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Oskarshamn site investigation

Difference flow measurements in borehole KSH02 at Simpevarp

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PRG-Tec Oy

December 2003

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Keywords: Simpevarp, hydrogeology, bedrock, borehole, groundwater, flow, hydraulic tests, flow log, hydraulic parameters, transmissivity, Posiva Flow Log.

Abstract

Posiva Flow Log/Difference Flow method can be used for relatively fast determination of hydraulic conductivity and hydraulic head in fractures or fractured zones in cored boreholes. This report presents the principles of the method as well as the results of the measurements carried out in borehole KSH02 at Simpevarp in July 2003.

The main aim of the measurements presented in this report was to determine the depth and flow rate of flowing fractures in borehole KSH02.

The measurements in borehole KSH02 were carried out between the depths of 80 m and 1000 m; the flow rate into or out from a 5 m long test section was measured. This was done both without pumping the borehole and with pumping it. Flow logging was repeated at the location of the detected flow anomalies using 1 m section length and 0.1 m point intervals.

Depth calibration was made based on the known depth marks in the borehole. The depth marks were detected by Caliper measurements and by Single point resistance measurements. These two sensors are connected to the flowmeter electronics.

Electric conductivity (EC) of borehole water was also measured. EC measurement was used to study the occurrence of saline water in the borehole when the borehole was in natural condition (not pumped) and when it was pumped. Fracture specific EC was also measured from certain selected fractures.

The downhole tool also includes an absolute pressure sensor. It is used for determination of hydrostatic pressure in the open borehole.

Sammanfattning

Föreliggande rapport presenterar resultat ifrån genomförda mätningar med Posiva Flow Log/Difference Flow i borrhål KSH02. Mätningarna utfördes med syftet att identifiera inflöden längs borrhålet. Dessa utfördes dels utan att pumpa i borrhålet i 5 m sektioner och 5 m steglängd (sekventiell mätning) och dels med pumpning i borrhålet med 5 m sektion och 0.5 steglängd samt 1 m sektion och 0.1 m steglängd (överlappande mätning). Både termisk puls och termisk utspädning användes som mätprinciper i den sekventiella mätningen. I den överlappande mätningen användes endast termisk utspädning.

Dessutom gjordes mätningar av absoluttryck, elektrisk konduktivitet och temperatur av borrhålsvattnet samt för valda sprickor även av sprickspecifik elektrisk konduktivitet.

Längdposition längs med borrhålet kalibrerades mot referensspår vilka detekterats med kaliper instrument och SPR (singel point resistance) vilka mättes samtidigt.

Slutligen beräknades hydraulisk konduktivitet (K) och naturlig trycknivå (h_i) för 5 m sektionerna.

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1 Introduction

A general program for site investigations presenting survey methods has been prepared /SKB, 2001a/, as well as a site-specific program for the investigations in the Simpevarp area /SKB, 2001b/. The difference flow measurements forms part of the site characterization program under item 1.1.5.7 in the work breakdown structure of the execution programme /SKB, 2002a/.

Measurements were carried out according in borehole KSH02 during July 7–22, 2003 following the methodology described in SKB MD 322.010 and in the activity plan AP PS 400-03-33 (SKB internal controlling document). Data and results were delivered to the SKB site characterization database SICADA with field note numbers Simpevarp 123.

The borehole is situated at the Simpevarp site near Oskarshamn. It is sub-vertical c 85.4° from the horizontal, drilled to a depth of c 1003 m and cased to c 80 m depth. The borehole diameter is 76 mm in the interval 80–1003 m. The location is shown in Figure 1-1.

The work carried out in borehole KSH02 is defined in Table 5-1. The main purpose of the difference flow logging is is to hydrogeologicaly characterise the borehole with regard to

- identification of water-conductive sections/fractures along the hole,
- determine hydraulic conductivity at 5 m scale along the borehole,
- determine conductive fracture frequency along the borehole.

Besides the difference flow logging, the measuring program also includes associated measurements for a better understanding of the overall hydrogeochemical borehole dynamics, e.g. measurements of electric conductivity and temperature of the borehole fluid as well as single-point resistance of the borehole wall. Furthermore, a number of fracture specific electrical conductivities were measured and also drawdown of groundwater level and its recovery were continuously recorded.

Single point resistance measurement was also combined with Caliper (borehole diameter) measurement for detection of depth marks that are drilled on the borehole wall. This was done for depth calibration of all results.

An accurate absolute pressure sensor is used for determination of hydrostatic pressure in the open borehole. The results are used when hydraulic head of formations are calculated.

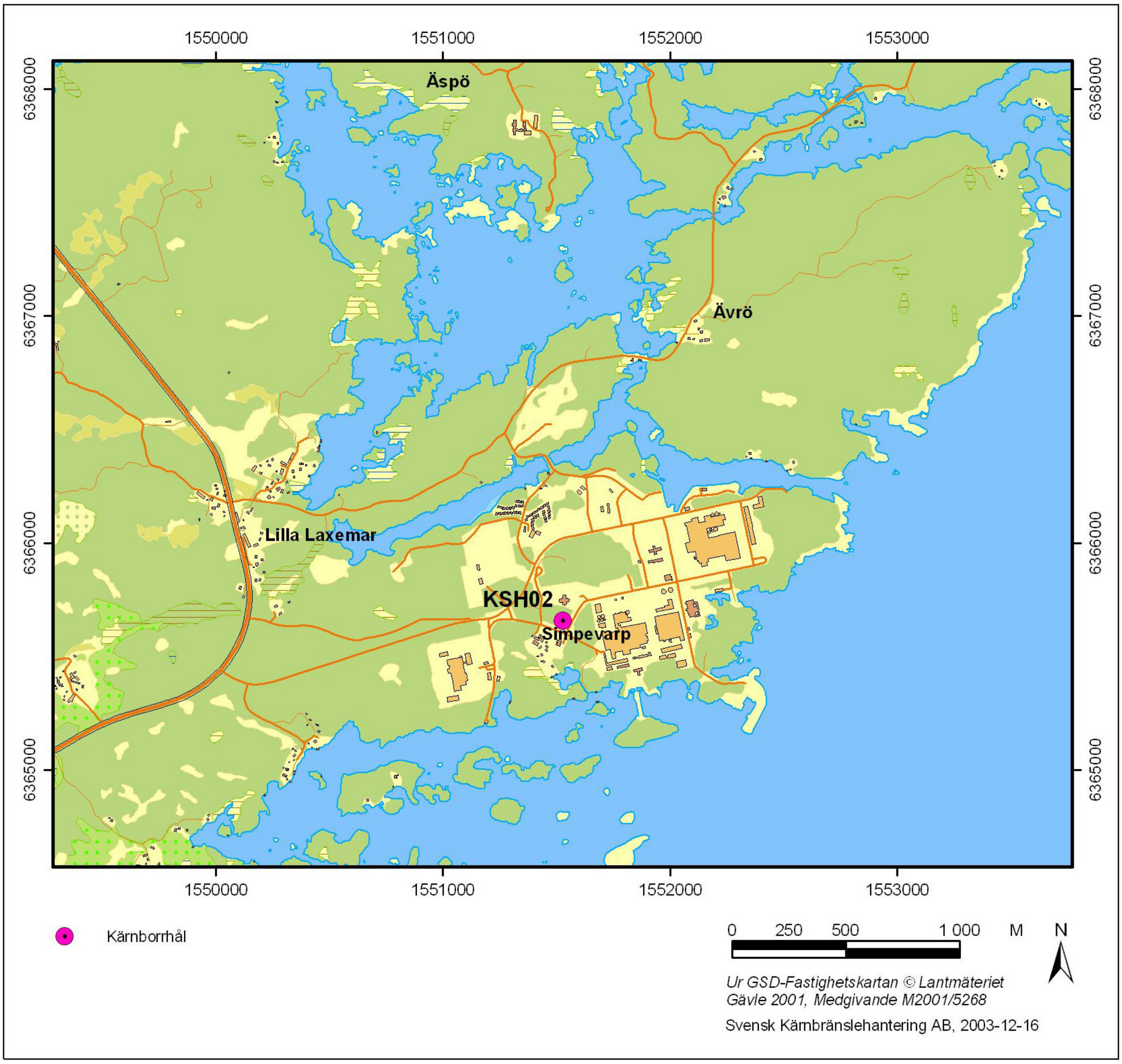

Figure 1-1. *Site map with showing the location of borehole KSH02 on the Simpevarp sub-area. (From GSD-Fastighetskartan © Lantmäteriet Gävle 2001, Permission M2001/5268)*

2 Principles of measurement and operation

The Difference flowmeter is a borehole flowmeter that measures flow rates within borehole sections (inflows or outflows) but not the flow rates along the borehole as ordinary borehole flowmeters. The ordinary flowmeters measure the accumulated flow along the borehole. However, the incremental changes of flow along the borehole are generally very small and can easily be missed unless they are measured directly. The name "Difference flowmeter" comes from the fact that this flowmeter directly measures differences of flow along the borehole. These differences of flow are seepage from the bedrock into the borehole or flows from the borehole into the bedrock.

The flow into or out from the borehole in the test section is the only flow that passes through the flow sensor. This is achieved with the flow guide of the Difference flowmeter. Flow along the borehole outside the test section is directed so that it does not come into contact with the flow sensor. A set of rubber disks is used at both ends of the equipment to isolate the test section from the borehole. These guide the flow to be measured, see Figure 2-1.

The Difference flowmeter can be used in two modes, in sequential and overlapping flow logging modes. In sequential mode, the depth increment is as long as the section length. It is used for determination of hydraulic conductivity and head /Öhberg and Rouhiainen, 2000/. In the overlapping mode, the depth increment is shorter than the section length. It is mostly used to determine the exact location of hydraulically conductive fractures and to classify them by flow rates.

In the sequential mode, the flow rate is measured by thermal pulse and thermal dilution method. In the overlapping mode, only thermal dilution method is used because it is faster than thermal pulse method.

Electric conductivity (EC) of borehole water can be measured with the flowmeter tool. The electrode is placed on the flow sensor, Figure 2-1. The lower rubber disks are removed for the measurement of borehole water.

The Single point resistance (SPR) measurement (grounding resistance) is another parameter that is possible to measure with the flowmeter tool. The electrode of the Single point resistance tool is located within the upper rubber disks, see Figure 2-1. This method is used for high resolution depth determination of fractures and geological structures.

A Caliper tool is also connected to flowmeter electronics. This tool combined with SPR is used for detection of the depth marks drilled on the wall of the borehole. This makes accurate depth calibration possible.

The downhole tool encloses also an absolute pressure sensor (Digiquartz 9000-3K-101), which is used for determination of hydrostatic pressure in the open borehole. It is located inside the electronics tube and connected through a tube to the borehole water, Figure 2-2.

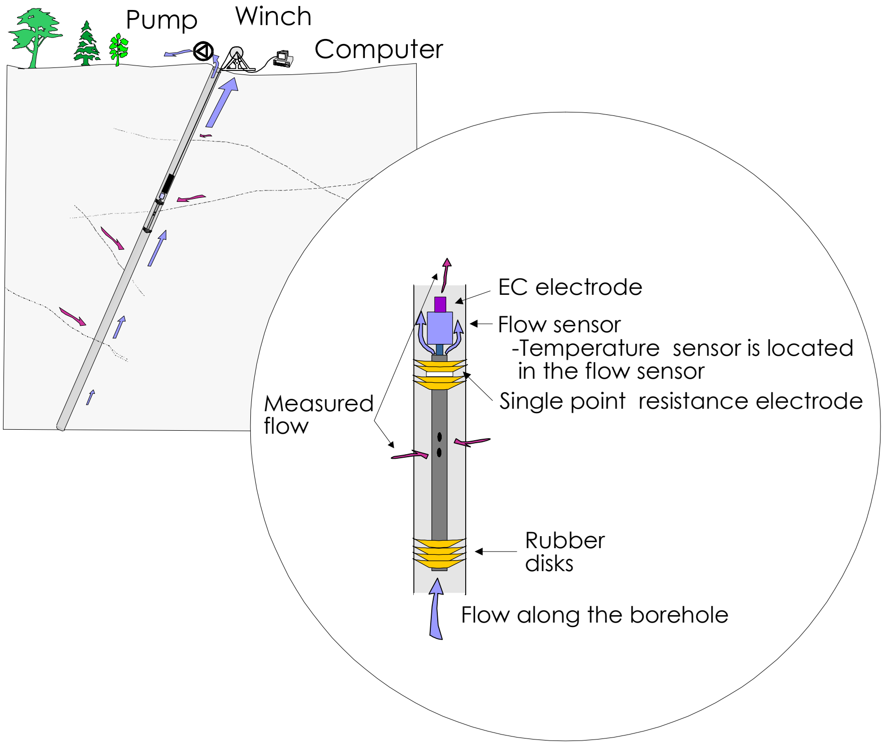

Figure 2-1. *Schematic of the downhole equipment used in the Difference flowmeter.*

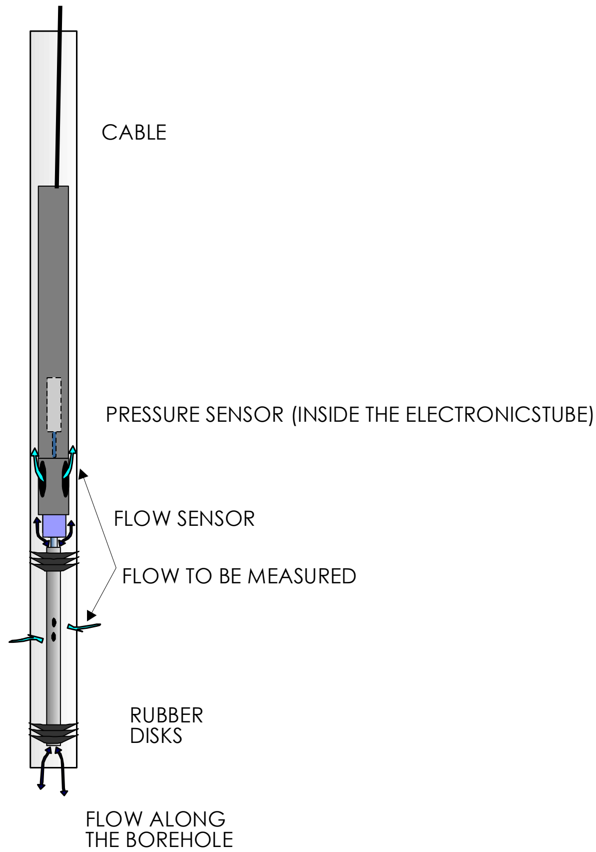

Figure 2-2. *The absolute pressure sensor is located inside the electronics tube and connected through a tube to the borehole water.*

Flow measurement is described in Figures 2-3 and 2-4. There are three thermistors in flow sensor Figure 2-3a. The center thermistor, A, is used both for heating element and for thermal dilution method Figure 2-3b and c. The side thermistors, B1 and B2 are used to detect the moving thermal pulse, Figure 2-3d, caused by the constant power heating Figure 2-3b.

Flow rate is measured during the constant power heating (Figure 2-3b). If it is larger than 10 mL/min, a larger constant power heating is applied, Figure 2-4a). It is used for thermal dilution method for flow rates larger than 10 mL/min.

If the flow rate during the constant power heating (Figure 2-3b) is less than 10 mL/min, the measurement continues with monitoring of thermal dilution transient and thermal pulse response (Figure 2-3d). Thermal dilution is always measured when thermal pulse method is used. The same heat pulse is used for the both methods.

Flow is measured when the tool is at rest. After the tool is moved to a new position, there is a waiting time (length can be chosen) before the heat pulse (Figure 2-3b) is launched. The waiting time after the constant power thermal pulse can also be chosen. It is normally 300 s if thermal pulse is measured and 10 s if only thermal dilution is measured. The measuring range of each method is given in Table 2-1.

Table 2-1. Ranges of flow measurement.

Method	Range of measurement (mL/min)
Thermal dilution P1	0.5–100
Thermal dilution P2	10–5000
Thermal pulse	0.1–10

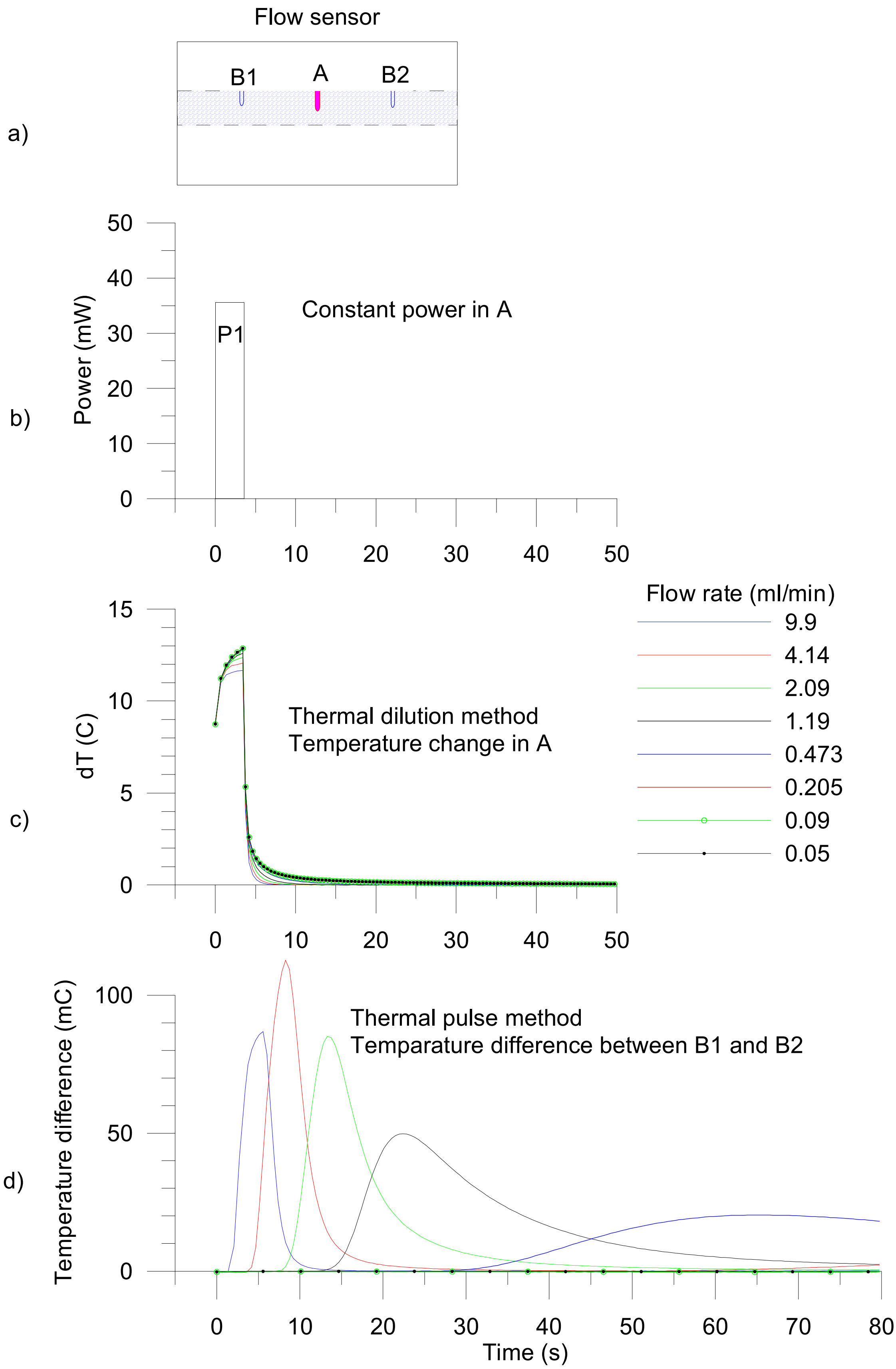

Figure 2-3. *Flow measurement, flow rate < 10 mL/min.*

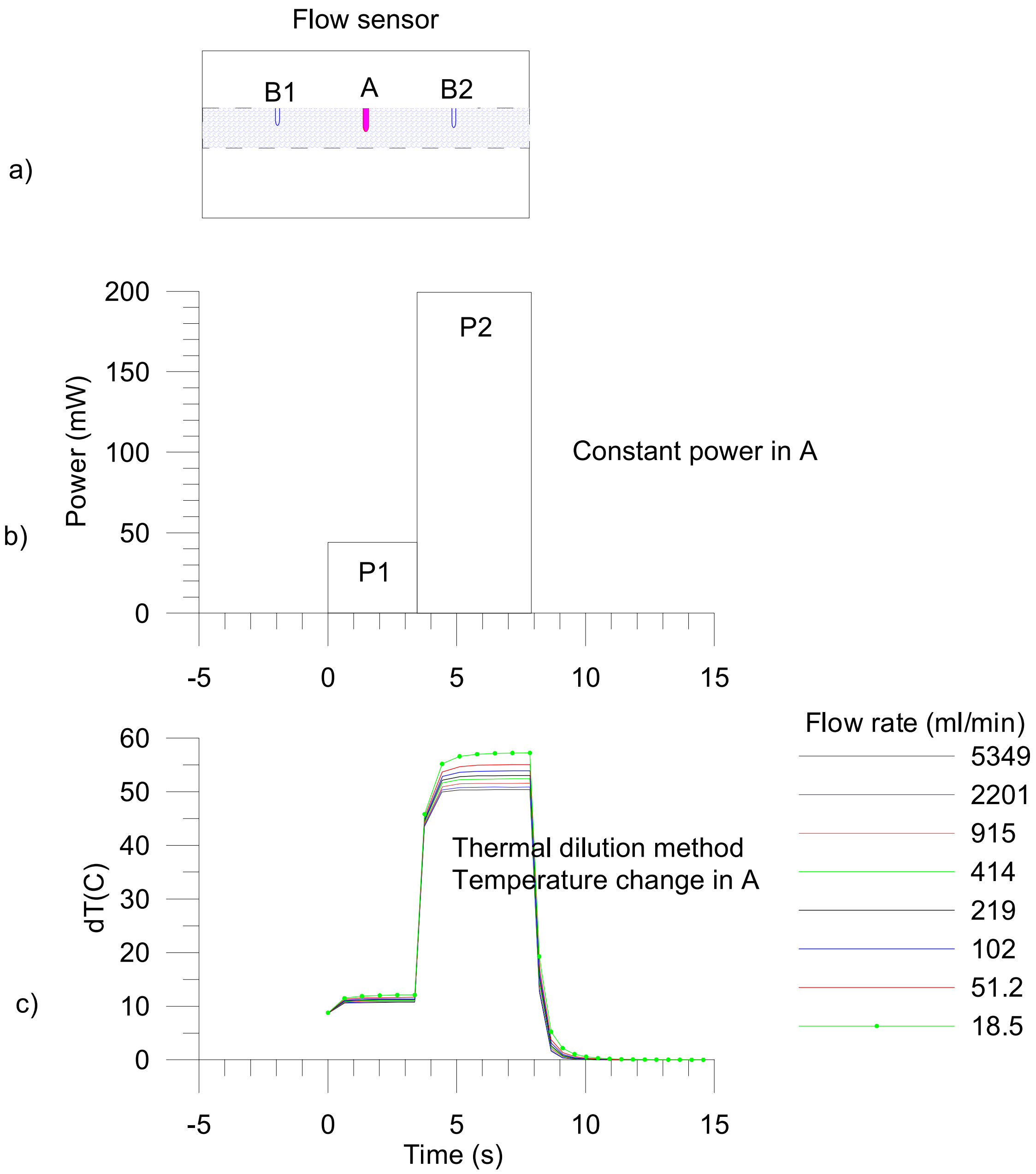

Figure 2-4. *Flow measurement, flow rate > 10 mL/min.*

3 Interpretation

If flow rate measurements are carried out using two levels of hydraulic heads in the borehole, then the static hydraulic head of the formation and the hydraulic conductivity can be calculated. The calculations assume that steady state flow conditions prevail.

