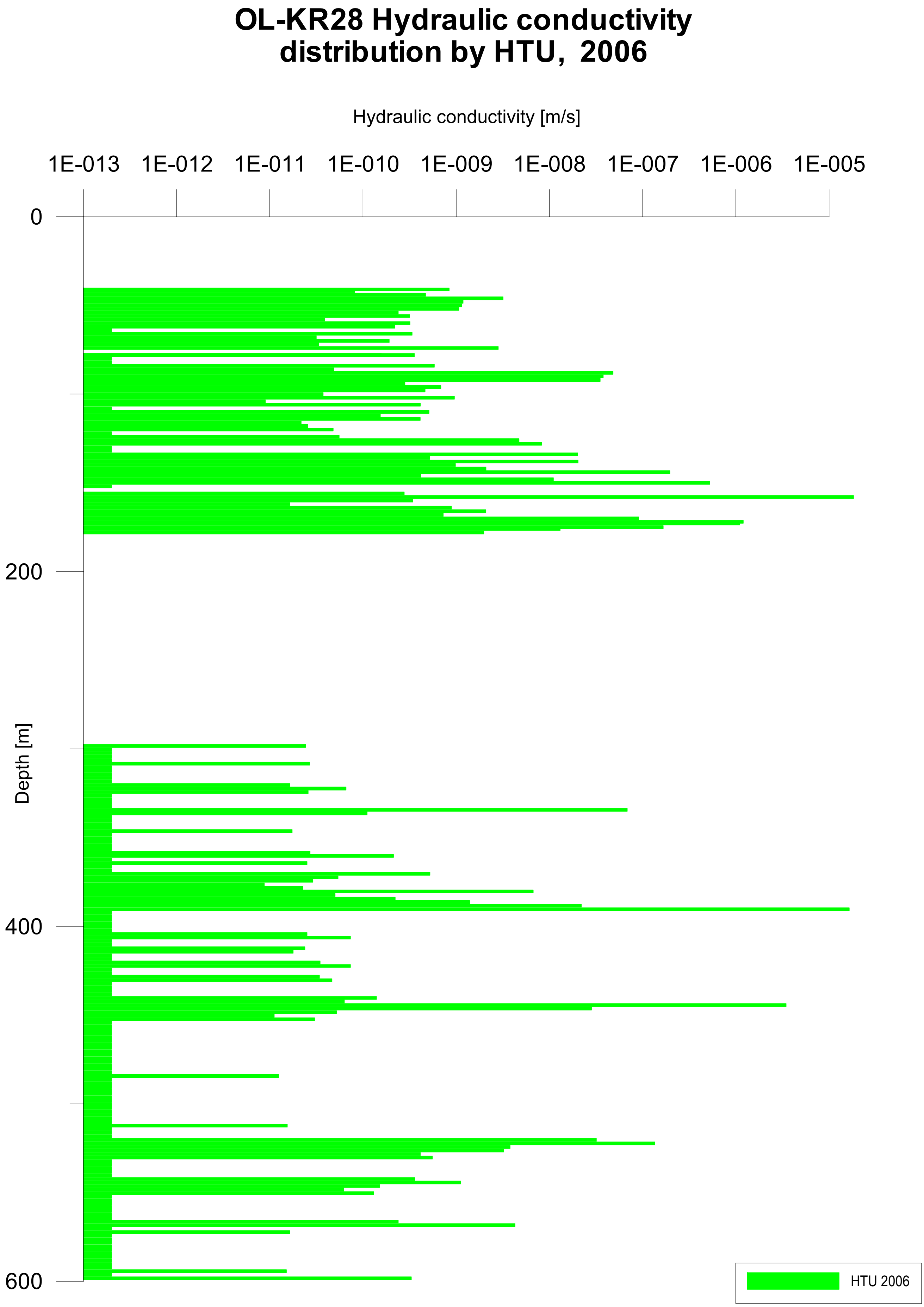
Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
395.15	2	OLK39a53	5.7.2006	300	1081	300	
397.15	2	OLK39a54	5.7.2006	300	1330	900	
399.15	2	OLK39a55	5.7.2006	301	1199	901	
401.15	2	OLK39a56	5.7.2006	300	1210	899	
403.15	2	OLK39a57	5.7.2006	301	1259	901	
405.15	2	OLK39a58	5.7.2006	300	1199	901	
407.15	2	OLK39a59	6.7.2006	301	1330	379	
409.15	2	OLK39a60	6.7.2006	310	1361	299	
411.15	2	OLK39a61	6.7.2006	301	1530	900	
413.15	2	OLK39a62	6.7.2006	300	759	301	
415.15	2	OLK39a63	6.7.2006	301	770	300	Warning: 84.5 mm void at 418.1 m depth, damage risk for lower packer
417.15	2	OLK39a64	6.7.2006	300	1319	900	Warning: 84.5 mm void at 418.1 m depth, damage risk for upper packer
419.15	2	OLK39a65	6.7.2006	300	1350	900	Warning: 84.5 mm void at 418.1 m depth, damage risk for upper packer
421.15	2	OLK39a66	6.7.2006	300	1510	900	
423.15	2	OLK39a67	7.7.2006	300	1319	301	
425.15	2	OLK39a68	7.7.2006	301	779	300	
427.15	2	OLK39a69	7.7.2006	300	1369	900	
429.15	2	OLK39a70	7.7.2006	301	1670	299	
431.15	2	OLK39a71	7.7.2006	301	810	300	
433.15	2	OLK39a72	7.7.2006	301	1559	910	
435.15	2	OLK39a73	7.7.2006	311	1270	299	
437.15	2	OLK39a74	11.7.2006	300	1730	300	
439.15	2	OLK39a75	11.7.2006	300	1511	899	
441.15	2	OLK39a76	11.7.2006	309	751	300	
443.15	2	OLK39a77	11.7.2006	300	1250	480	
445.15	2	OLK39a78	11.7.2006	299	1371	300	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments
447.15	2	OLK39a79	11.7.2006	300	1309	900	
449.15	2	OLK39a80	11.7.2006	299	1291	899	
451.15	2	OLK39a81	11.7.2006	301	1290	900	
453.15	2	OLK39a82	11.7.2006	301	1170	899	
455.15	2	OLK39a83	11.7.2006	300	1490	300	
457.15	2	OLK39a84	12.7.2006	301	1290	540	
459.15	2	OLK39a85	12.7.2006	299	1501	359	
461.15	2	OLK39a86	12.7.2006	300	1430	420	
463.15	2	OLK39a87	12.7.2006	299	1301	900	
465.15	2	OLK39a88	12.7.2006	299	1311	310	
467.15	2	OLK39a89	12.7.2006	311	750	300	
469.15	2	OLK39a90	12.7.2006	299	781	300	
471.15	2	OLK39a91	12.7.2006	299	791	299	
473.15	2	OLK39a92	12.7.2006	300	1561	300	
475.15	2	OLK39a93	12.7.2006	299	781	299	
477.15	2	OLK39a94	12.7.2006	299	1481	300	Warning: 95.9 mm void at 478.89 m depth, damage risk for lower packer
479.15	2	OLK39a95	12.7.2006	301	780	300	Warning: 95.9 mm void at 478.89 m depth, damage risk for upper packer
481.15	2	OLK39a96	12.7.2006	300	780	299	
483.15	2	OLK39a97	13.7.2006	301	849	300	
485.15	2	OLK39a98	13.7.2006	300	1059	301	
487.15	2	OLK39a99	13.7.2006	300	1111	299	
489.15	2	OLK39b01	13.7.2006	301	1609	901	
491.15	2	OLK39b02	13.7.2006	300	891	299	
493.15	2	OLK39b03	13.7.2006	300	1310	300	
495.15	2	OLK39b04	13.7.2006	301	779	300	
497.15	2	OLK39b05	13.7.2006	300	890	299	