$Q_{n1} = K_n\ a\ (h_i - h_1)$ 3-1

$Q_{n2} = K_n\ a\ (h_i - h_2)$ 3-2

where
h_1 and h_2 are the hydraulic heads in the borehole,
a is a constant depending on the assumed flow geometry,
Q_{n1} and Q_{n2} are the measured flows rates in the test section,
K_n is hydraulic conductivity of the test section, and
h_i is the undisturbed hydraulic head zone far from the test section.

Since, in general, very little is known of the flow geometry, cylindrical flow without skin zones is assumed. Cylindrical flow geometry is also justified because the borehole is at a constant head and there are no strong pressure gradients along the borehole, except at the ends of the borehole. For cylindrical flow, constant a is:

$a = 2\ \pi\ L/\ln(R/r_0)$ 3-3

where
L is the length of the test section,
R is the radial distance to the undisturbed hydraulic head hi, and
r_0 is the nominal radius of the borehole.

The radial distance to the undisturbed hydraulic head hi is not known and it must be chosen. Here R/r_0 is chosen to be 500.

Hydraulic head and conductivity can be deduced from the two measurements:

$h_i = (h_1 - b\ h_2)/(1 - b)$ 3-4

$K_n = (1/a)\ (Q_{n1} - Q_{n2})\ /(h_2 - h_1)$ 3-5

where
$b = Q_{n1}/Q_{n2}$

Transmissivity of individual fractures can be calculated if flow rates at individual fractures are known. Similar assumptions as before have to be used (cylindrical flow without skin zones and steady state flow).

$h_i = (h_1 - b\ h_2)/(1 - b)$ 3-6

$T_n = (1/a)\ L\ \ (Q_{n1} - Q_{n2})\ /(h_2 - h_1)$ 3-7

where
Q_{n1} and Q_{n2} are flow rates at fracture n,
h_i and T_n are the hydraulic head and the transmissivity of fracture n.

Since the actual flow geometry is not known, calculated conductivity values should be taken as indicating orders of magnitude. As the calculated hydraulic heads do not depend on geometrical properties but only on the ratio of the flows measured at different heads in the borehole they should be less sensitive to unknown fracture geometry.

Transmissivity of the entire borehole can be evaluated in several ways using the data of the pumping phase and of the recovery phase. The assumptions above (cylindrical and steady state flow) leads to Dupuits formula /Marsily, 1986/:

$$T = \frac{Q}{s2\pi} \ln\left(\frac{R}{r_0}\right), \qquad 3\text{-}8$$

where
s is drawdown and
Q is the pumping rate at the end of the pumping phase.

In the Moye /Moye, 1967/ formula it is assumed the steady state flow is cylindrical near the borehole (to distance r = L/2, where L is the section under test) and spherical further away:

$$T = \frac{Q}{s2\pi} \cdot \left[1 + \ln\left(\frac{L}{2r_0}\right)\right], \qquad 3\text{-}9$$

where L is length of test section (m).

Jacob's approximation can be used for the recovery phase /Marsily, 1986/:

$$s = \frac{Q}{T4\pi} \ln\left(\frac{t_0 + t}{t_0}\right), \qquad 3\text{-}10$$

where

t_0 is the duration of the pumping period and
t is time from the end of the pumping period.

If s is plotted as a function of $\ln\left(\frac{t_0 + t}{t_0}\right)$ (Horner's diagram), a straight line appears.

T can be solved from the slope:

$$T = \frac{Q}{4\pi} \frac{\Delta\left[\ln\left(\frac{t_0 + t}{t_0}\right)\right]}{\Delta s} \qquad 3\text{-}11$$

4 Equipment specifications

Posiva Flow Log/Difference flow method monitors the flow of groundwater into or out from a borehole by means of a flow guide (discs). That is, the flow guide defines the test section to be measured but does not alter the hydraulic head. Groundwater flowing into or out from the test section is guided to the flow sensor. Flow is measured using the thermal pulse and/or thermal dilution methods. Measured values are sent in digital form to the PC computer.

The flowmeter was calibrated in June 2003

Type of instrument:	Posiva Flow Log/Difference Flowmeter.
Borehole diameters:	56 mm, 66 mm and 76 mm.
Length of test section:	A variable length flow guide is used.
Method of flow measurement:	Thermal pulse and/or thermal dilution.
Additional measurements:	Temperature, Single point resistance, conductivity of water, Caliper, Absolute pressure.
Winch:	Mount Sopris Wna 10, 0.55 kW, 220V/50Hz. Steel wire cable 1450 m, four conductors, Gerhard-Owen cable head.
Depth determination:	Based on the marked cable and on the digital depth counter.
Logging computer:	PC, Windows 2000.
Software:	Based on MS Visual Basic.
Total power consumption:	1.5–2.5 kW depending on the pumps.
Calibrated:	June 2003.
Calibration of cable length:	Using depth marks in the borehole.

Table 4-1. Range and accuracy of sensors.

Sensor	Range	Accuracy
Flow	0.1 – 5000 mL/min	+/– 10% curr. value
Temperature (middle thermistor)	0 – 50°C	0.1°C
Temperature difference (between outer thermistors)	–2 – +2°C	0.0001°C
Electric conductuvtivty of water (EC)	0.02 – 11 S/m	+/– 5% curr. value
Single point resistance	5 – 500 000 Ω	+/– 10% curr. value
Groundwater level sensor	0 – 0.1 MPa	+/– 1% full scale
Absolute pressure sensor	0 – 20 MPa	+/– 0.01% full scale

5 Results

5.1 Field work

Before the actual measurements, the tools and the cable were cleaned. Clocks were synchronized to local Swedish time. The activity schedule of the borehole measurements is presented in Table 5-1. The items and activities in Table 5-1 are the same that were used when the work was carried out.

Caliper (borehole diameter) measurement was carried out first, together with Single point resistance measurement (SPR) (Item 6). This was done for detection of depth marks drilled on the borehole wall and for detection widened parts of the borehole. Electric conductivity (EC) and temperature of borehole water (Item 8) was thereafter measured while the borehole was at rest (no pumping).

The sequential flow logging (Item 7) was carried out between the depths of 80–1000 m. The section length was 5 m, step (depth increment) 5 m for thermal pulse and for thermal dilution methods . The measurement was done without pumping the borehole.

Pumping was started on July 11. After 25 hours of pumping in order to obtain a stable drawdown, the combined sequential/overlapping flow logging (Item 9) was again carried out between the depths of 80–1000 m. Section length was 5 m. Step length was 0.5 m for thermal dilution method and 5 m for thermal pulse method (thermal pulse was measured at every 10^{th} point at same sections as sequential flow logging, Item 7).

The overlapping flow logging was then continued, i.e. it was originaly intended that the previously measured flow anomalies were measured again with 1 m section length and 0.1 m step (Item 10). It was however decided to measure the whole borehole, since the anomalies from the sequential 5 m measurements were quite frequent along the hole. These measurements have a theoretical lower measurement limit of 0.1 mL/min.

Selective Overlapping flow logging and fracture specific EC were measured again with 0.5 m section length and 0.1 m step (Item 11).

Thereafter EC of borehole water (Item 12) was measured, still at pumping. After this, the pump was stopped and groundwater recovery was monitored (Item 13).

Absolute pressure was also registered with the other measurements in Items 7–12.

Table 5-1. Flow logging and testing in KSH02. Activity schedule.
(The item numbers from actual work are retained in this table.)

Item	Activity	Explanation	Date
6	Length calibration of the down-hole tool	Dummy logging (SKB Caliper and SPR) Logging without the lower rubber discs, no pumping	2003-07-07 2003-07-08
8	EC- and temp-logging of the borehole fluid, absolute pressure	Logging without the lower rubber discs, no pumping	2003-07-08 2003-07-09
7	Sequential flow logging	Section length L_w=5 m, Step length dL=5 m, no pumping	2003-07-09 2003-07-11
9	Combined sequential and overlapping flow logging	Section length L_w=5 m, Step length dL=0.5 m Pulse measurement every 10th point, at pumping (includes 24 h waiting after beginning of pumping)	2003-07-11 2003-07-14
10	Overlapping flow logging	Section length L_w=1 m, Step length dL=0.1 m, at pumping (only in conductive borehole intervals)	2003-07-14 2003-07-18
11	Selective Overlapping flow logging and fracture-EC	Section length L_w=0.5 m, Step length dL=0.1 m, at pumping (only in selective conductive borehole intervals)	2003-07-18 2003-07-19
12	EC- and temp-logging of the borehole fluid	Logging without the lower rubber discs, at pumping	2003-07-19 2003-07-20
13	Recovery transient	Measurement of water level in the borehole after stopping of pumping	2003-07-20 2003-07-22
7	Combined sequential and overlapping flow logging	Section length L_w=5 m, Step length dL=0.5 m Pulse measurement every 10th point, no pumping. Some depth intervals were checked	2003-07-22

5.2 Depth calibration and SPR measurement

Caliper (borehole diameter) measurement was carried out together with Single point resistance measurement (SPR). The Caliper tool, provided by SKB, was attached to the flowmeter in such a way that Caliper and SPR could be measured simultaneously. The Caliper tool is on/off type showing an anomaly if the borehole diameter is larger than 77–78 mm.

Depth marks were previously drilled in the borehole for depth calibration of various logging tools. Using of the depth marks makes an accurate depth correction possible because the cable can be calibrated in the borehole to be measured.

Each mark includes two 20 mm wide tracks on the borehole wall. Distance between the tracks is 100 mm. The upper track of these two represents the reference level.

The result of the entire borehole is presented in Appendix 1.1. There are four SPR curves plotted together with Caliper. They were measured in Items 6, 7, 9, 10 and 11, see Table 5-1.

The zoomed results of Caliper and SPR are presented in Appendices 1.1–1.33. The depth marks were detected at 105 m, 153 m, 203 m, 256 m, 317 m, 362 m, 415 m, 468 m, 519 m, 571 m, 624 m, 674 m, 727 m, 780 m, 830 m, 852 m, 900 m and at 950 m. They can be seen also in SPR results but the anomaly is complicated because there are four rubber disks used at the upper end of the section, two rubber disks at the both sides of the resistance electrode.

Some other depths are plotted as well, where a clear SPR anomaly was found.

The aim of the plots in Appendices 1.1–1.33 is to verify the accuracy of the depth correction. The curves in these plots are already depth corrected results. The same depth corrections were applied to the flow and EC results.

The amount of depth correction is presented in Appendix 1.34. If the error is negative, the cable is longer than expected.

The procedure of depth correction was the following:

- Caliper+SPR measurement (Item 6) was first depth corrected to the known depth marks, black curve in Appendix 1.34. Corrections between the borehole depth marks were obtained for each depth by linear interpolation.
- The SPR curve of Item 6 was then compared with the SPR curves of Items 7, 9, 10, 11 to obtain relative depth errors of Items 7, 9, 10, 11.
- All SPR curves could then be synchronized, as can be seen in Appendices 1.2–1.33.

5.3 Electric conductivity and temperature of borehole water

Borehole EC was first measured when the borehole was at rest. This was done both downwards and upwards, see Appendix 2.1.

Borehole EC measurements were repeated during pumping (after about eight days pumping period), see Appendix 2.1 red curves.

In addition to this, electric conductivity of fracture specific water was measured from certain selected fractures. The waiting time at these fractures was long enough to flush the water volume within the test section, see Appendices 12.1–12.7.

Temperature of borehole water was measured during the EC measurements. The EC values are temperature corrected to 25°C to make them more comparable with other EC measurements /Heikkonen et al, 2002/.

Temperature of borehole water was measured simultaneously with the EC measurements. The temperature results in Appendix 2.2 correspond to the EC results in Appendix 2.1.

5.4 Flow logging

The flow logging was started with sequential flow logging with a 5 m section length and with 5 m depth increments, see Appendices 3.1–3.46. In this first flow measurement the borehole was at rest. The thermal dilution and thermal pulse methods were used for flow determination. Depth intervals 91.5–111.5 m, 166.5–181.5 m and 201.5–256 m were also measured after pumping with combined mode, because there were some uncertain results, i.e. there was a risk that the rubber disks had leaked. At the depth of 219 m the finally used sequential flow and pressure results were from these re-measurements after pumping.

Depth and flow of interpreted anomalies (fractures) are also listed in Appendices 7–10. These tables are discussed later in Chapter 5.9.

The flows were re-measured with pumping the borehole. The drawdown was held almost constant at about 10.5 m. The flow logging was performed in combined mode. 0.5 m depth increments were used for thermal dilution method and 5 m depth increments for thermal pulse method, see Appendices 3.1–3.46. The method gives the depth and the thickness of conductive zones with a depth resolution of 0.5 m. Thermal pulse method is slower but it makes it possible to measure smaller flow rates and flow directions (into the borehole or out from it).

The overlapping flow logging (only thermal dilution method was used) was carried out again in the vicinity of identified flow anomalies using a 1 m long test section and 0.1 m depth increments. During the measurements of electric conductivity of fracture specific water, the flow logging was performed using 0.5 m long test sections and 0.1 m depth increments in some depth intervals.

The length of the test section determines the width of a flow anomaly of a single fracture. If the distance between flowing fractures is less than the section length, the anomalies will be overlapped resulting in a stepwise flow anomaly. In all plots of the overlapping flow logging, the depth of a fracture is chosen to be at the lower end of anomalies. The actual depths are calibrated using the depth marks in the borehole. The depth marks were detected with Caliper and SPR (Item 6) measurements. The depth corrections of Items 7 and 9–11 were carried out synchronizing the SPR curves of Items 7 and 9–11 with the depth corrected first SPR measurement (Item 6).

The depths of flowing fractures are marked with lines in the appendices of the detailed flow logs. Long line represents the depth of a flowing fracture; short line denotes that the existence of a flowing fracture is uncertain. Short line is used if the flow rate is less than 30 mL/h or if the flow anomalies are overlapped.

The electrode of the Single point resistance tool is located within the upper rubber disks. Thus, the depth of the resistance anomalies of the leaky fractures fit with the lower end of the flow anomalies.

5.5 Pressure measurements

Absolute groundwater pressure was registered along with the other measurements in Items 7–12. The pressure sensor measures the sum of hydrostatic pressure in the borehole and air pressure. Air pressure was also registered, Figure 5-1. Hydraulic head along the borehole at natural and pumped conditions is determined in the following way. Firstly, the monitored air pressure at the site is subtracted from the measured absolute pressure by the pressure sensor. Then hydraulic head (h) at a certain elevation z is calculated according to the following expression /SKB, 2002/:

$$h = (p_{abs} - p_b)/\rho_{fw}\, g + z \qquad (5\text{-}1)$$

where
h is the hydraulic head (masl) according to the RHB 70 reference system,
p_{abs} is absolute pressure (Pa),
p_b is barometric (air) pressure (Pa),
ρ_{fw} is unit density 1000 kg/m^3,
g is standard gravity 9.80065 m/s^2 and
z is the elevation of measurement (masl) according to the RHB 70 reference system.

A sensor specific offset, given by the sensor manufacturer, of 13.5 kPa is subtracted from all absolute pressure results.

The calculated head results are presented in Appendix 4. Exact depth information is important in head calculation, 10 cm error in level means 10 cm error in head. The depth correction of borehole EC measurement is not as accurate as depth correction of flow measurement because SPR was not measured during borehole EC. Therefore, the head values during the borehole EC measurements are not as accurate as the other head values. The depth correction of Caliper measurement was applied to borehole EC measurements, black curve in Appendix 1.34. In spite of the different depth corrections of flow and EC measurements, there are no detectable deviations in head, see Appendix 4.

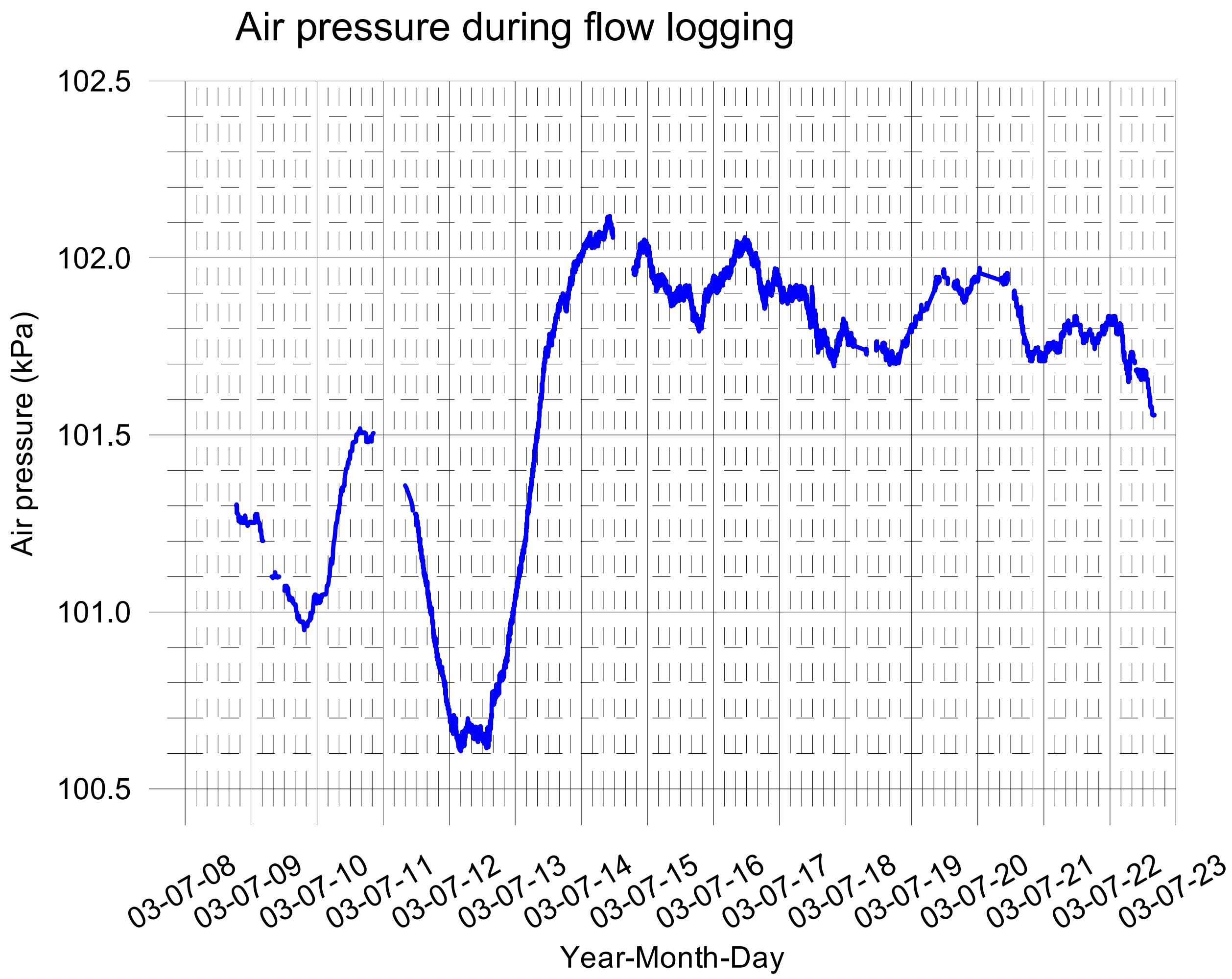

***Figure 5-1.** Air pressure measured at the borehole.*

5.6 Hydraulic head and conductivity of formations

Hydraulic head and conductivity of formations was calculated from the results of sequential flow logging when both thermal dilution and thermal pulse methods were used. The borehole was measured with 5 m depth increments. Section length was also 5 m.