Depth [m]	Section [m]	Datafile (,PRO)	Date	Stab. [s]	Injection [s]	Fall-Off [s]	Comments

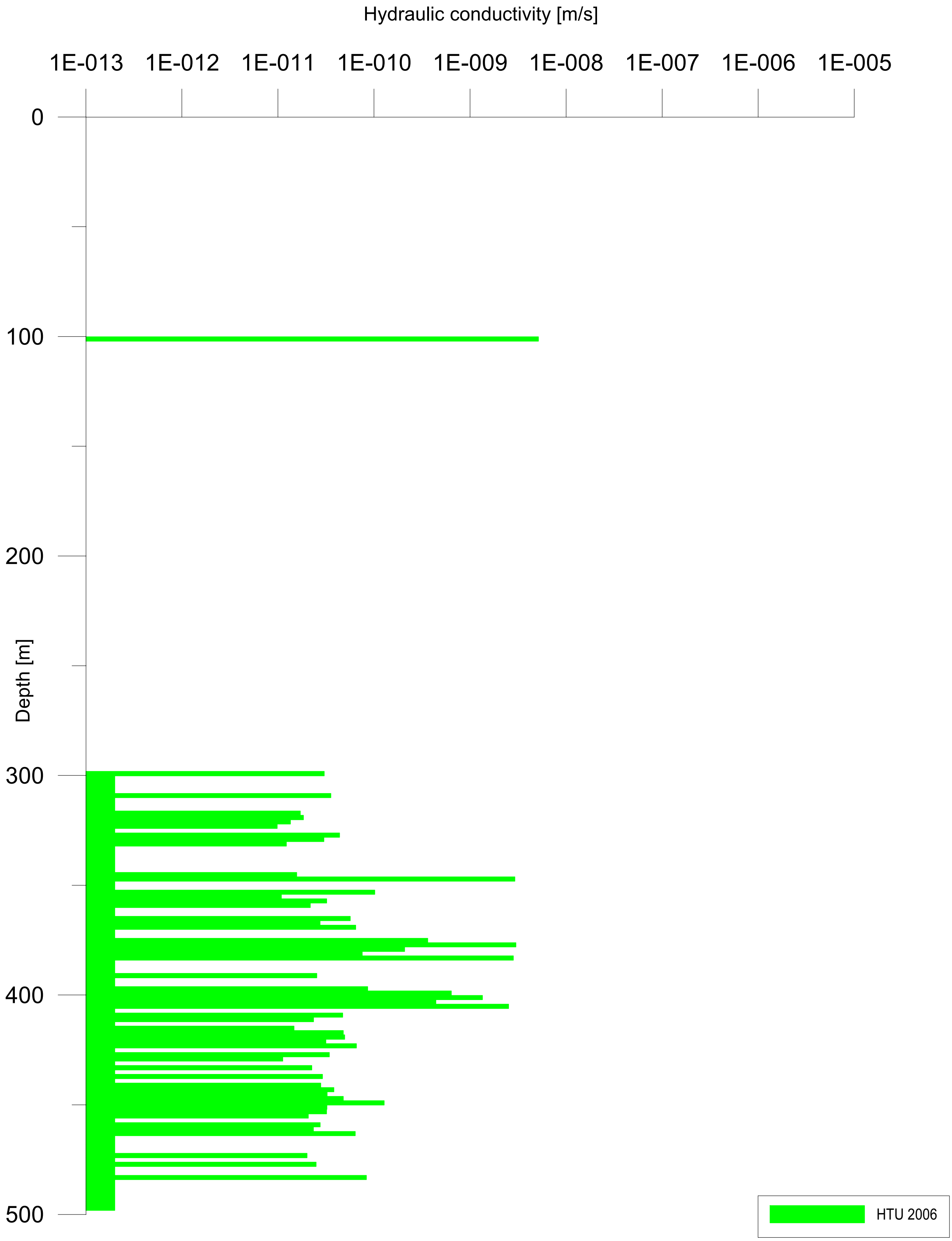
Total 103

Appendix 2


OL-KR28 Hydraulic conductivity
distribution by HTU, 2006
Hydraulic conductivity [m/s]
1E-013
1E-012
1E-011
1E-010
1E-009
1E-008
1E-007
1E-006
1E-005
0
200
400
600
Depth [m]
HTU 2006

Appendix 2

OL-KR39 Hydraulic conductivity distribution by HTU, 2006



Appendix 3

Summary of fracture depth checks

Model date: **9.12.1998**
Data updated: **22.9.2005**

Cable correction Kk = Aa+Bb*x+Cc*(Ln(x)-Dd)+Ee*x/(x-Ff)^2 x = syvyys (m)
Tension correction Vk = Gg*x*(t+Hh) t = cable tension (kp)
Cable length for a certain depth using the refrence point in the trailer
Cable length = depth-tool constant+casing length+reference height-(Kk+Vk)

Cablemodel 1298 coefficients

Cable correction
Aa= -12.095878
Bb= -0.003778
Cc= 2.077621
Dd= -0.438742
Ee= 259.025034
Ff= -13.410853

Comments
- Shaded tensions interpolated
- At depths below 100 m always 0 m
- Negative lenght change is cable shrinkage
-HH-KR1 strongly curved, initial inclination is 60 and final inclination 40 degrees