Thermal pulse method is slow but makes it possible to measure smaller flow rates and their flow directions (into the borehole or out from it). The waiting time after thermal pulse as well as the stabilization time before thermal pulse are longer when thermal pulse method is used compared with that when only thermal dilution method is applied.

Thermal pulse flow results were used when the flow rate was smaller than 600 mL/h; above this thermal pulse results are only used for detection of flow direction.

The flow results are presented in Appendices 5.1 and 5.2. The depths represent the distance from the reference depth (top of the casing tube) to the middle point of the test section.

Borehole head was measured and calculated as described in Chapter 5.5. Head1 and Head2 represent heads without and with pumping the borehole, respectively. Borehole head and calculated formation head (fracture head) are given in RHB 70 scale.

The flow results (Flow1 and Flow2) are similarly given without and with pumping the borehole. Flow rates are positive if the flow direction is from the bedrock into the borehole. The sum of detected flows without pumping was –1929 mL/h (about –0.03 L/min). This is about 17% of all measured flows without pumping. This sum should be should be zero if all the flows in the borehole are correctly measured, borehole is not pumped, water level is constant, salinity distribution in the borehole is stabilized and the fractures are at steady state pressure. More flows were measured away from the borehole than into it. The reason is unknown.

Flow values in the flow rate plots are shown using a logarithmic scale, see Appendix 5.1. The flows are shown in both directions, the left hand side of each diagram represents flow out from the borehole within a test section and the right hand side represents flow into the borehole within a test section. If the measured flow was zero, it is not visible in the logarithmic scale of the appendices. All the sections between 80 m and 1000 m were measured.

Fresh water head of fractures and hydraulic conductivities can be calculated from the flows using the method described in Chapter 3. Hydraulic heads of formations are presented in the plots if both of the flows at the same depth are not equal to zero. Hydraulic conductivity is presented if both or either of the flows are not equal to zero, Appendix 5.2. **The minimum measurement limit for the transmissivity is given in Table 5-3.**

5.7 Groundwater level and pumping rate

Water level in the borehole during the measurements is presented in Figure 5-2. The borehole was not pumped between July 7 and 11 when the first Caliper, EC and flow measurements were carried out.

Later the borehole was pumped with a drawdown of about 10.5 m. The groundwater recovery was measured after pumping period, July 20–22, Figure 5-3. The recovery was measured with two methods, using the water level sensor (pressure sensor for monitoring water level) and using the absolute pressure sensor. The two methods give nearly equal results.

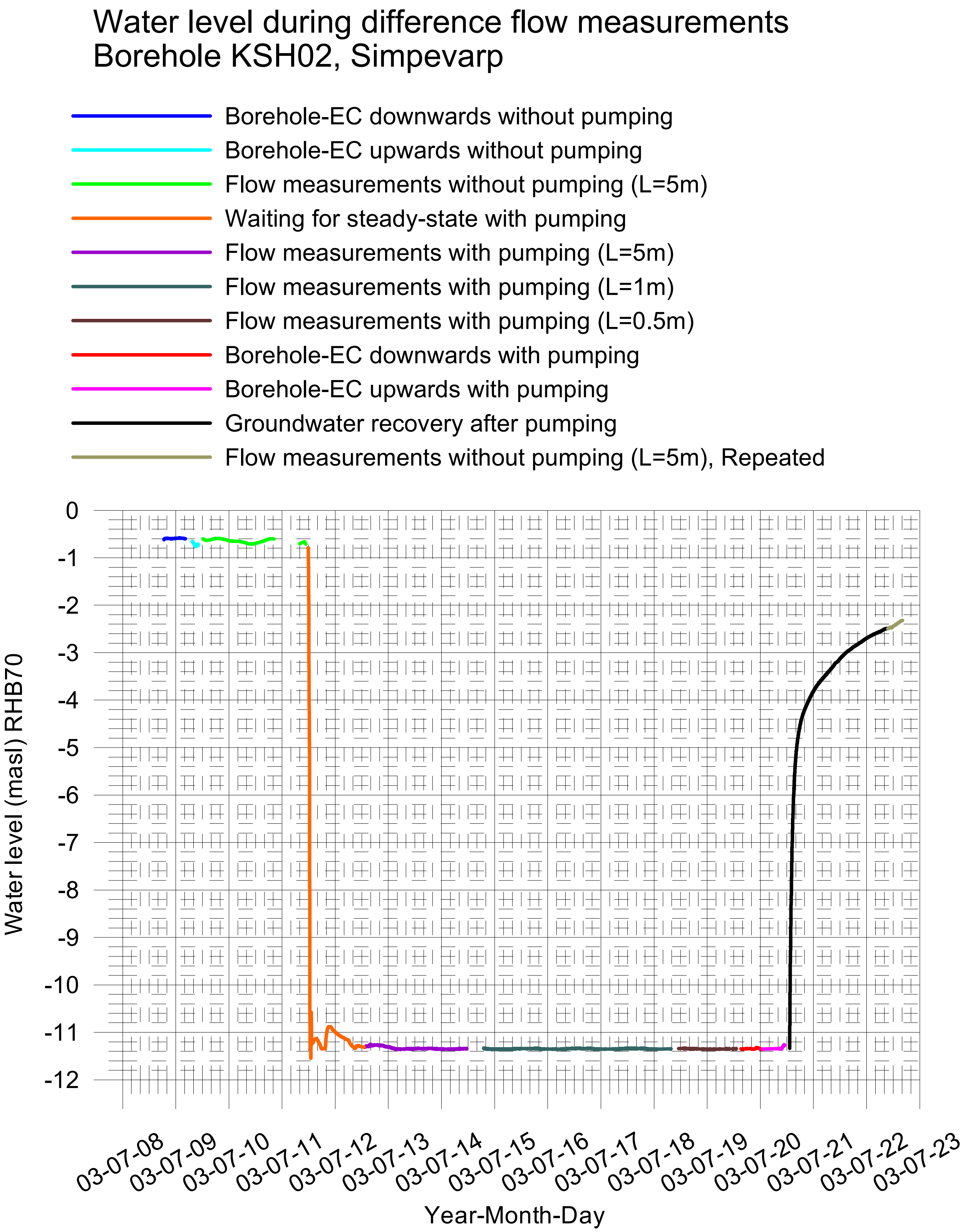

Figure 5-2. *Groundwater level in borehole KSH02.*

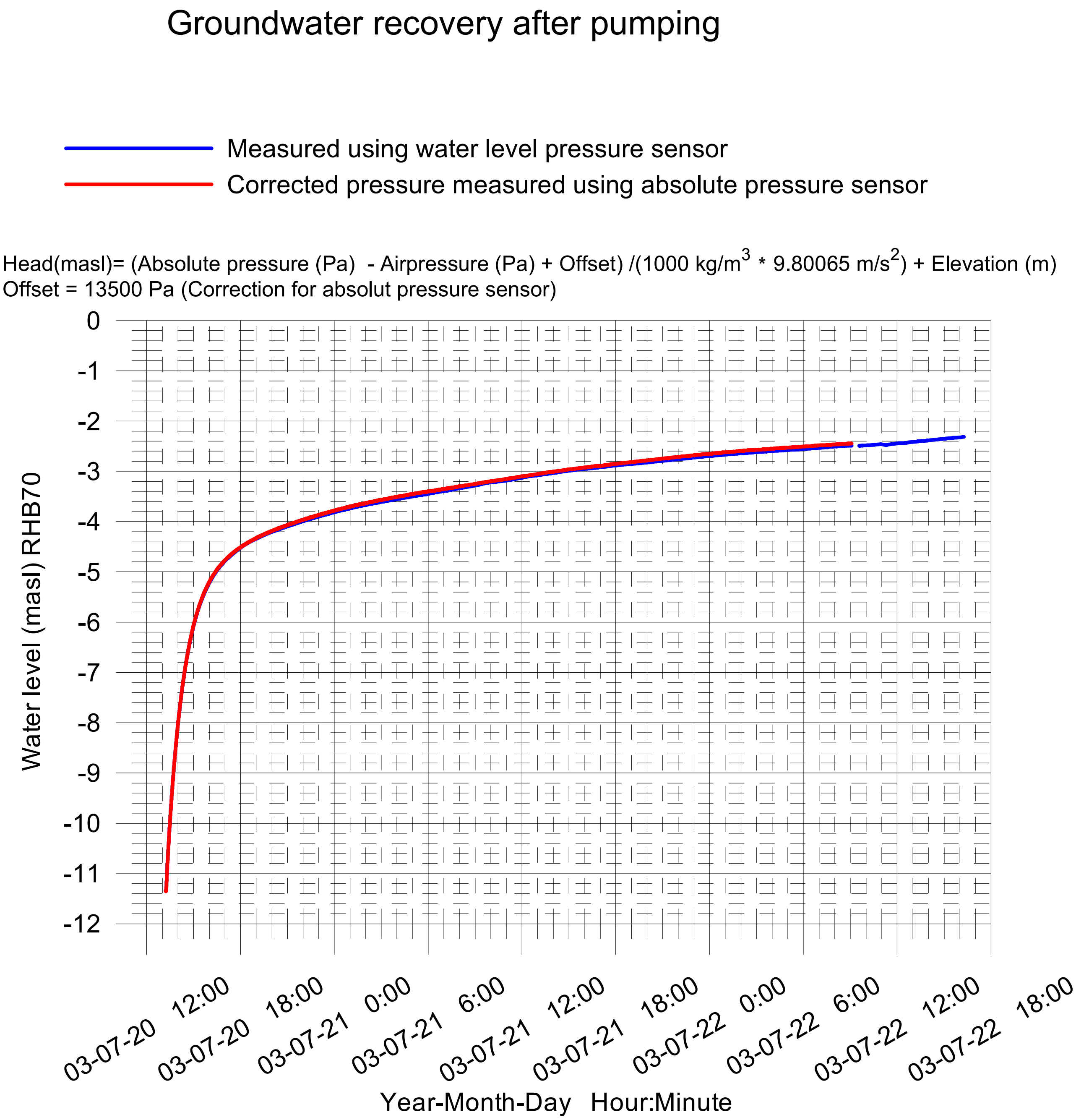

Figure 5-3. *Groundwater recovery in borehole KSH02.*

Pumping rate was measured during the flow loggings, see Figure 5-4. It showed a decreasing trend from the beginning of the pumping period, changing from 4.8 L/min to 3.3 L/min. This can be compared with the summed up flow result from of flow measurements from the entire borehole. The sum is about 4 L/min.

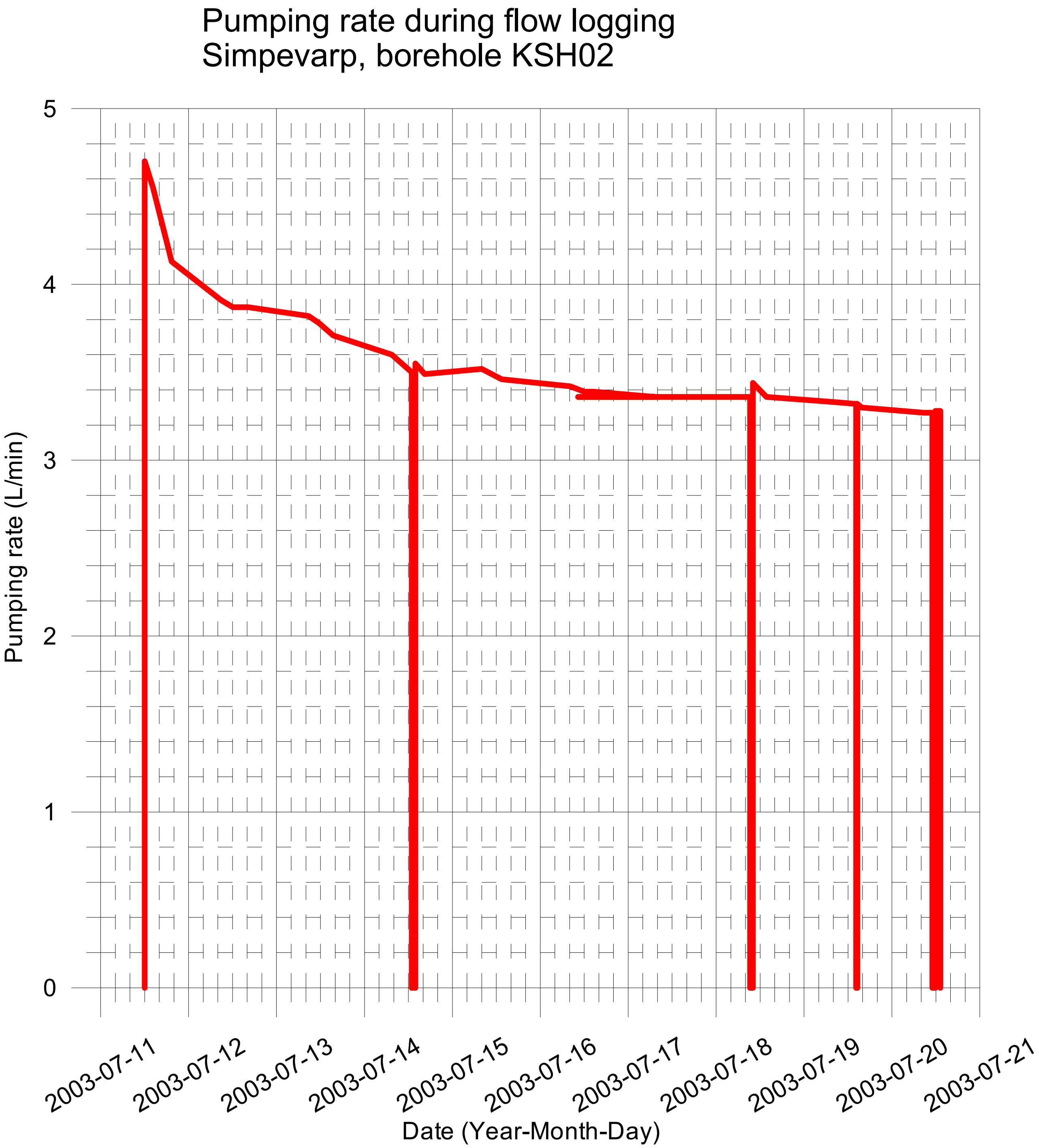

***Figure 5-4.** Pumping rate during the flow logging.*

5.8 Transmissivity of the entire borehole

Transmissivity of the entire borehole is evaluated with the three methods described in Chapter 3.

For the Dupuit's formula (equation 3-8) R/r_0 is chosen to be 500.

In the Moye's formula (equation 3-9) length of test section L is 900 m and borehole diameter $2r_0$ is 0.076 m.

Jacob/Horner's approximation for the recovery phase (equation 3-11) is presented in Figure 5-5.

The results of the three methods are given in Table 5-2 where the flow was set to Q=3.4 L/min and drawdown s=10.75 m. Moye's approximation gives the highest and Jacob/Horner method the lowest transmissivity. Basic test data is gathered in Appendix 6.

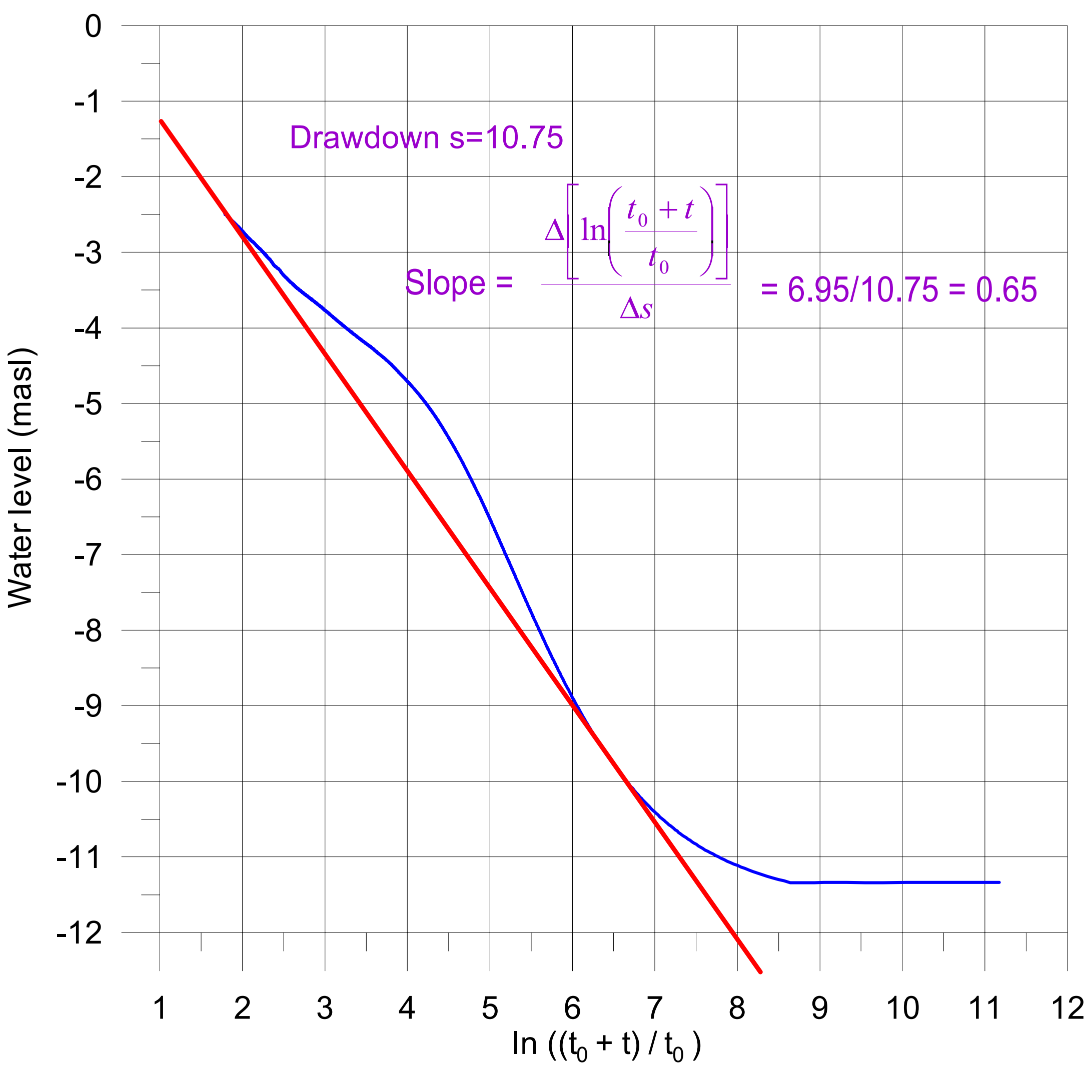

Figure 5-5. *Horner's diagram for the recovery phase.*

Table 5-2. Transmissivity of the entire borehole.

Method	Transmissivity (m^2/s)
Dupuit	5.2 E-6
Moye	8.7 E-6
Jacob/Horner	2.9 E-6

5.9 Tables of sequential and overlapping logging

The results of sequential flow logging are presented in Appendices 7.1–7.6. Explanations of the columns are given Appendix 9. The lowest possible limit of transmissivity is presented in column Td-measl. It is calculated assuming the lowest measurable flow rate (6 mL/h) at the used drawdown. It is a theoretical limit, often the actual limit is higher because of various disturbing conditions in the borehole.(see Chapter 5.10)

The results of overlapping flow logging are presented in Appendices 8.1–8.3. Overlapping measurements were used in inferring these fracture specific values. The lowest possible limit of transmissivity is similar as described above except that it is about five times higher (lowest measurable flow rate 30 mL/h). Many of the fracture specific results are marked as uncertain. In these cases the measured flow rate is below 30 mL/h or the fractures are very close each other making the flow evaluation difficult.

No overlapping measurements were carried out without pumping. The flow rate without pumping (Q_0) was assumed to be zero when calculating transmissivity.

The table in Appendix 8 was used to calculate conductive fracture frequency (CFF), Appendices 10.1–10.4. The number of conductive fractures were counted on the same 5 m sections as in Appendices 7 and 8 before. The number of conductive fractures were sorted in six columns depending on their flow rate. The total conductive fracture frequency is presented graphically, see Appendix 11.

5.10 Noise in flow

The flow rates of the overlapping measurements are shown in Appendices 3.1–3.46. Noise level or minimum measurable flow rate in the overlapping results varies as a function of depth. Theoretical minimum is about 30 mL/h. Noise level of the overlapping measurements was near this limit when the borehole was not pumped, at least where it was measured, see Appendices 3.2, 3.5, 3.8 and 3.9.

Noise level of the overlapping results with pumping was often much larger than 30 ml/h, see Table 5-3. Noise levels in Table 5-3 are evaluated from the overlapping measurements with section length of 1 m (L=1 m), where it was available.

There are several known reasons for increased noise in flow:

1) Rough borehole wall.

2) Solid particles in water such as clay or drilling mud.

3) Gas bubbles in water.

Rough borehole wall always causes high noise not only in flow but also in Single point resistance results. In this case SPR curve is often even but noise level in flow is still high. Therefore this cannot explain the noise detected in borehole KSH02, at least in most parts of it.

Drilling mud usually causes increased noise level for the results obtained without pumping and with pumping. Therefore it hardly explains the noise in borehole KSH02 because higher noise appeared only with pumping.

Pumping causes pressure drop in borehole water and in fracture water near the borehole. This may lead to transformation of gas from dissolved form to gas bubbles. This process could explain the increased noise in KSH02.

Typical features of noise caused by gas are sudden increases and decreases of noise level. Noise level may increase at fractures that produce gas bubbles (for instance at the fracture group between 99 m and 105 m). Noise level is higher below this depth because the borehole was measured downwards. From the experience from other boreholes it could be predicted that noise level had increased above the fractures if the borehole would have been measured upwards. It has been noticed that increase of noise level is stronger if the tool is stopped on such fractures, for instance for measurement of fracture-specific EC.

At the depth of 515 m noise level suddenly decreases. This kind of feature is explained by the widened borehole (Caliper anomaly) where gas bubbles could escape from the section. Similar decrease of noise level can often be achieved by moving the tool up and down in the borehole.

Often noise caused by gas is higher with longer section length. This was the case also in KSH02; noise level was higher with L=5 m than with L=1 m. Noise level was also higher with L=1 m than with L=0.5 m in most cases, see Appendices 3.15, 3.18, 3.21, 3.23, 3.27, 3.32, 3.44 and 3.46

An exception in the list above is noise level with L=0.5 m below the fracture at the depth of 523.9 m. Noise level with L=0.5 m remains very high below this fracture, see Appendix 3.23.

EC of fracture-specific water was measured on this fracture with L=0.5 m. Noise in EC in this fracture was the highest of all the measured EC results, see Appendix 12. Noise in EC is probably also caused by gas bubbles.

It is not known whether there is a mechanism that causes higher noise level in flow with larger section lengths. Another alternative explanation could be longer pumping time that is usually used with shorter section lengths.

Table 5-3. Estimated minimum measurable transmissivity in KSH02.

Upper depth (m)	Lower depth (m)	Minimum measurable flow rate with pumping (mL/h)	Approximate minimum measurable K (*E-10 m/s)	Approximate minimum measurable T (*E-10 m^2/s)
80	100	20	1.2	6
100	320	300	18	90
320	425	40	3	15
425	515	100	7	35
515	580	10	0.8	4
580	600	50	4	20
600	700	200	16	80
700	760	400	32	160
760	1000	200	22	110

6 Summary and discussion

In this study Posiva Flow Log/Difference Flow method has been used in combined sequential/overlapping logging mode to determine the depth and flow rate of flowing fractures. Measurements were carried out when the borehole was at rest with 5 m section length and with 5 m depth increments. Both thermal pulse and thermal dilution methods were applied. The same was repeated when the borehole was pumped except that the thermal dilution method was applied with 0.5 m depth increments. Measurements with pumping were repeated using 1 m section length with 0.1 m depth increments over flow anomalies detected earlier. Only thermal dilution method was used in this measurement.

Depth calibration was made using depth marks in the borehole. Depth marks can be seen in Caliper results and in Single point resistance results. Depth correction could be done for all flow results because Single point resistance was measured at the same time as the flow measurements.

The movement of saline water in the borehole was followed by electric conductivity measurements and temperature measurements of borehole water.

Hydraulic conductivity and head of were calculated for formations. The highest conductivities 3.7 10^{-7} m/s and 2.2 10^{-7} m/s were detected in the fractures at the depths of 104.01 m and 424.06 m, respectively.

Conductive fracture frequency (CFF) was calculated from the detected flowing fractures, Appendices 10 and 11. CFF is partially qualitative because the detection limit of conductive fractures varies with depth, see Table 5-3. A more quantitative way could be to sort conductive fractures with their estimated transmissivity, see Appendix 8. For instance, CFF with transmissivity > 2E10-8 m^2/s could be then compared CCF in other boreholes having the same condition. The transmissivity limit should be above the detection limit.

EC of fracture-specific water was measured from some chosen fractures. Stabilisation time varies depending on the flow rate from the target fracture. Stabilisation time is automatically chosen so that the total amount of water going through the EC sensor is three times the water volume within the section (between the upper and lower rubber disks). In spite of this, EC transients do not look equally stabile, for instance EC at 176.2 m is not as stabile as EC at 99.33 m, see Appendix 12.1. There is a need of a more complicated criteria for stabilisation time.

Another problem in EC results is noise. At is assumed that it is caused by gas bubbles. Small gas bubbles could decrease conductance (increase resistance). It is more difficult to evaluate how larger gas bubbles (size near the EC electrode size) would change EC result.

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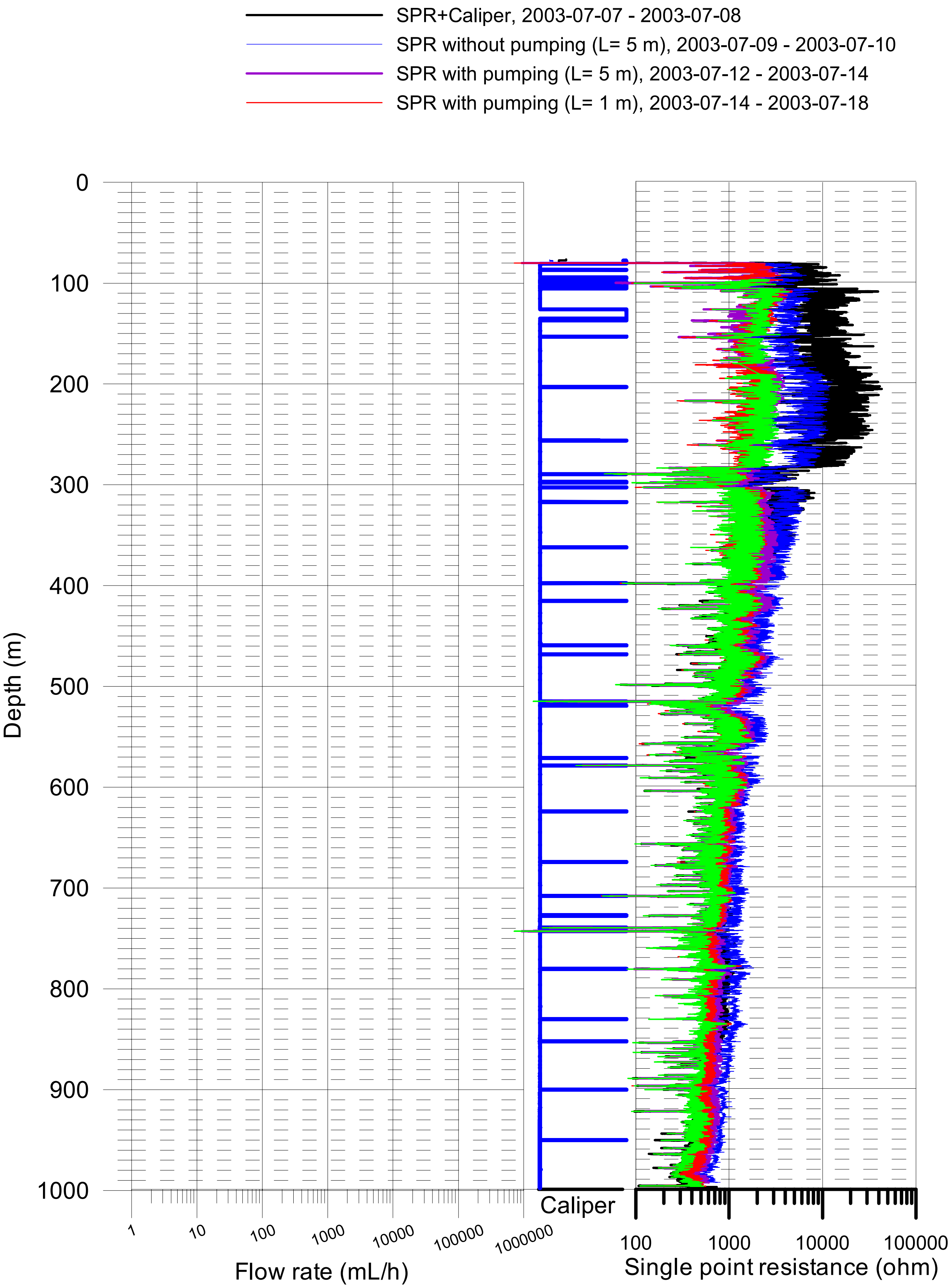
Simpevarp, KSH02
SPR and Caliper results after depth correction



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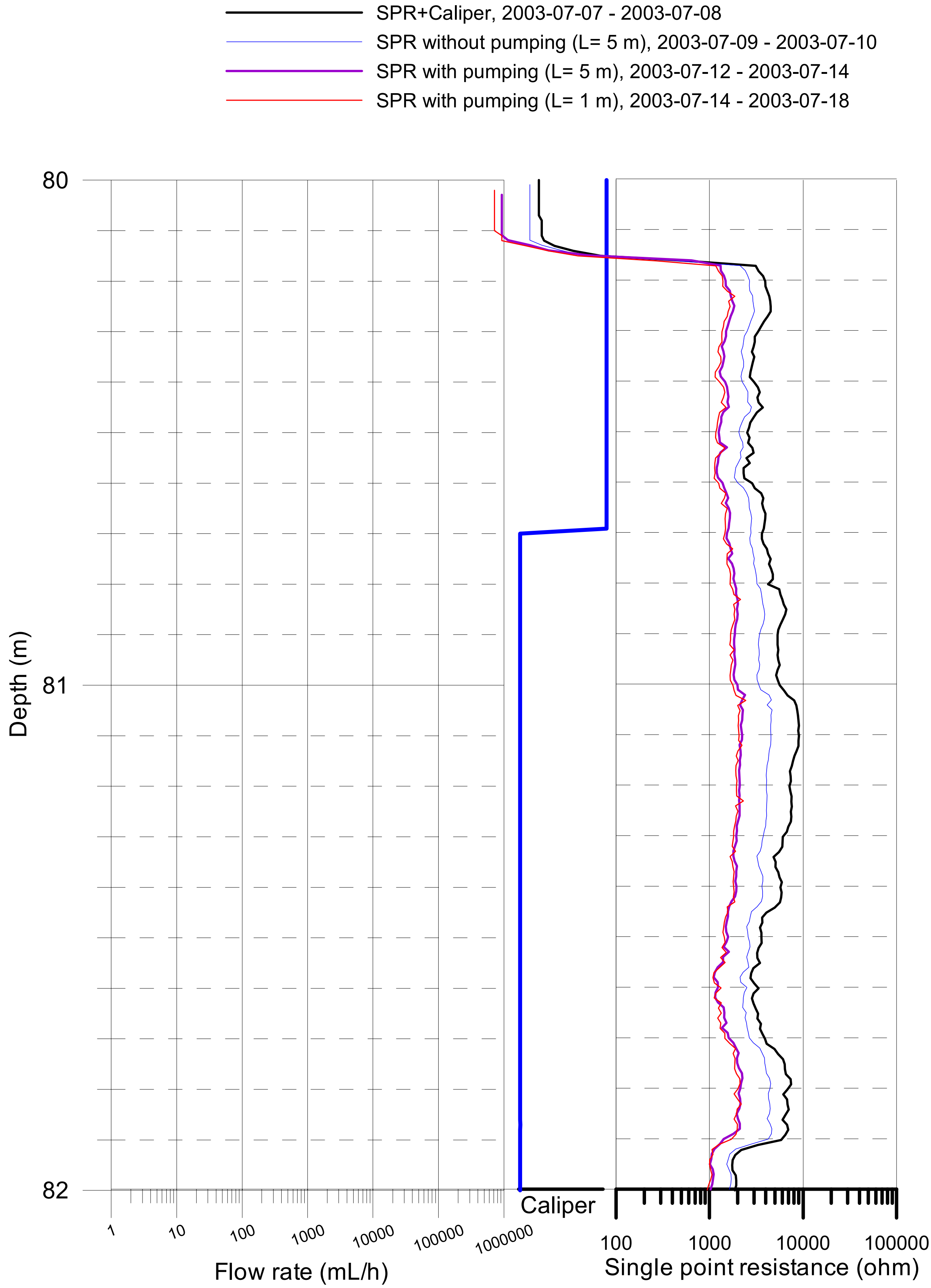

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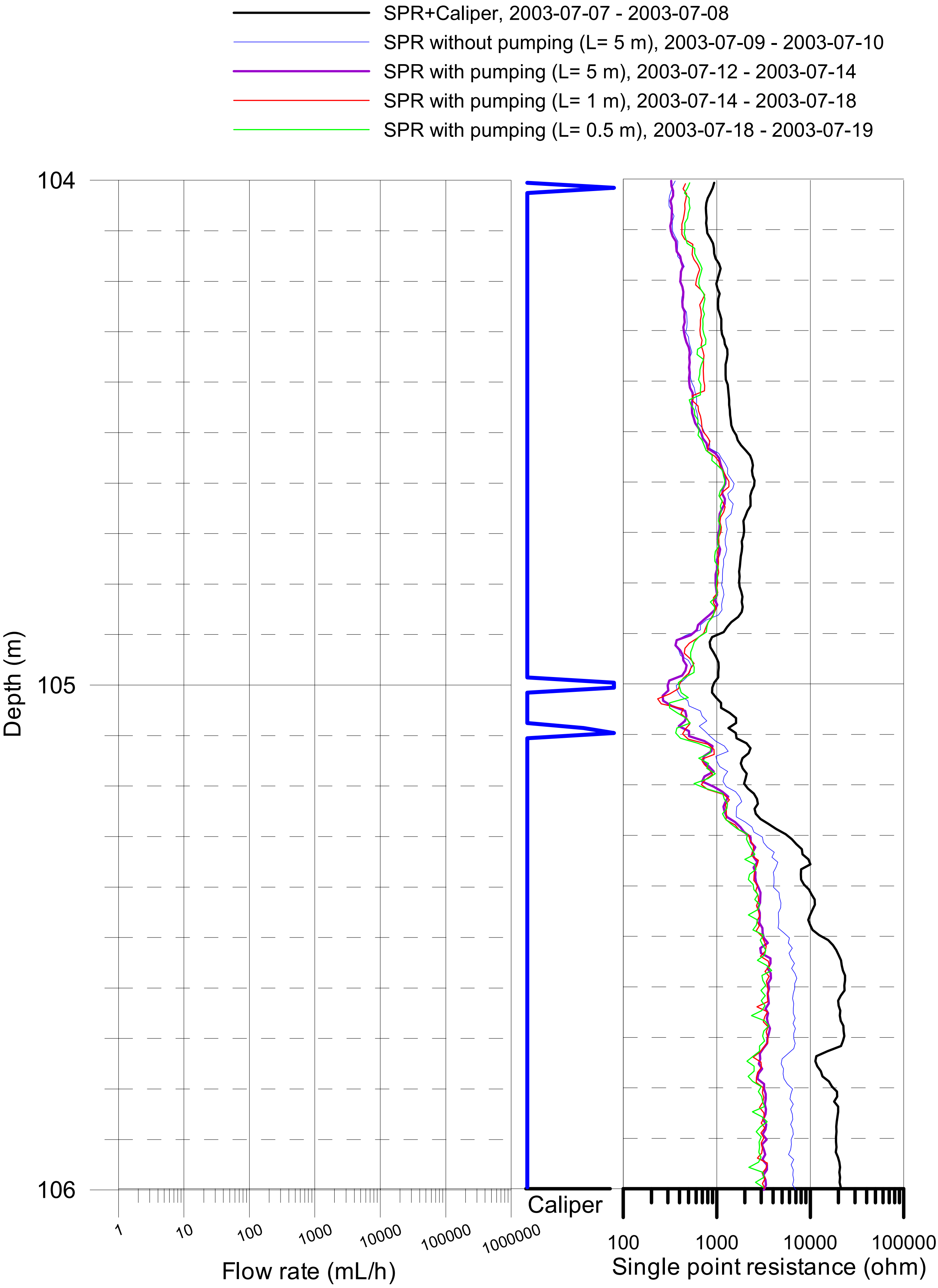

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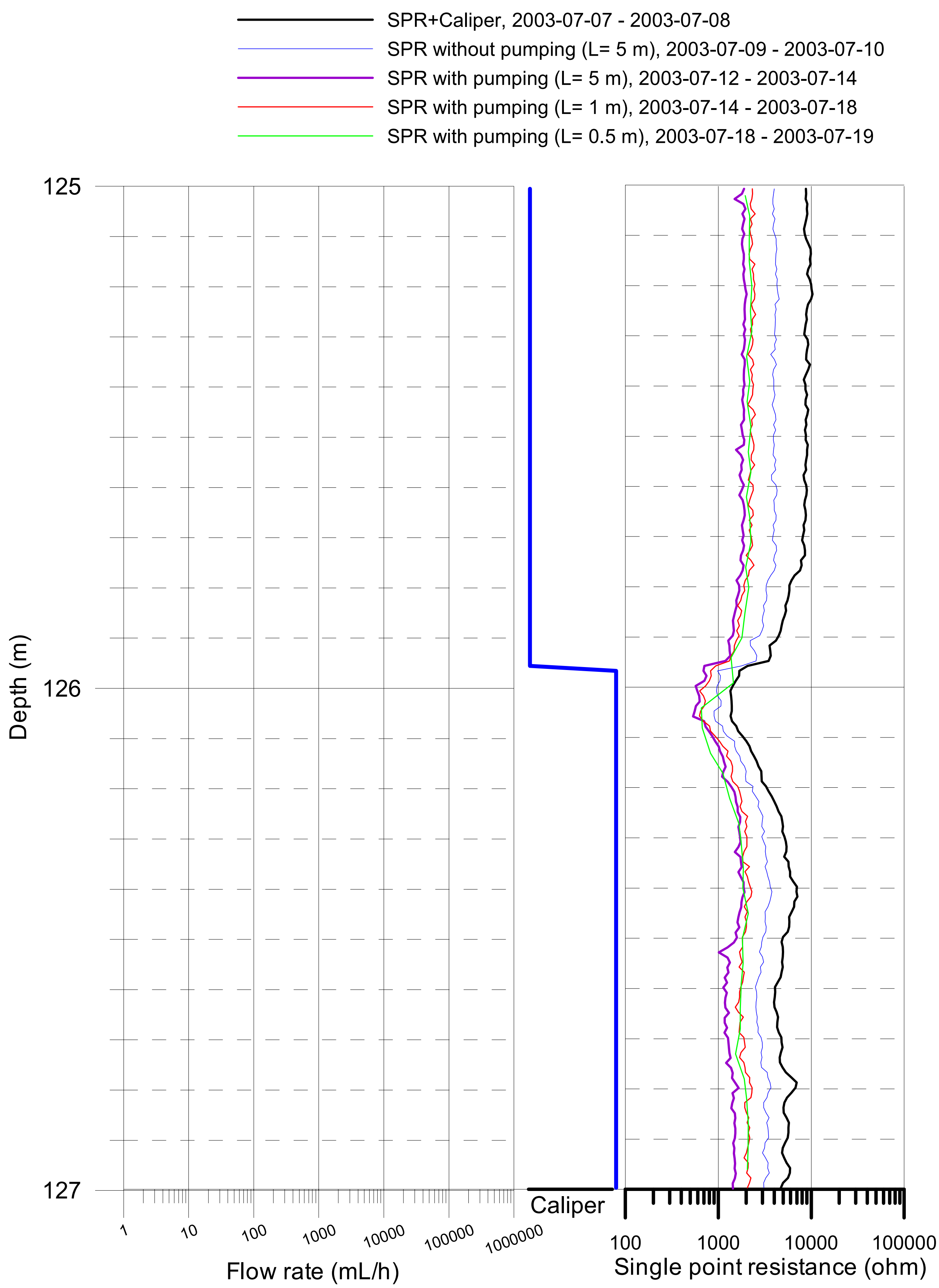