Tension correction 10m/56mm packers: Gg= 0.000027, Hh= -46.363869
Tension correction 2m/56mm packers: Gg= 0.000025, Hh= -55.211441

Tension correction 10m/76mm packers: Gg= 0.000027, Hh= -46.363869
Tension correction 2m/76mm packers: Gg= 0.000025, Hh= -55.211441

Hole	Packer-set (mm)	Initial inclinat. (degree)	Cable tension (kp)	Correct depth source	Correct depth (m)	Corrected HTU-depth (m)	HTU-depth without corrections	Cable correction (m)	Tension correction (m)	Indicated depth chg. (m)	Depth error after corrections (m)
OL-KR2	2/56	76	*35*		49.55	49.50	49.59	-0.02	-0.02	-0.04	0.01
HH-KR2	10/56	75	50	PRG	86.40	86.55	86.17	0.00	0.01	0.23	0.22
OL-KR2	2/56	76	*51*		86.70	86.96	86.96	0.00	-0.01	-0.26	-0.25
OL-KR2	2/56	76	*36*	HA	86.60	86.67	86.63	0.00	-0.04	-0.03	0.01
RO-KR10	2/76	90	*55*		133.90	134.40	134.00	0.08	0.00	-0.10	-0.18
OL-KR4	2/56	77	*54*		141.52	141.87	141.41	0.10	0.00	0.11	0.02
HH-KR2	10/56	75	54	PRG	145.60	146.85	145.27	0.11	0.03	0.33	0.19
HH-KR6	10/76	90	60	PRG	198.90	198.55	198.28	0.20	0.07	0.62	0.34
HH-KR6	2/76	90	54	PRG	198.90	198.68	198.42	0.20	-0.01	0.48	0.28
KI-KR11	2/56	70	55	HA	216.28	216.40	215.65	0.23	0.00	0.63	0.40
HH-KR2	2/56	75	58	HA	221.30	221.35	221.14	0.24	0.02	0.16	-0.09
HH-KR2	10/56	75	74	HA	226.25	227.37	225.72	0.25	0.17	0.53	0.12
OL-KR2	2/56	76	*74*		236.70	235.63	234.87	0.26	0.11	1.83	1.46
HH-KR6	2/76	90	58	PRG	238.90	238.87	238.59	0.26	0.02	0.31	0.03
HH-KR2	10/56	75	74	HA	286.75	287.12	285.88	0.31	0.21	0.87	0.35
HH-KR2	2/56	75	68	HA	286.75	285.15	284.94	0.31	0.09	1.81	1.41
OL-KR4	2/56	77	*78*		307.25	307.93	307.28	0.33	0.17	-0.03	-0.53
HH-KR6	2/76	90	64	PRG	309.60	309.42	309.02	0.33	0.07	0.58	0.18
HH-KR6	2/76	90	64	PRG	309.60	309.56	309.16	0.33	0.07	0.44	0.04
OL-KR10	2/76	90	*80*		325.70	326.65	326.06	0.34	0.20	-0.36	-0.90
HH-KR2	10/56	75	80	PRG	347.80	347.88	347.22	0.35	0.31	0.58	-0.08
OL-KR10	2/76	90	*82*		367.80	366.90	366.50	0.36	0.24	1.30	0.70
HH-KR3	2/56	69	72	HA	377.00	375.60	376.27	0.36	0.16	0.73	0.22
KI-KR12	2/56	65	48	HA	386.30	386.14	385.84	0.36	-0.07	0.46	0.17
HH-KR2	10/56	75	90	HA	401.70	401.12	401.20	0.36	0.47	0.50	-0.33
HH-KR2	2/56	75	80	HA	401.70	401.37	401.52	0.36	0.25	0.18	-0.42
HH-KR3	2/56	69	70	PRG	402.10	400.50	401.46	0.36	0.15	0.64	0.13
HH-KR6	2/76	90	74	PRG	431.60	431.62	431.06	0.36	0.20	0.54	-0.02
RO-KR10	2/76	90	*90*		437.35	436.65	436.66	0.35	0.38	0.69	-0.04
HH-KR6	10/76	90	80	PRG	438.25	438.35	437.60	0.35	0.39	0.65	-0.10
KI-KR11	2/56	70	70	TH	444.02	443.71	443.77	0.35	0.16	0.25	-0.27
HH-KR2	2/56	75	76	HA	453.05	451.90	452.76	0.35	0.23	0.29	-0.29
HH-KR4	10/56	70	70	PRG	471.90	468.25	470.89	0.34	0.30	1.01	0.37
OL-KR12	2/56	70	70	PRG	506.10	506.03	505.54	0.33	0.18	0.56	0.05
HH-KR1	2/56	52	52	HA	521.90	520.81	521.46	0.32	-0.04	0.44	0.16
HH-KR4	2/56	70	78	PRG	527.10	526.87	526.26	0.31	0.30	0.84	0.23
OL-KR12	2/56	70	74	PRG	536.10	535.93	535.37	0.31	0.25	0.73	0.17