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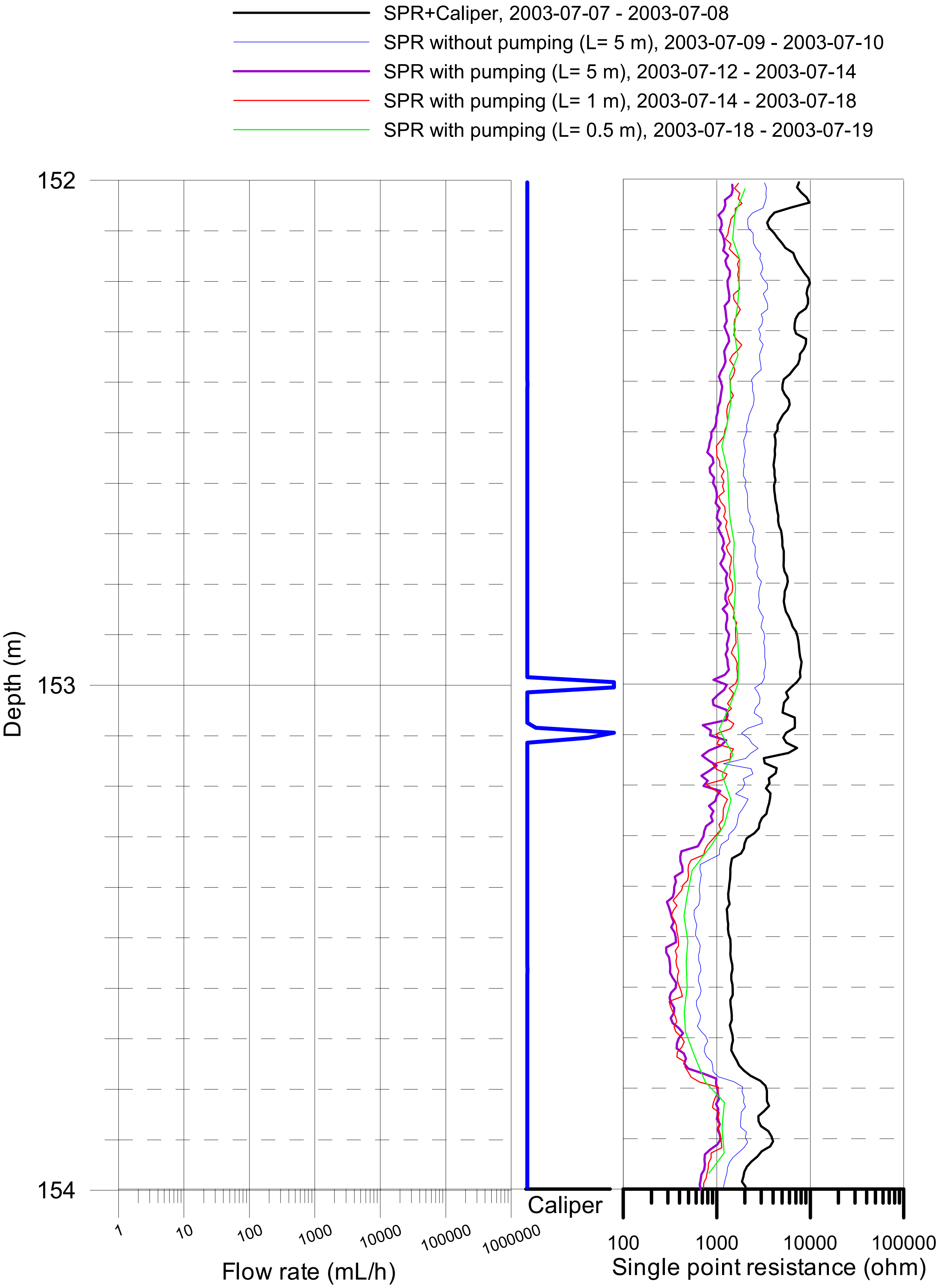

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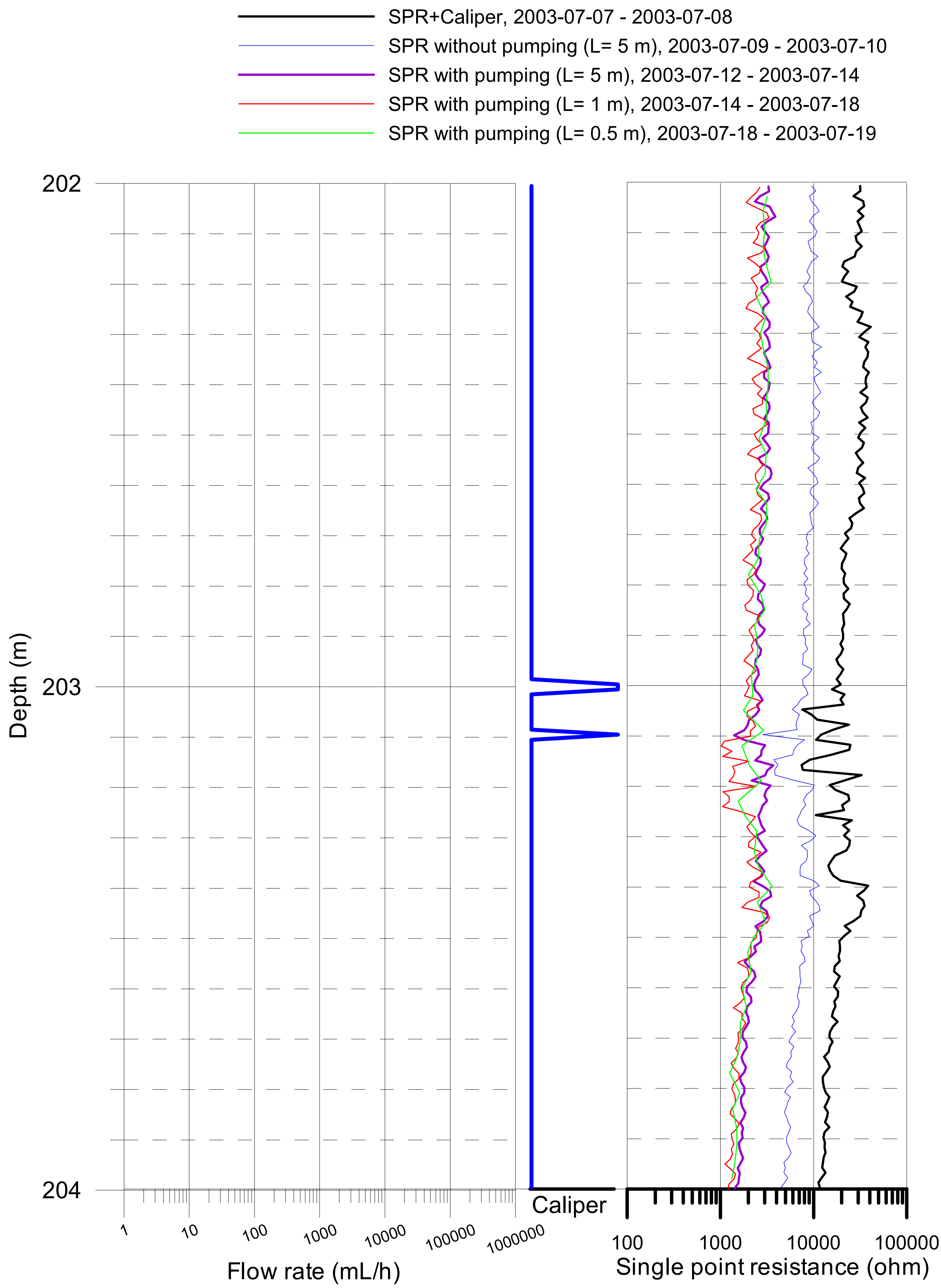

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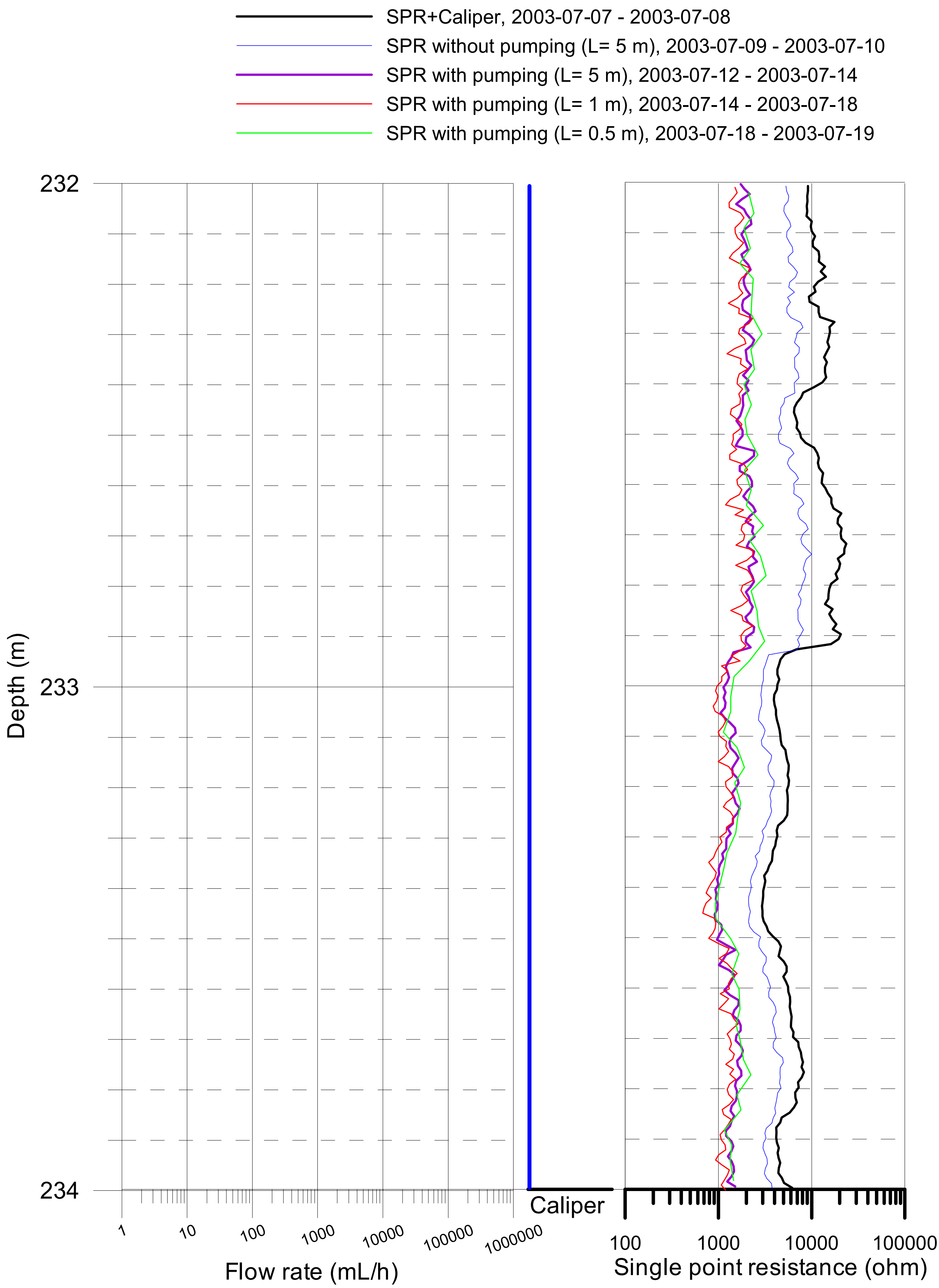

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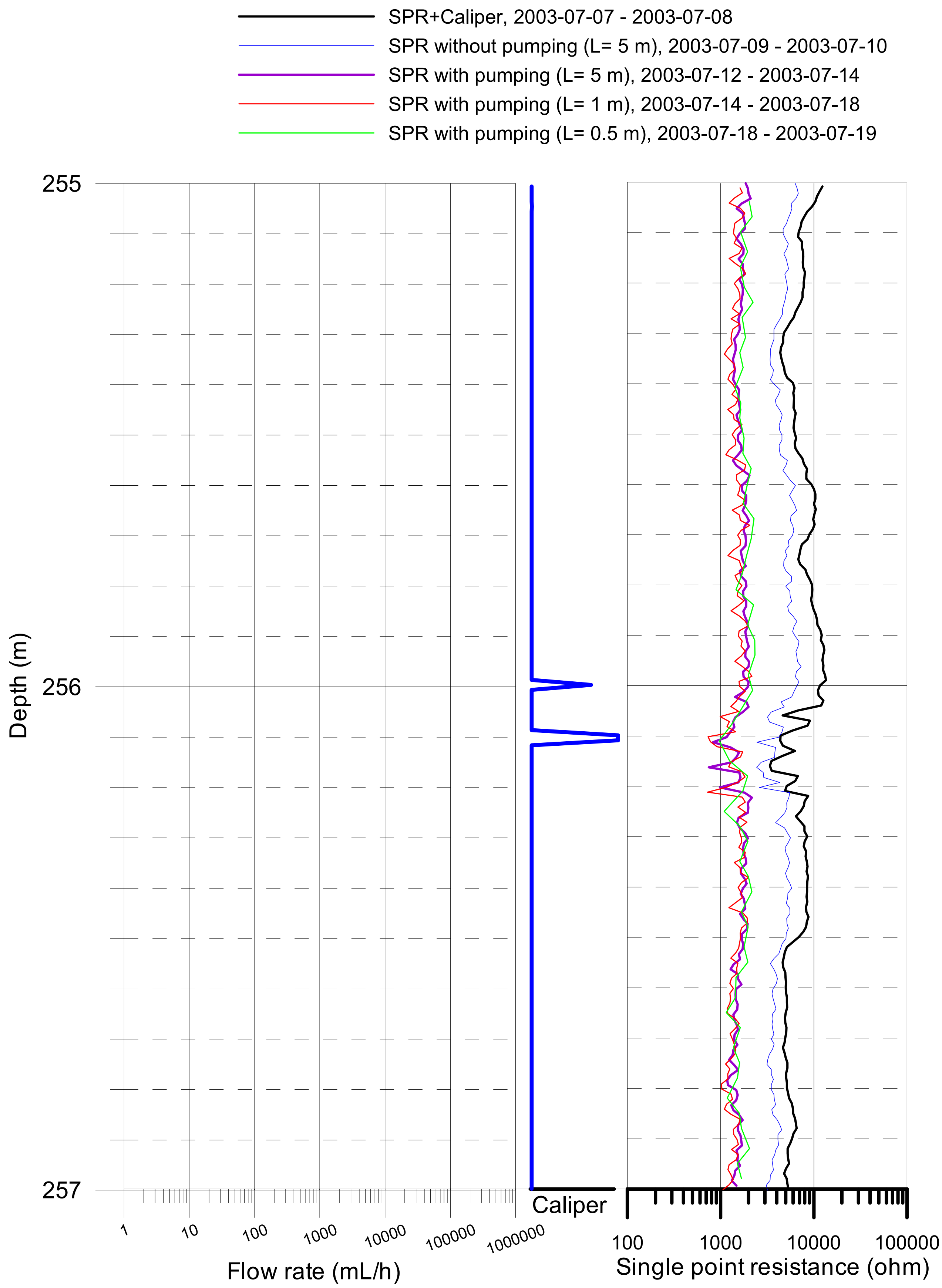

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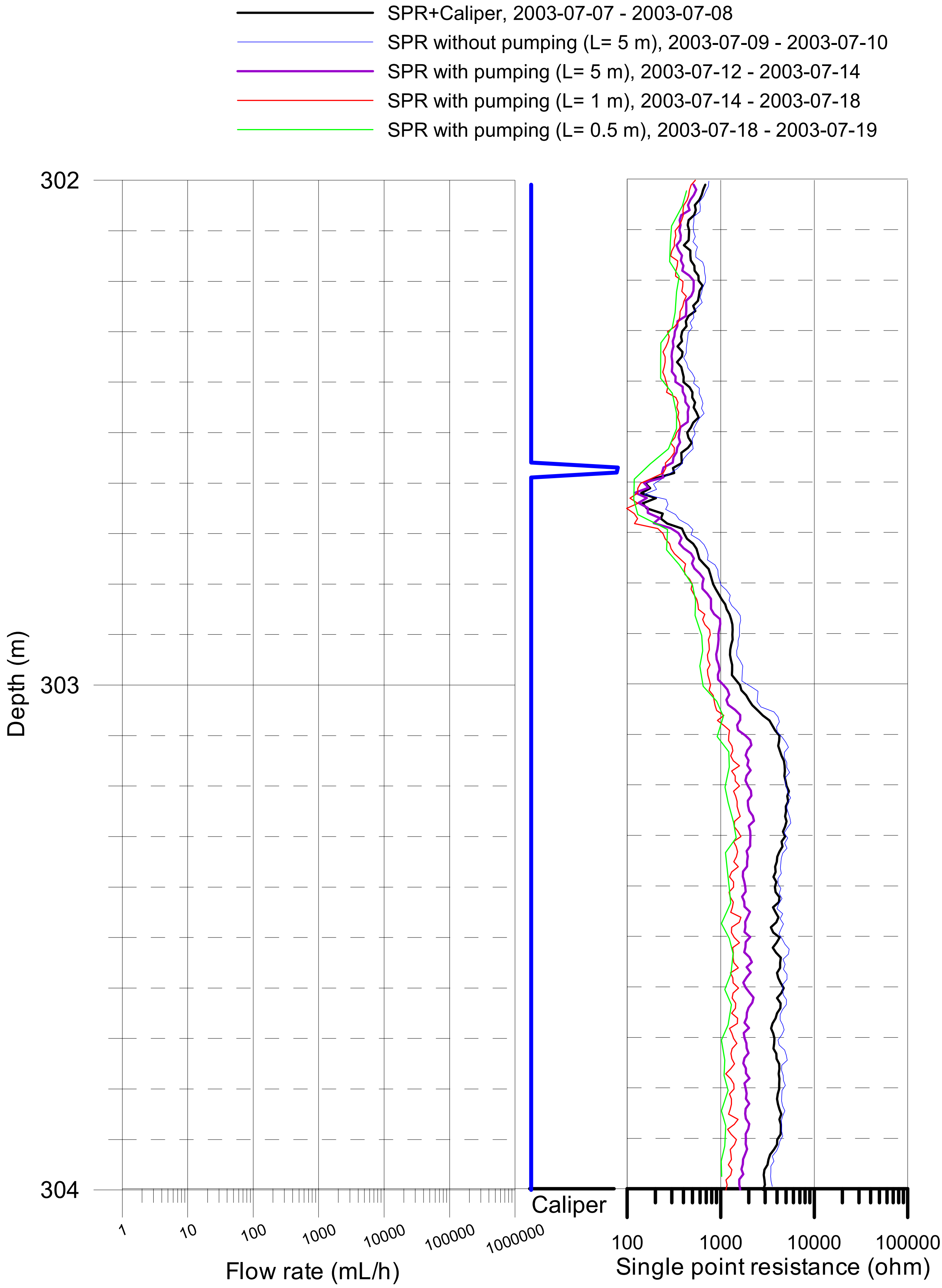

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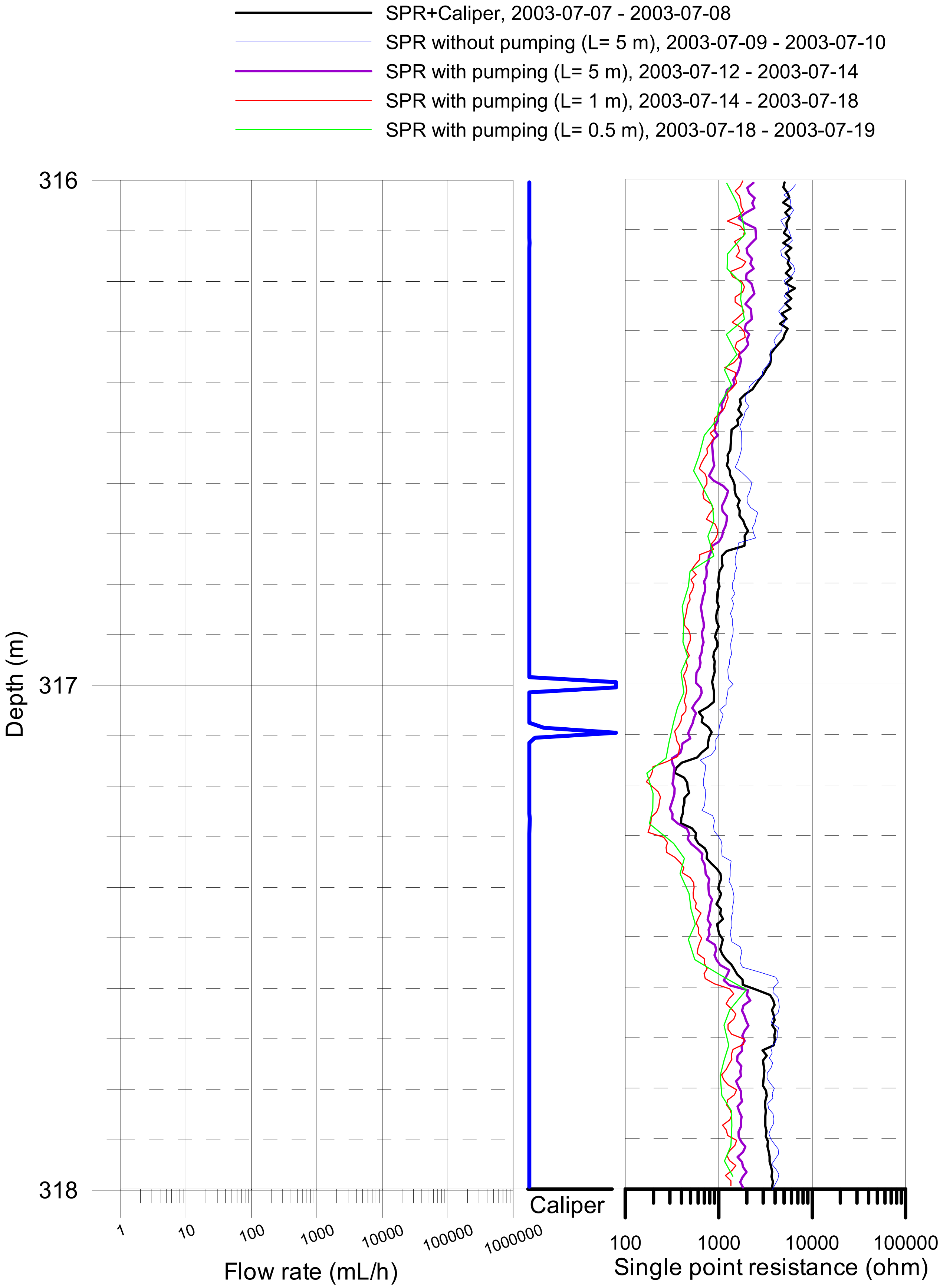

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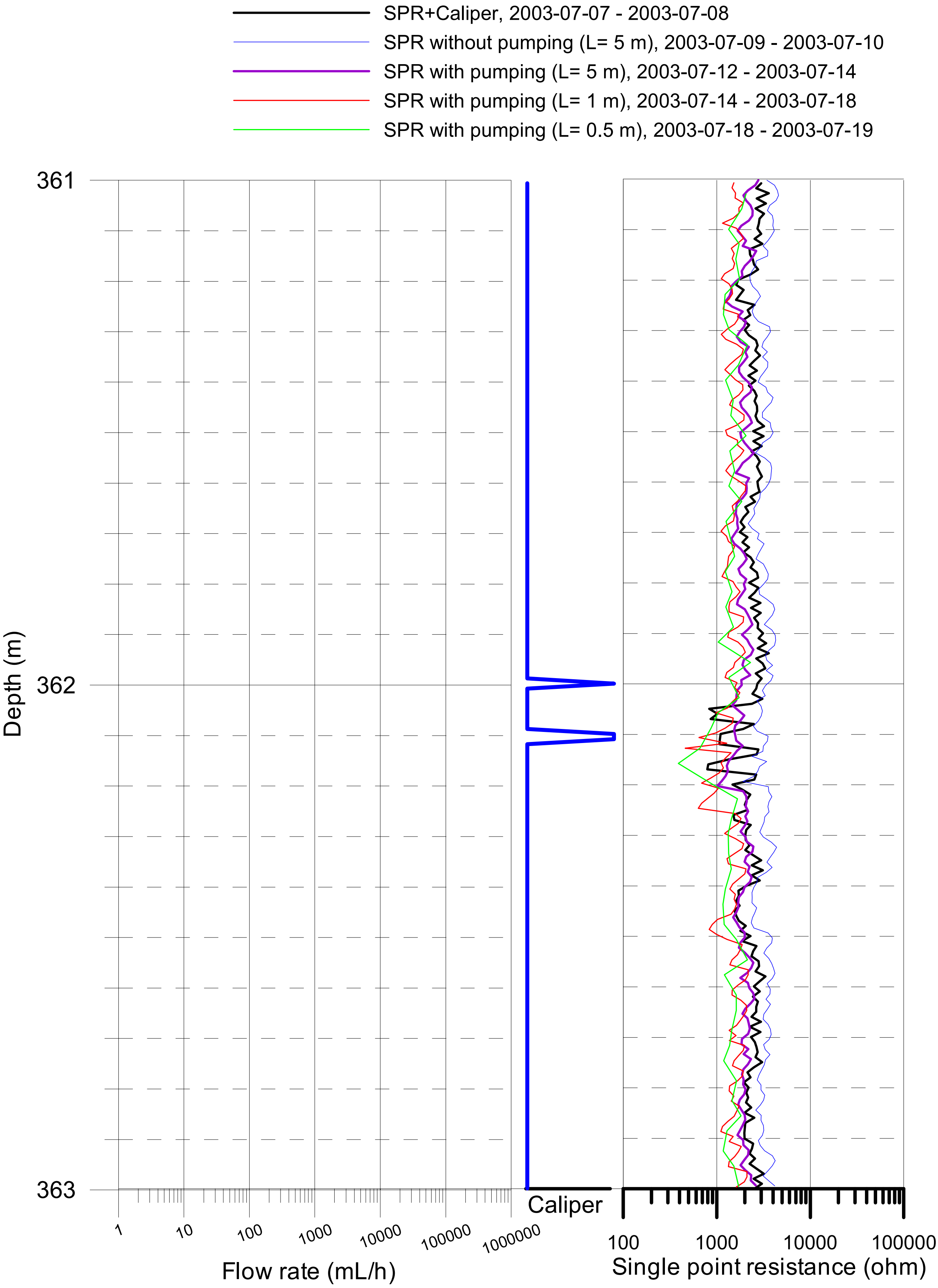

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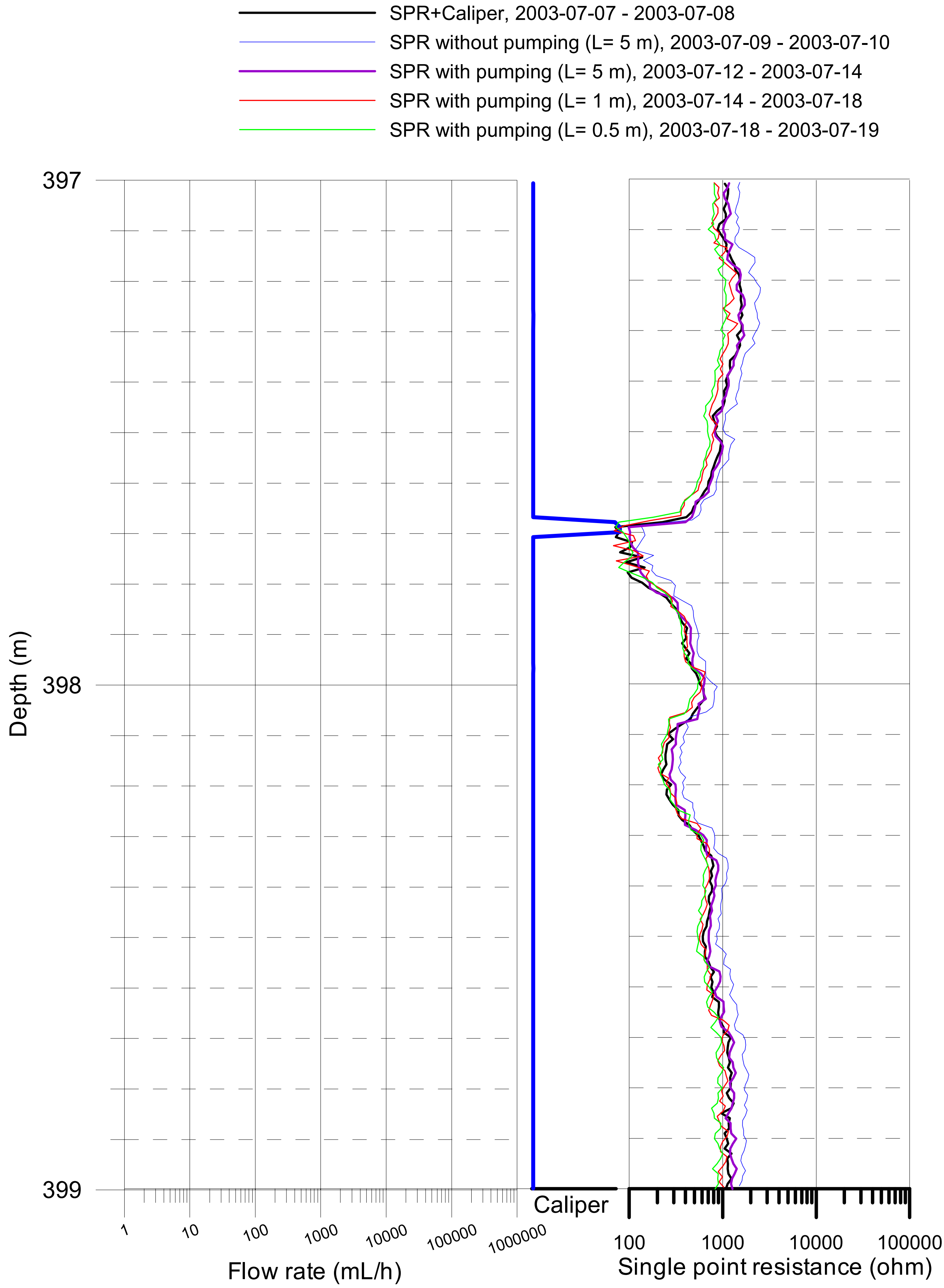

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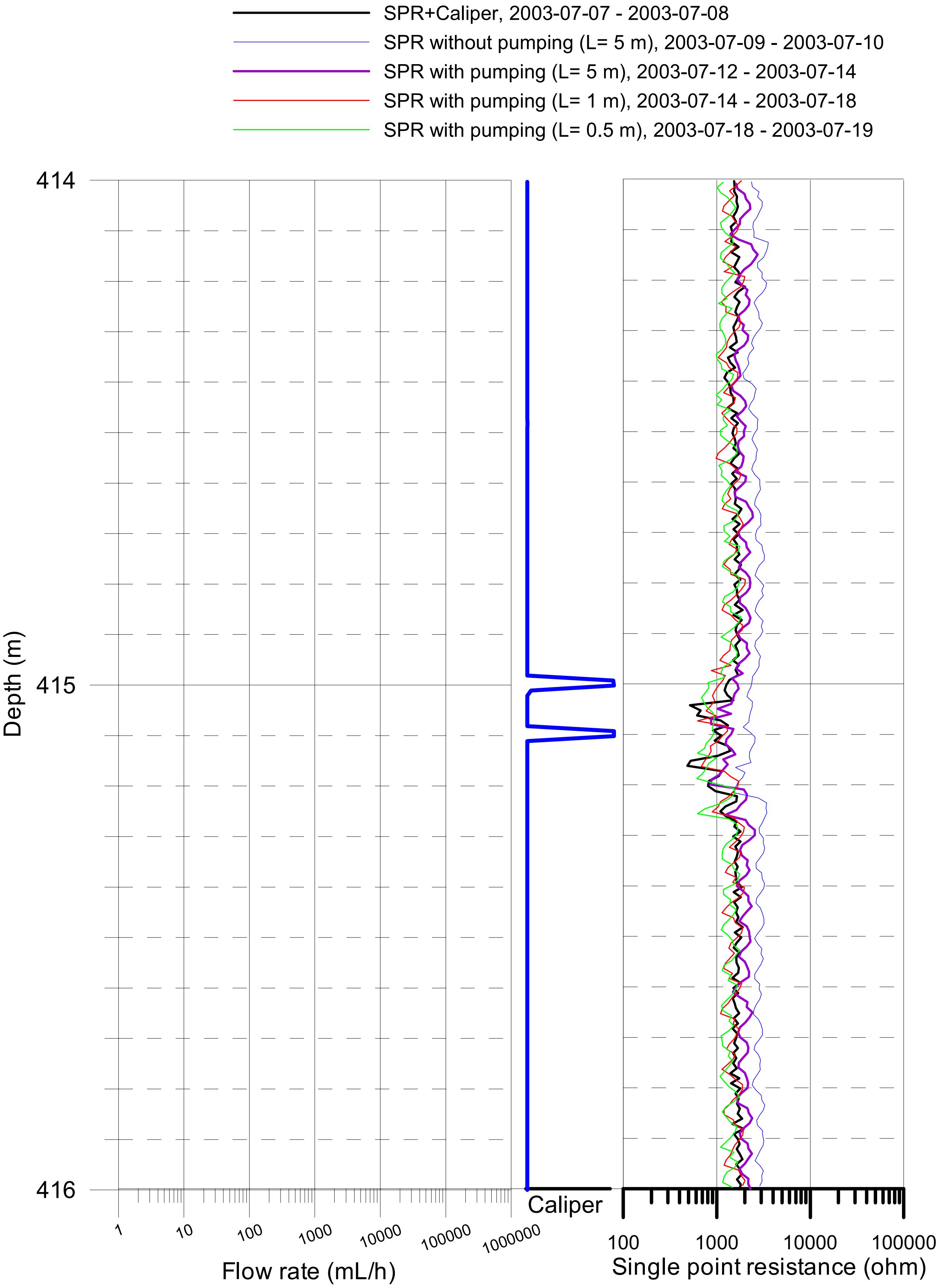

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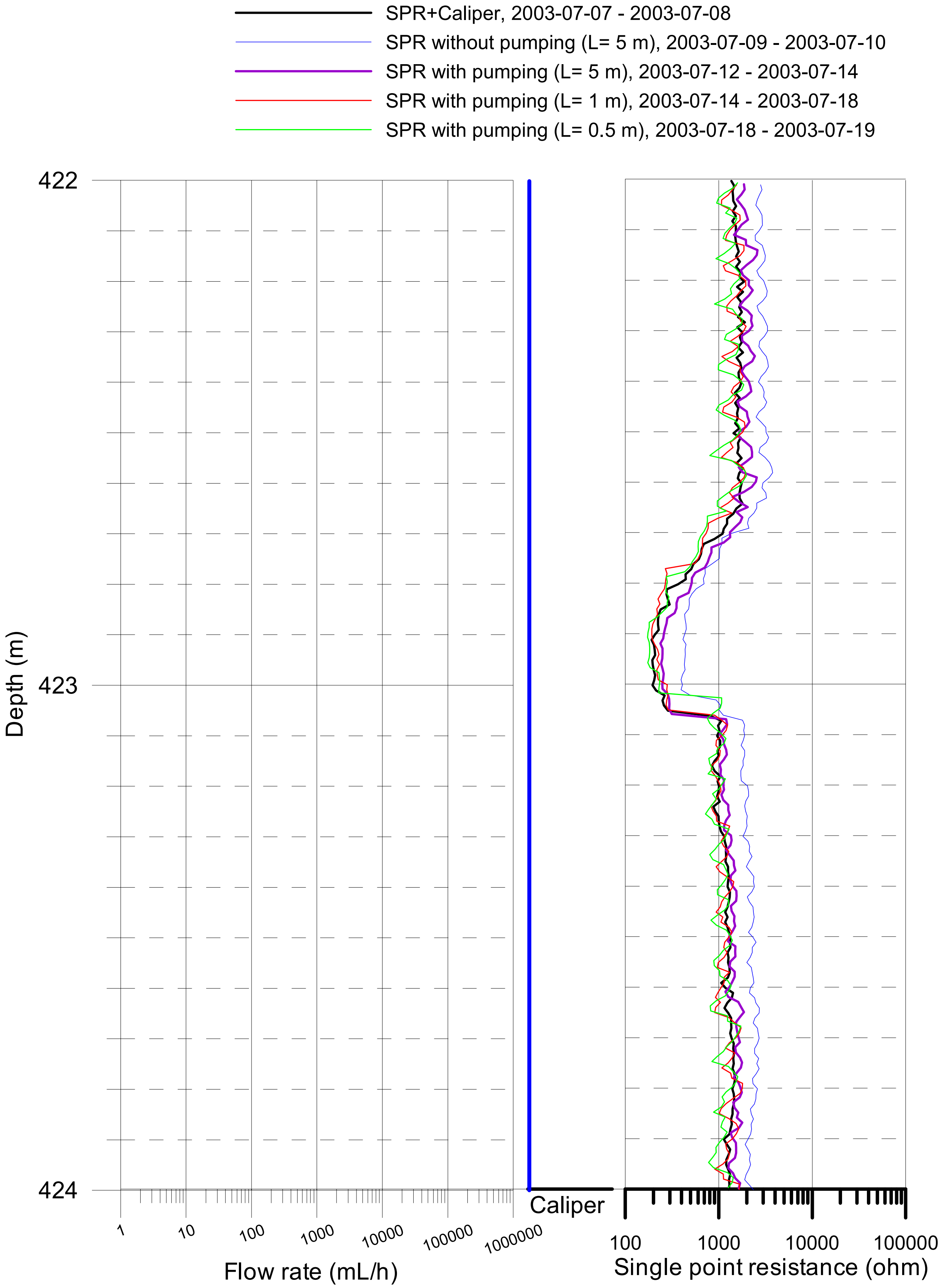

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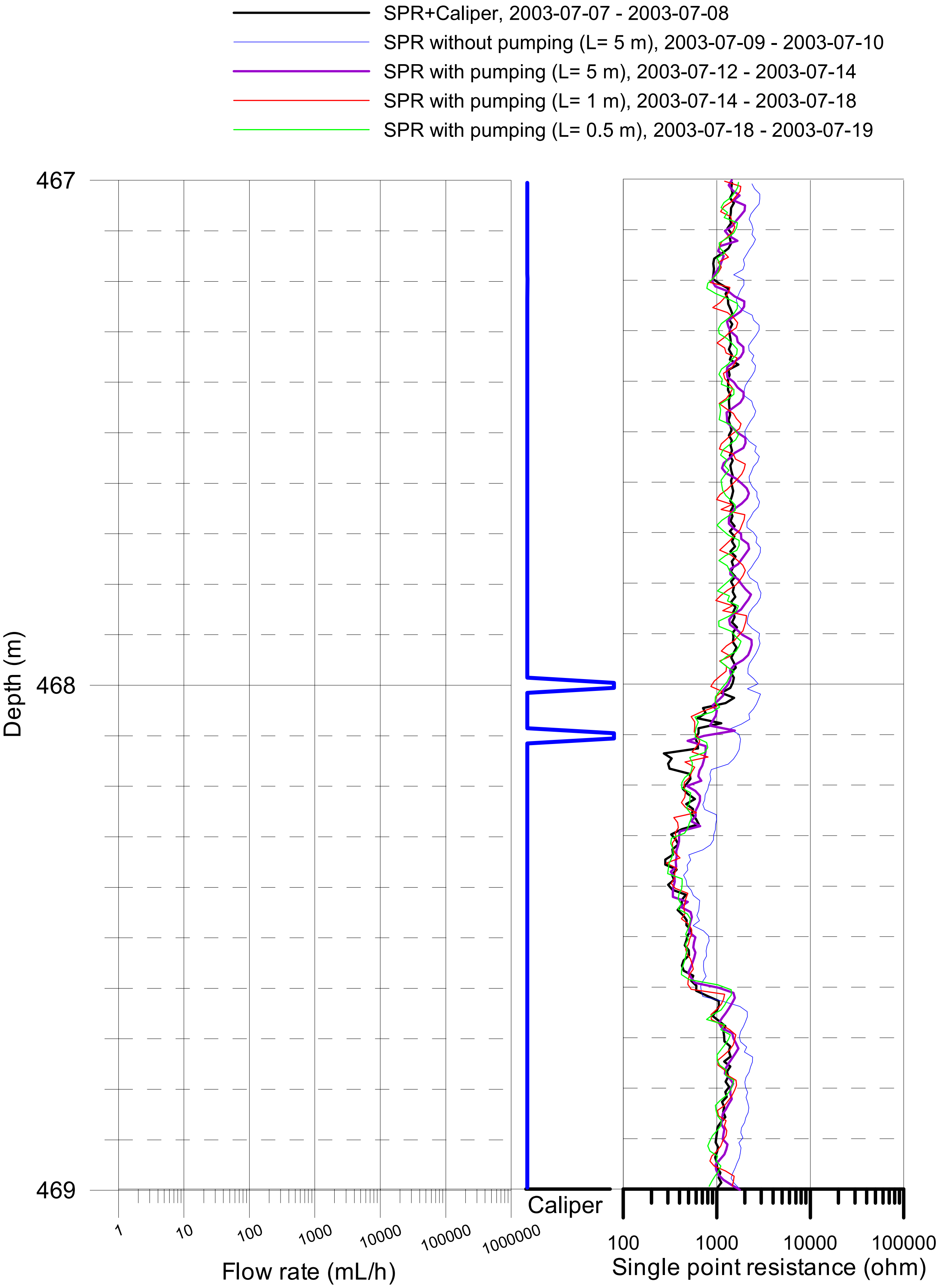

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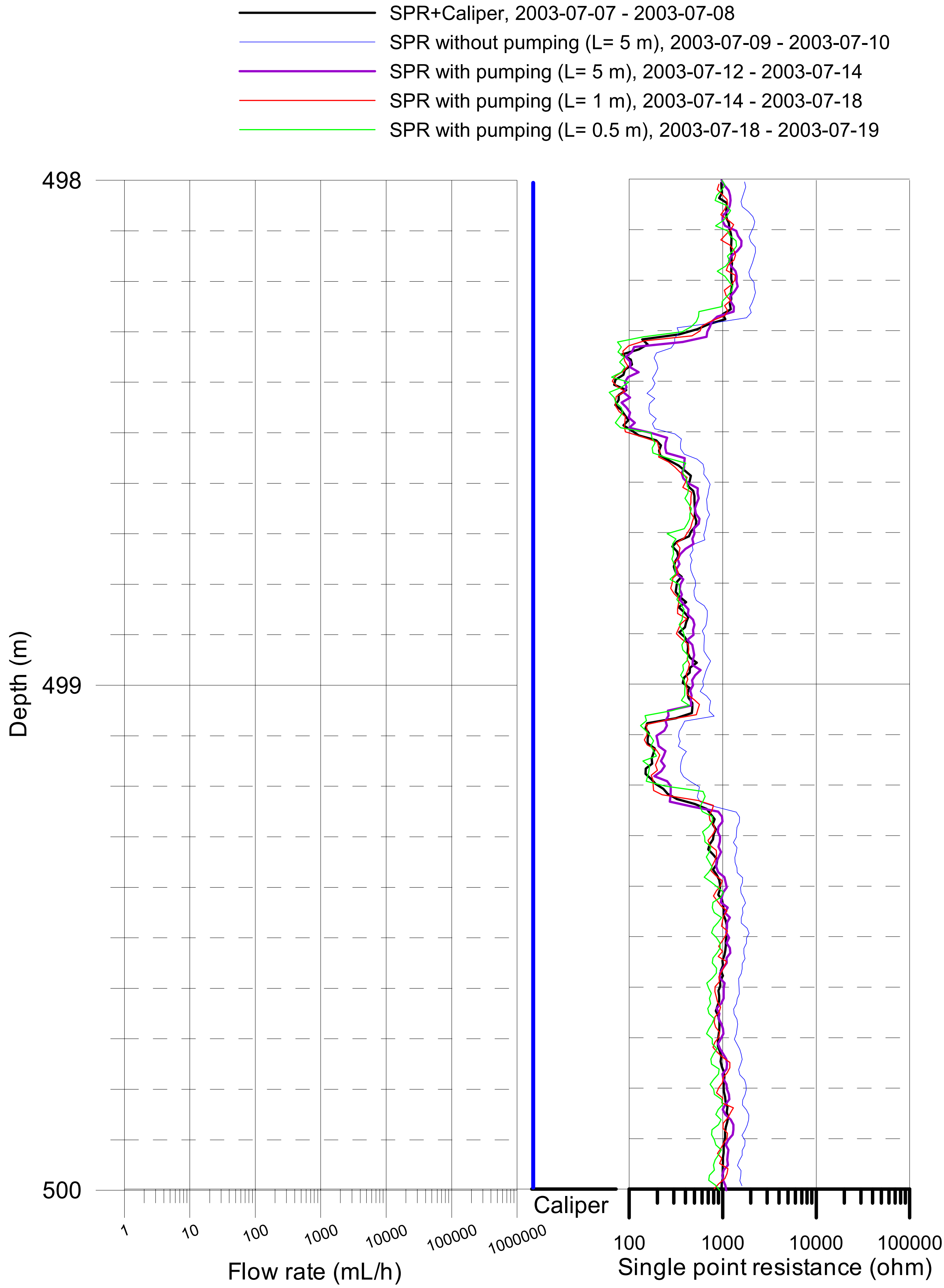