Hole	Packer-set (mm)	Initial inclinat. (degree)	Cable tension (kp)	Correct depth source	Correct depth (m)	Corrected HTU-depth (m)	HTU-depth without corrections	Cable correction (m)	Tension correction (m)	Indicated depth chg. (m)	Depth error after corrections (m)
RO-KR11	2/56	70	72	HA	541.95	540.99	541.81	0.30	0.22	0.14	-0.39
HH-KR4	2/56	70	80	PRG	553.70	553.62	552.98	0.29	0.34	0.72	0.09
OL-KR12	2/56	70	74	PRG	555.30	555.32	554.77	0.29	0.26	0.53	-0.02
HH-KR2	10/56	75	96	HA	555.40	553.62	555.73	0.29	0.73	-0.33	-1.36
HH-KR2	2/56	75	90	HA	558.90	556.62	557.71	0.29	0.48	1.19	0.42
HH-KR2	2/56	75	90	HA	565.10	562.82	563.97	0.28	0.49	1.13	0.36
RO-KR10	2/76	90	*92*	TH	566.20	564.30	565.33	0.28	0.51	0.87	0.07
OL-KR12	2/56	70	74	PRG	571.80	571.72	571.17	0.28	0.27	0.63	0.09
KI-KR12	2/56	65	62	HA	577.88	575.56	576.70	0.27	0.10	1.18	0.81
OL-KR12	2/56	70	74	PRG	581.50	581.51	580.97	0.27	0.27	0.53	-0.01
HH-KR5	2/56	70	84	SMOY	592.51	592.57	591.88	0.26	0.42	0.63	-0.05
HH-KR5	2/56	70	88	SMOY	621.91	622.06	621.32	0.23	0.50	0.59	-0.14
HH-KR2	10/56	75	104	HA	658.30	653.52	657.23	0.19	1.01	1.07	-0.13
HH-KR2	2/56	75	98	HA	658.30	656.12	657.65	0.19	0.70	0.65	-0.24
HH-KR1	2/56	50	60	HA	658.30	655.90	657.45	0.19	0.08	0.85	0.58
HH-KR4	10/56	70	96	HA	686.60	682.75	685.31	0.16	0.91	1.29	0.23
HH-KR2	2/56	75	76	HA	700.60	700.60	700.10	0.14	0.36	0.50	0.00
HH-KR4	2/56	70	80	PRG	708.50	708.62	708.05	0.13	0.43	0.45	-0.11
OL-KR12	2/56	70	78	PRG	729.00	729.06	728.55	0.10	0.41	0.45	-0.06
KI-KR12	2/56	65	72	TH	755.30	752.68	755.61	0.06	0.31	-0.31	-0.69
KI-KR12	2/56	65	70	TH	759.00	760.10	763.07	0.06	0.28	-4.07	-4.40
HH-KR1	2/56	45	66	HA	779.70	778.10	781.30	0.03	0.21	-1.60	-1.83
HH-KR2	10/56	75	114	HA	795.85	788.70	794.68	0.00	1.43	1.17	-0.26
HH-KR2	2/56	75	104	HA	795.85	792.00	794.54	0.00	0.96	1.31	0.35
HH-KR2	10/56	75	114	HA	853.50	844.75	851.78	-0.09	1.54	1.72	0.28
HH-KR2	2/56	75	110	HA	853.50	849.55	852.07	-0.09	1.16	1.43	0.37
OL-KR4	2/56	77	*60*		864.37	859.80	863.96	-0.11	0.10	0.41	0.42
HH-KR4	10/56	70	108	PRG	886.90	882.75	885.96	-0.15	1.45	0.94	-0.37