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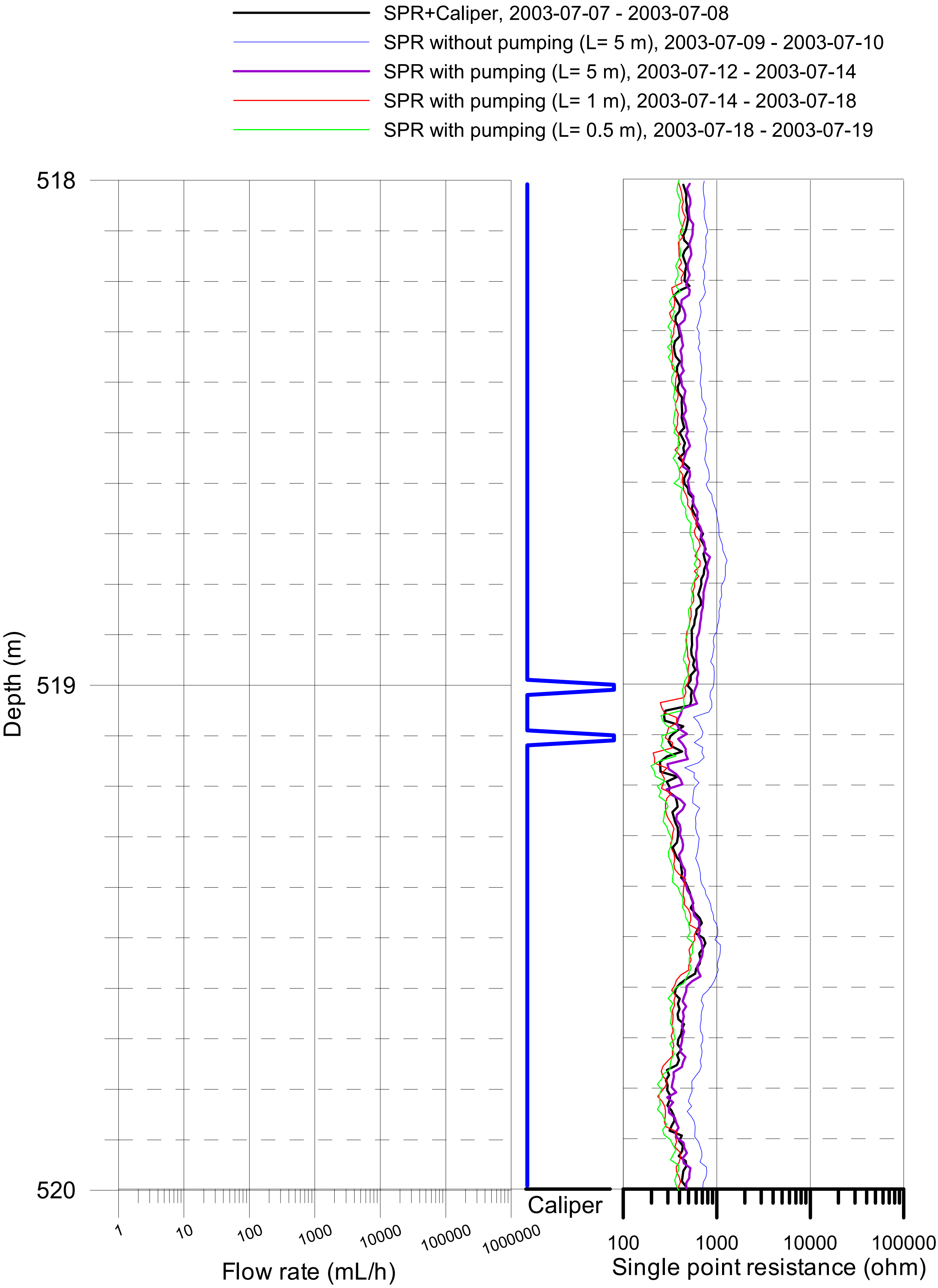

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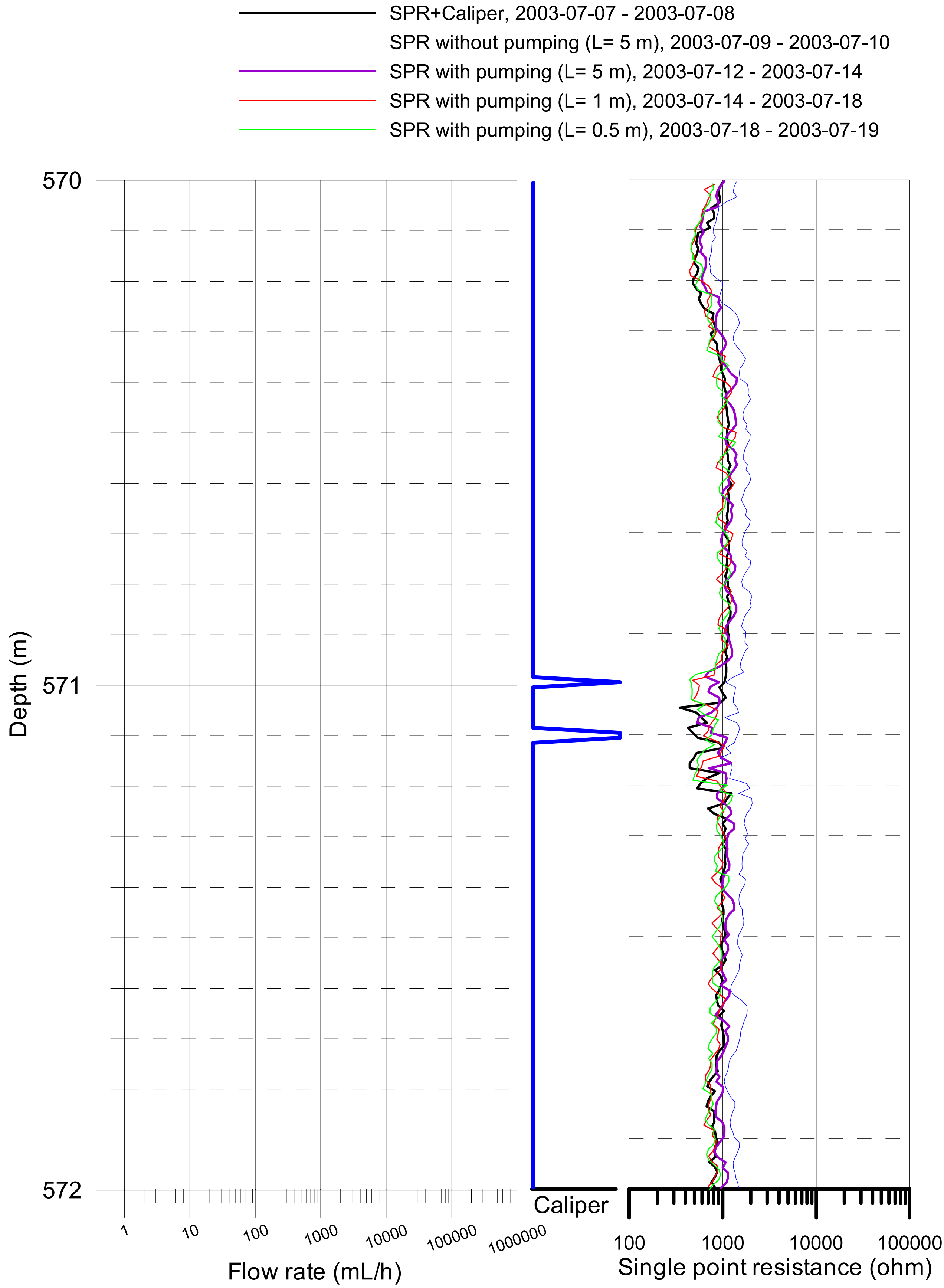

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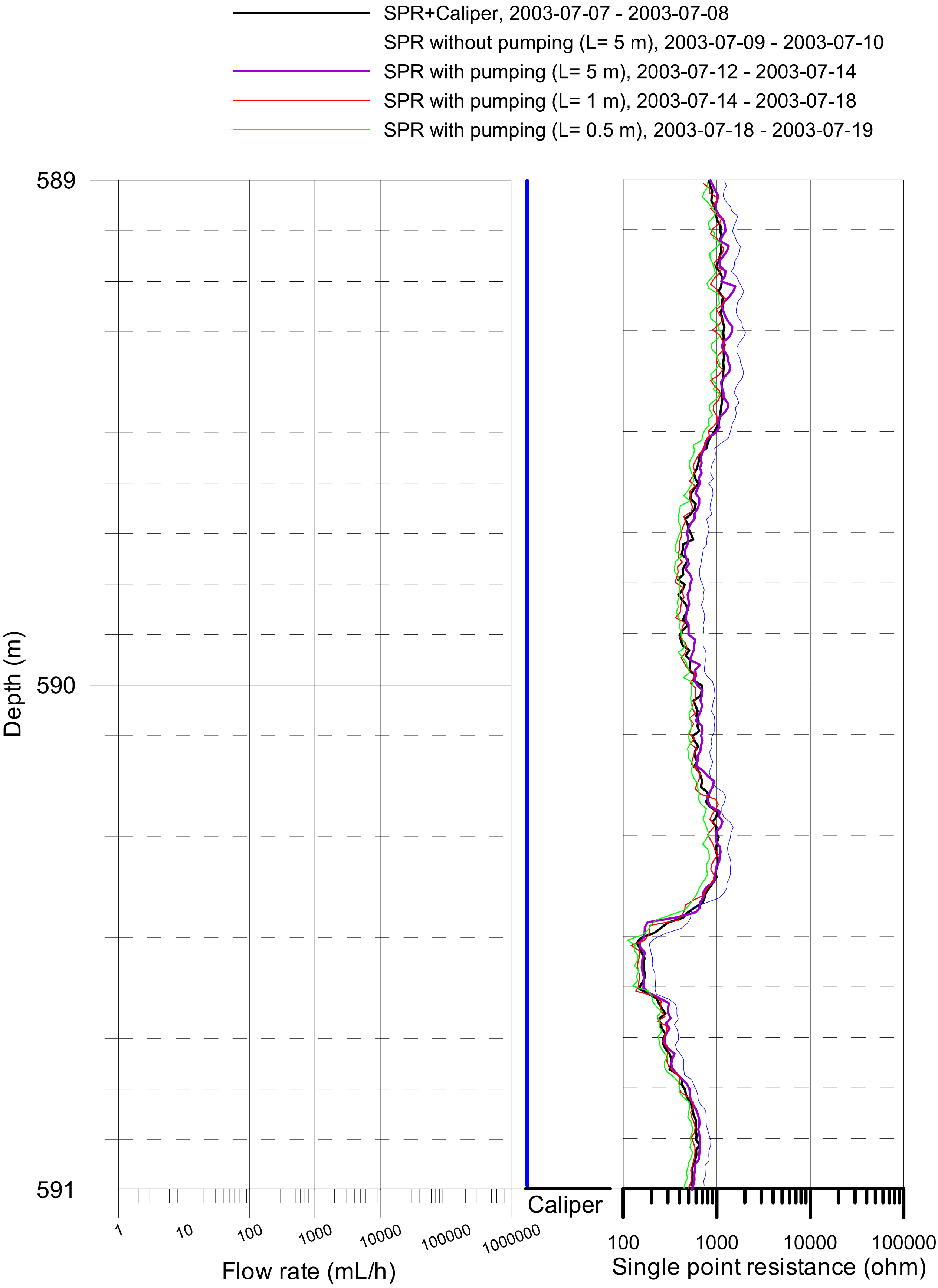

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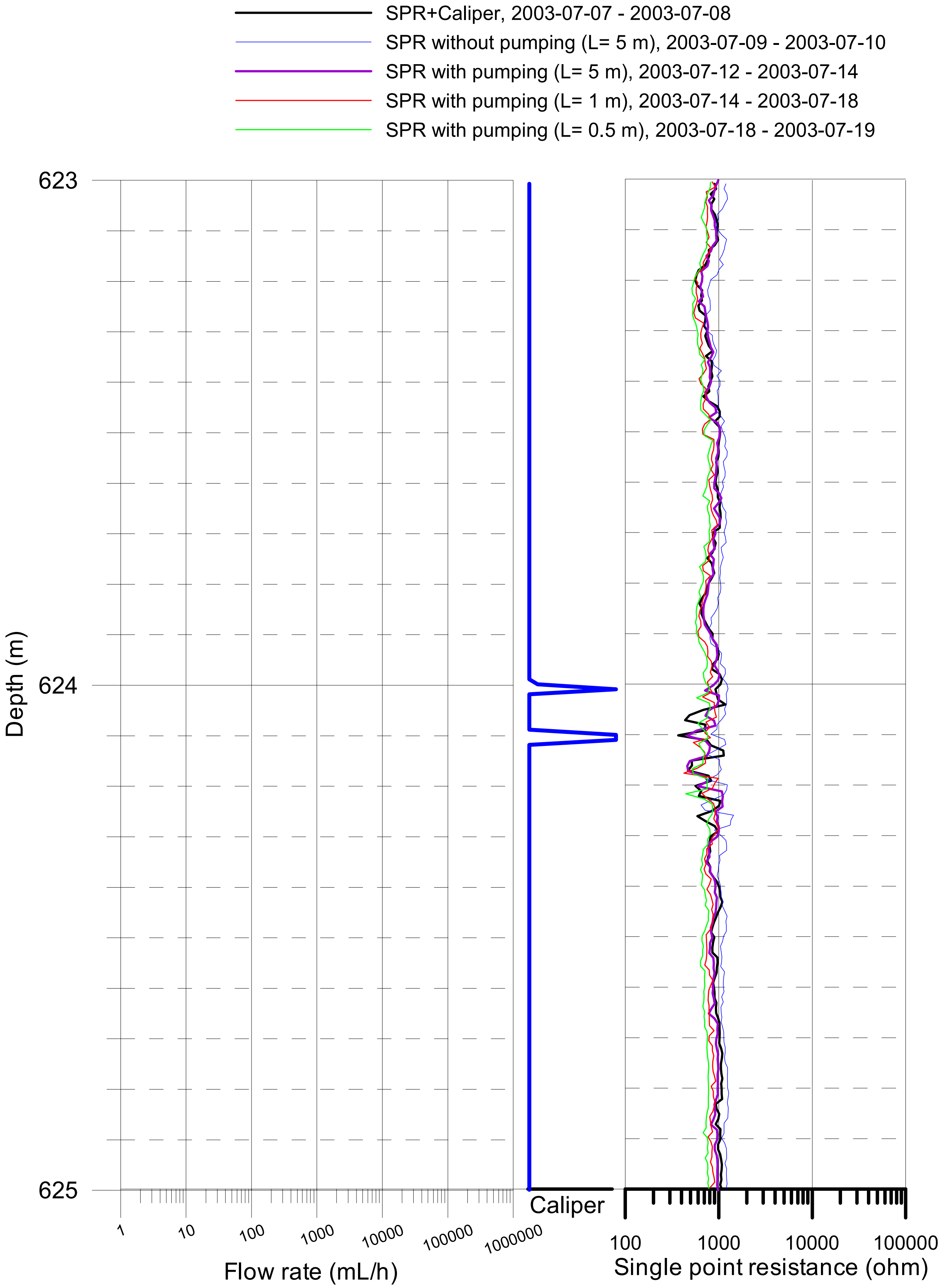

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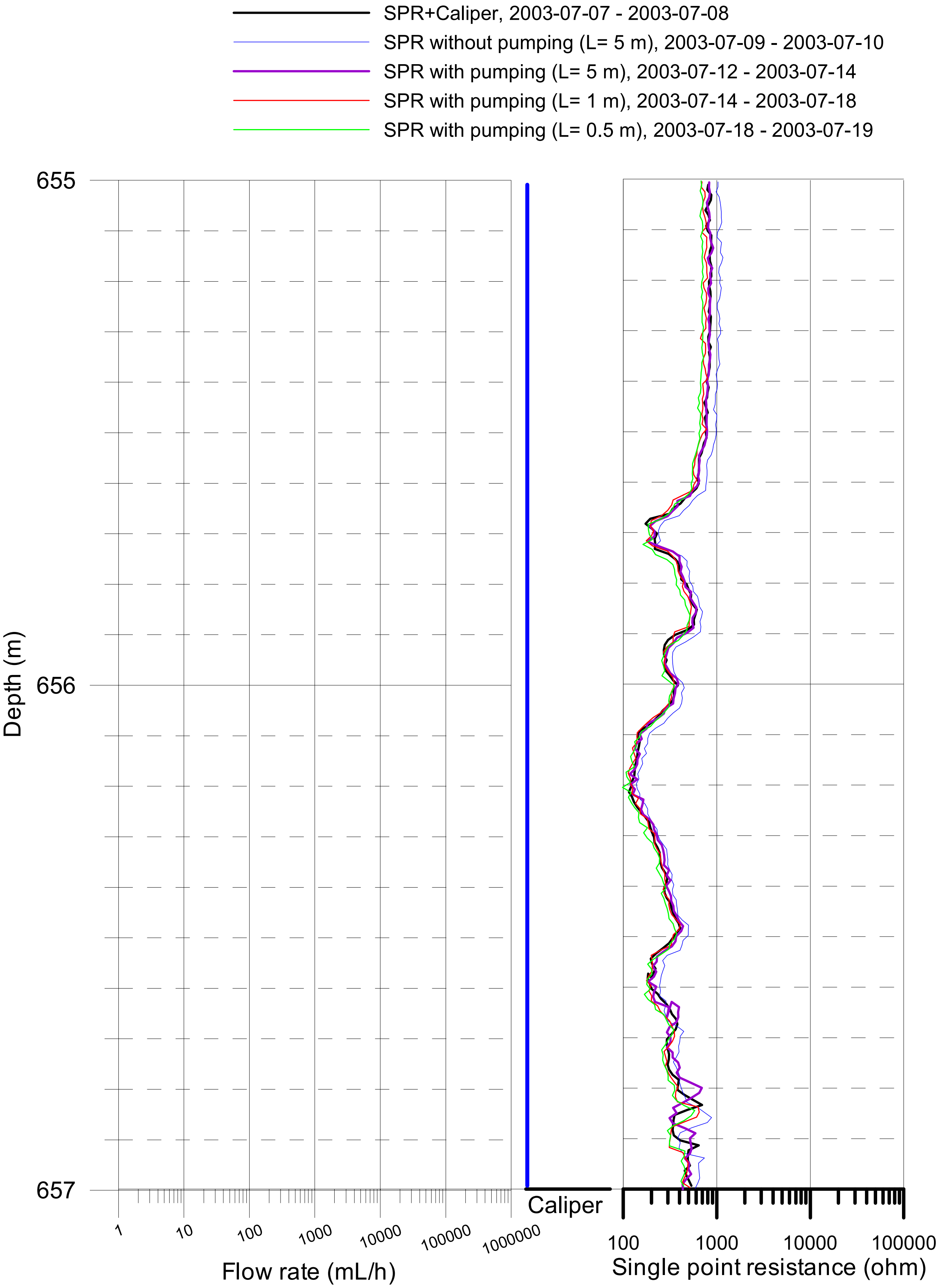

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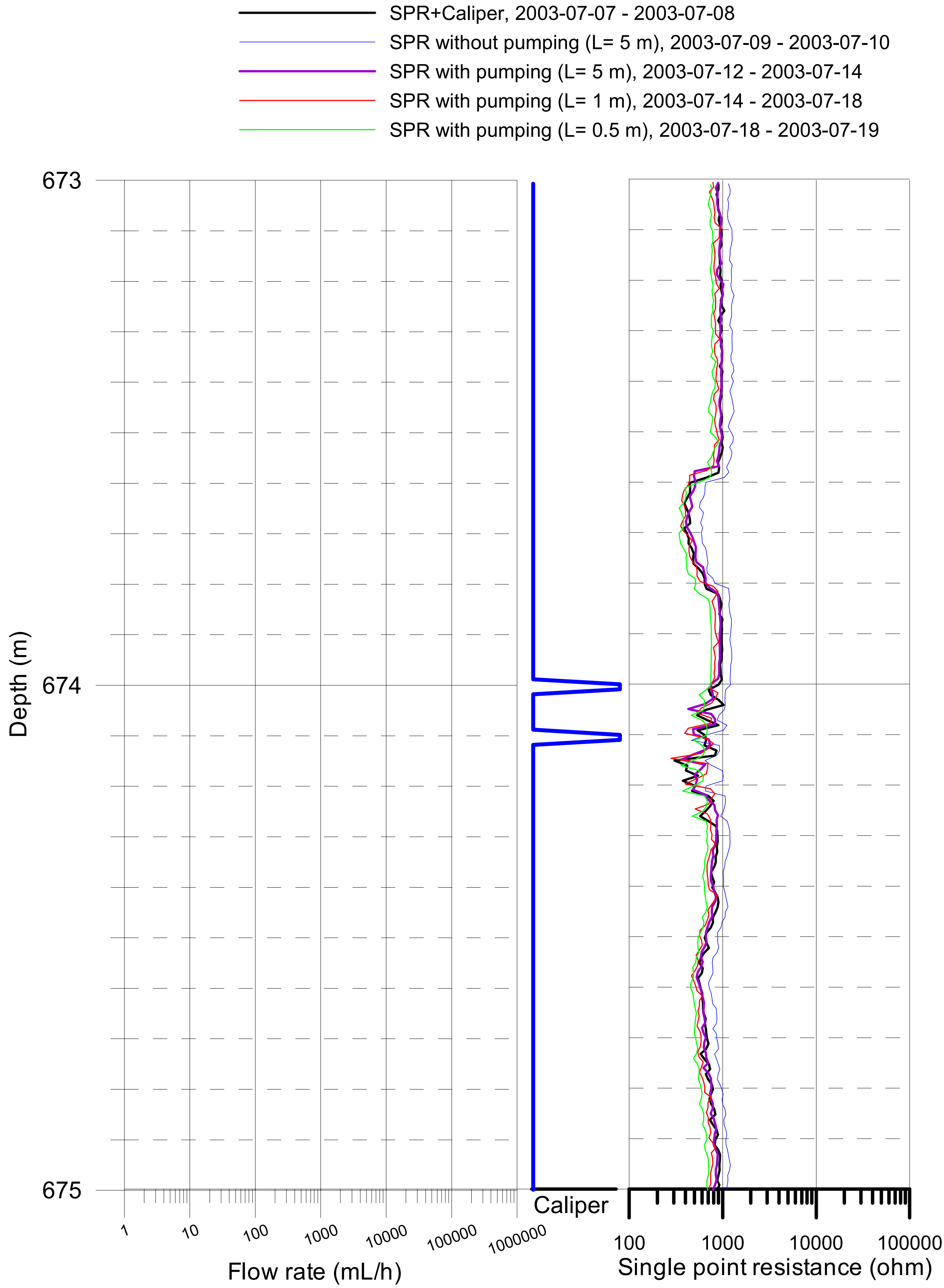

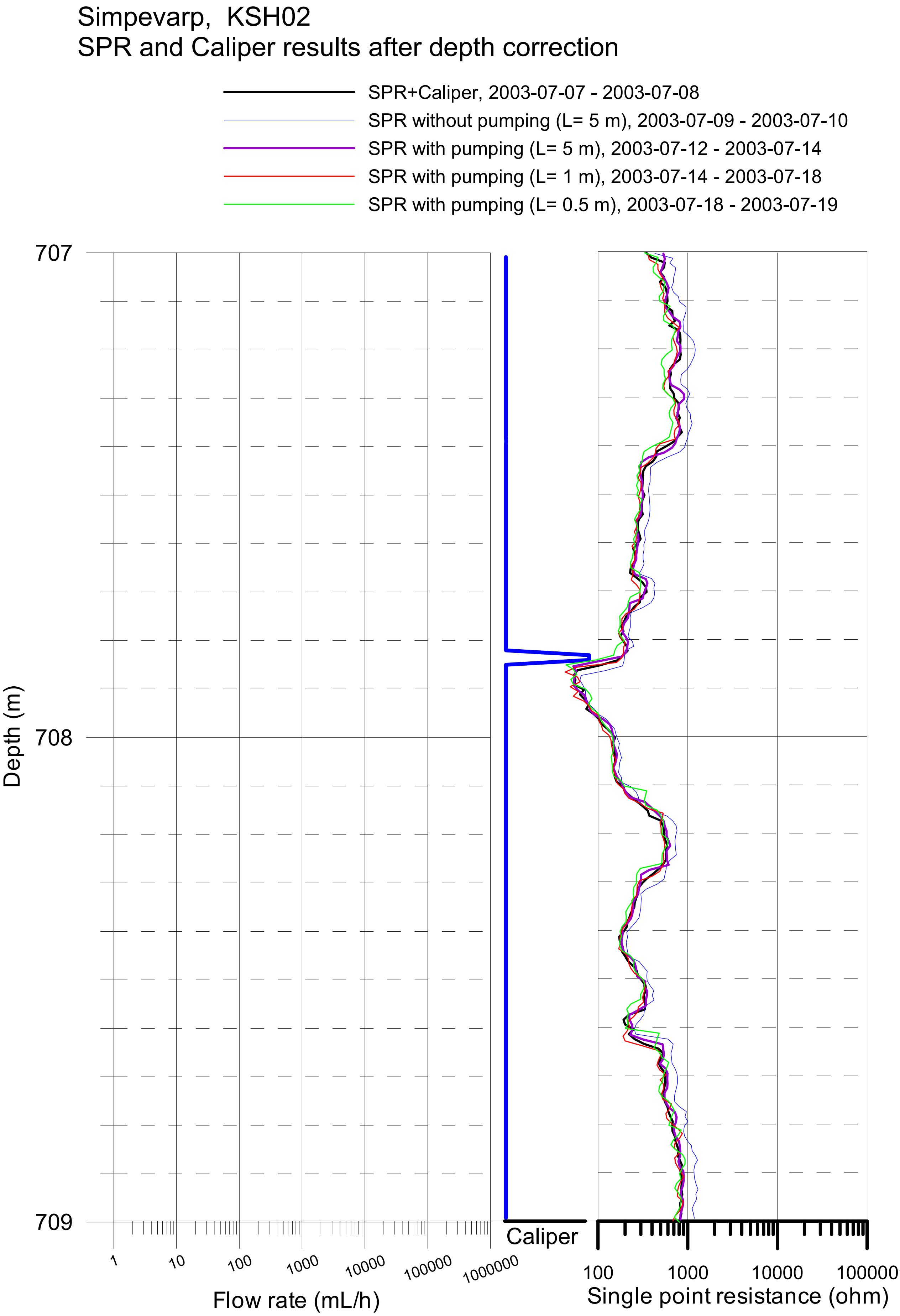
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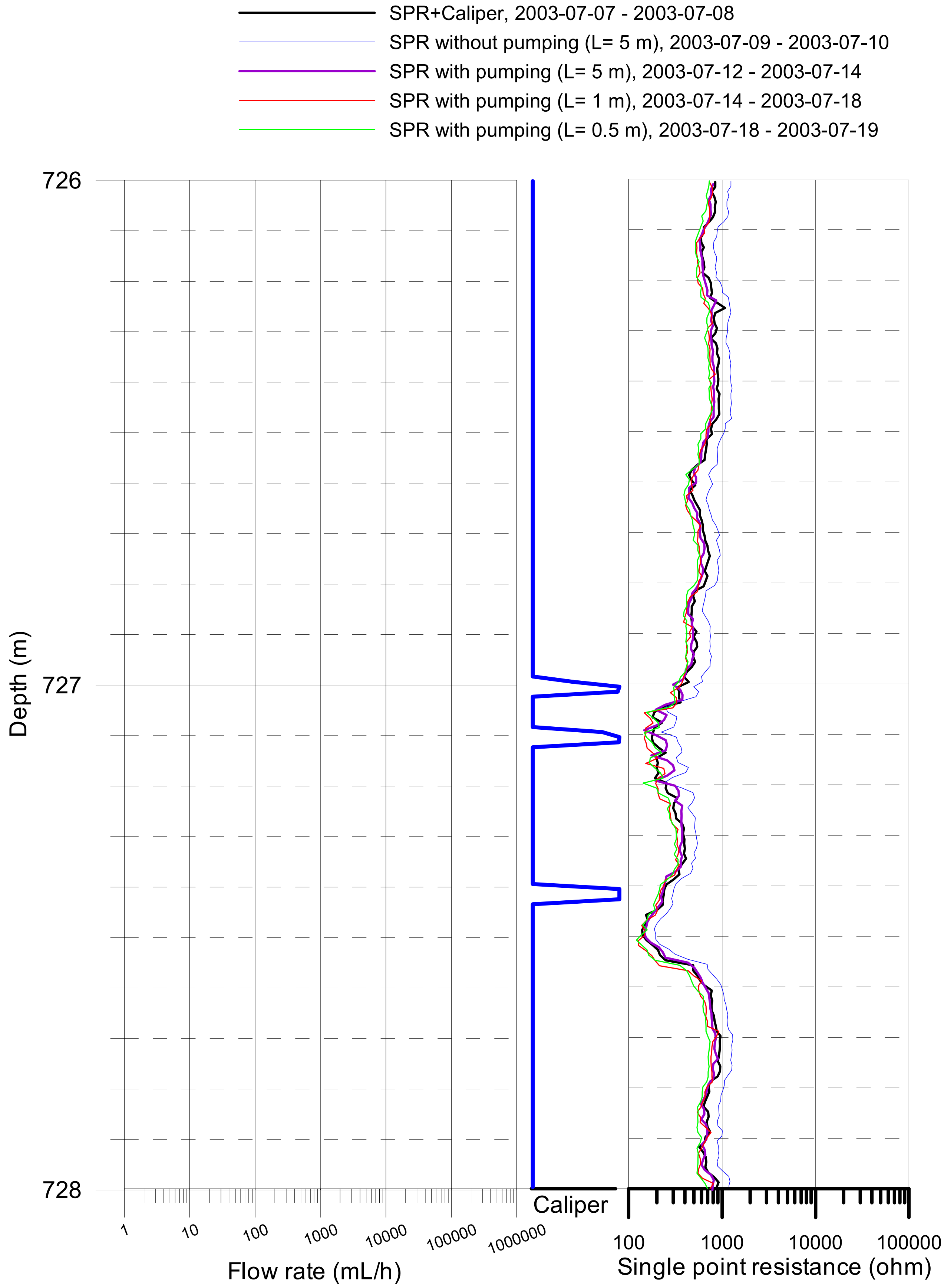
SPR with pumping (L= 5 m), 2003-07-12 - 2003-07-14
SPR with pumping (L= 1 m), 2003-07-14 - 2003-07-18
SPR with pumping (L= 0.5 m), 2003-07-18 - 2003-07-19
707
708
709
Depth (m)
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)

Simpevarp, KSH02
SPR and Caliper results after depth correction



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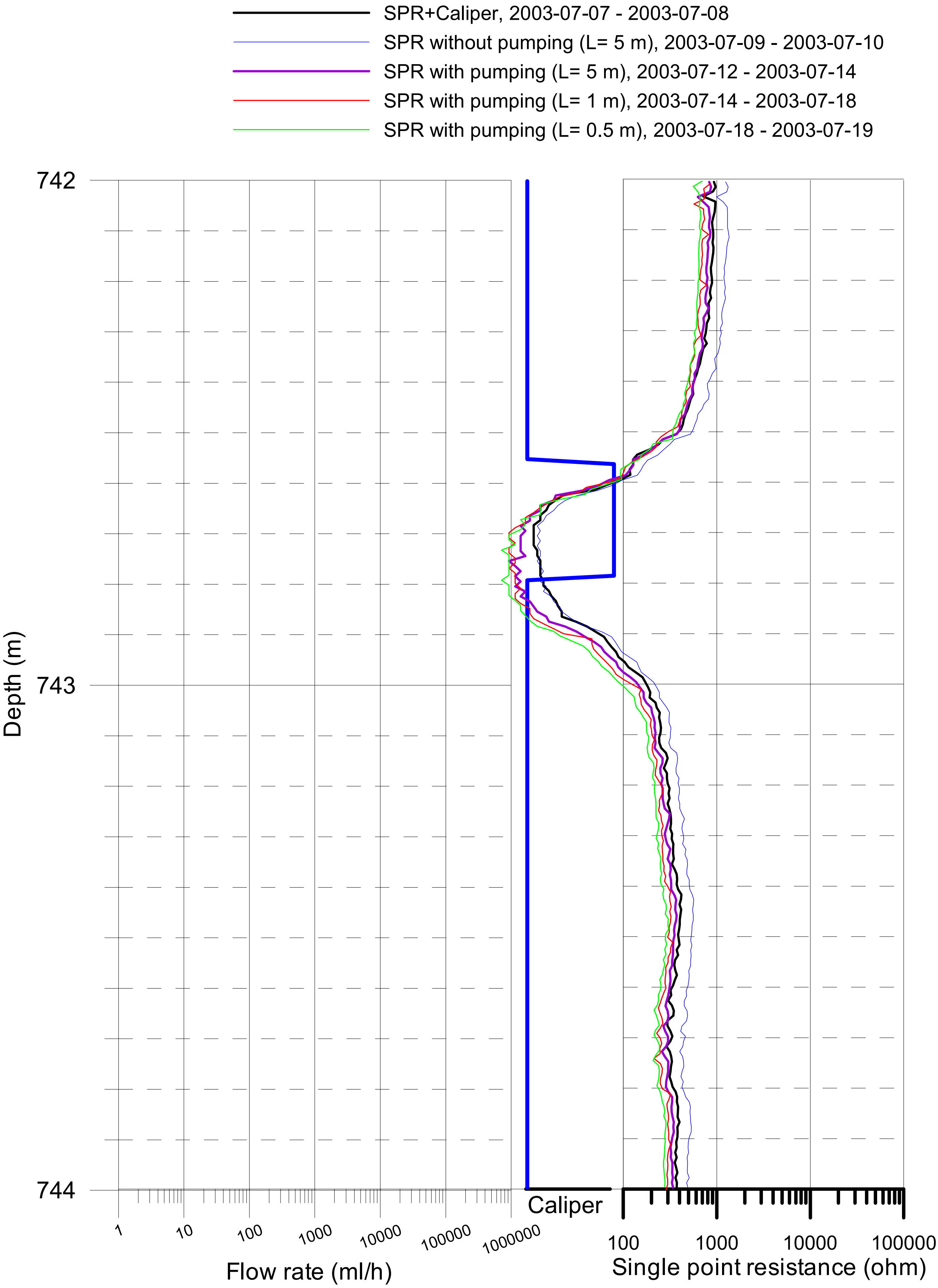

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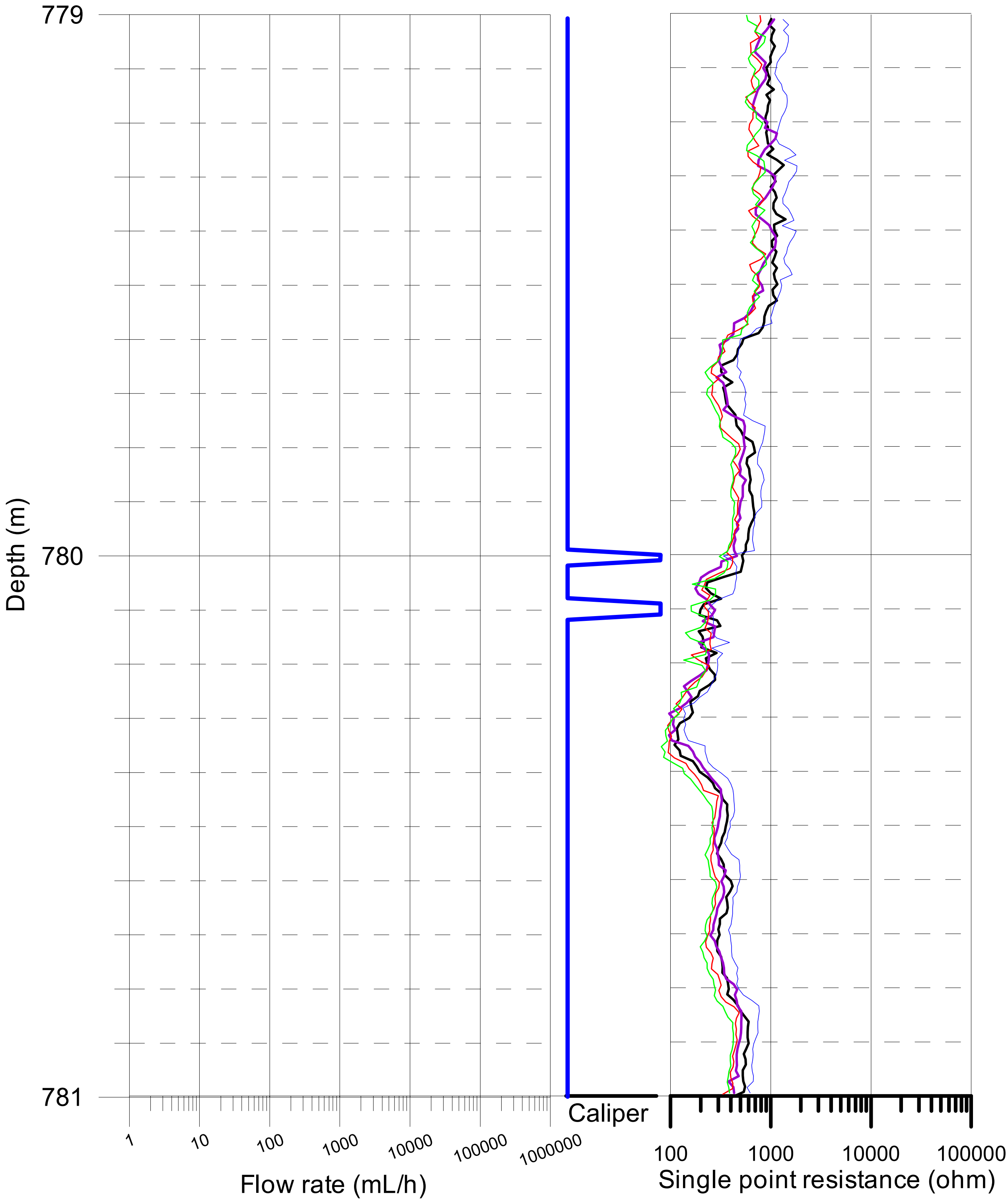

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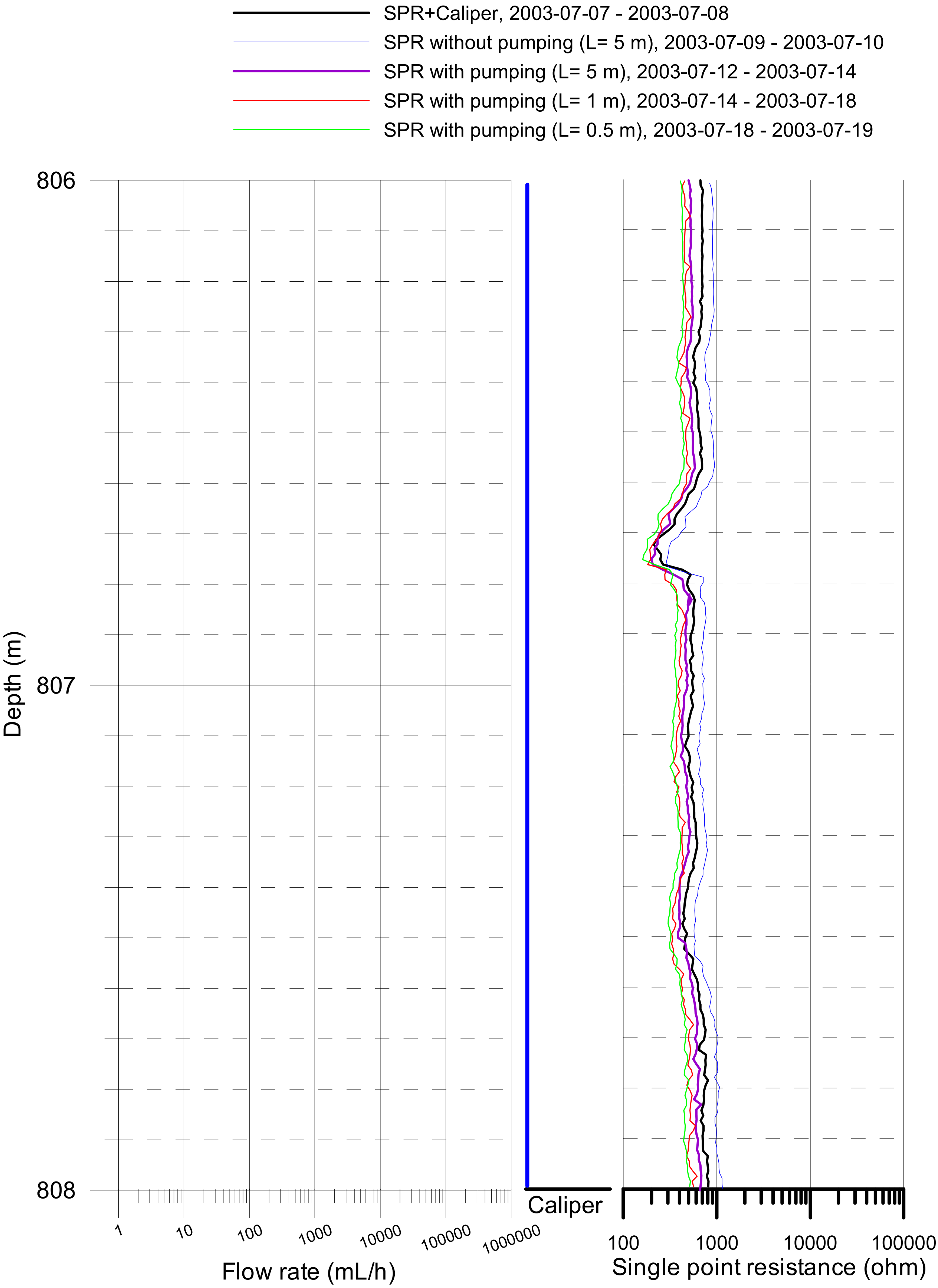

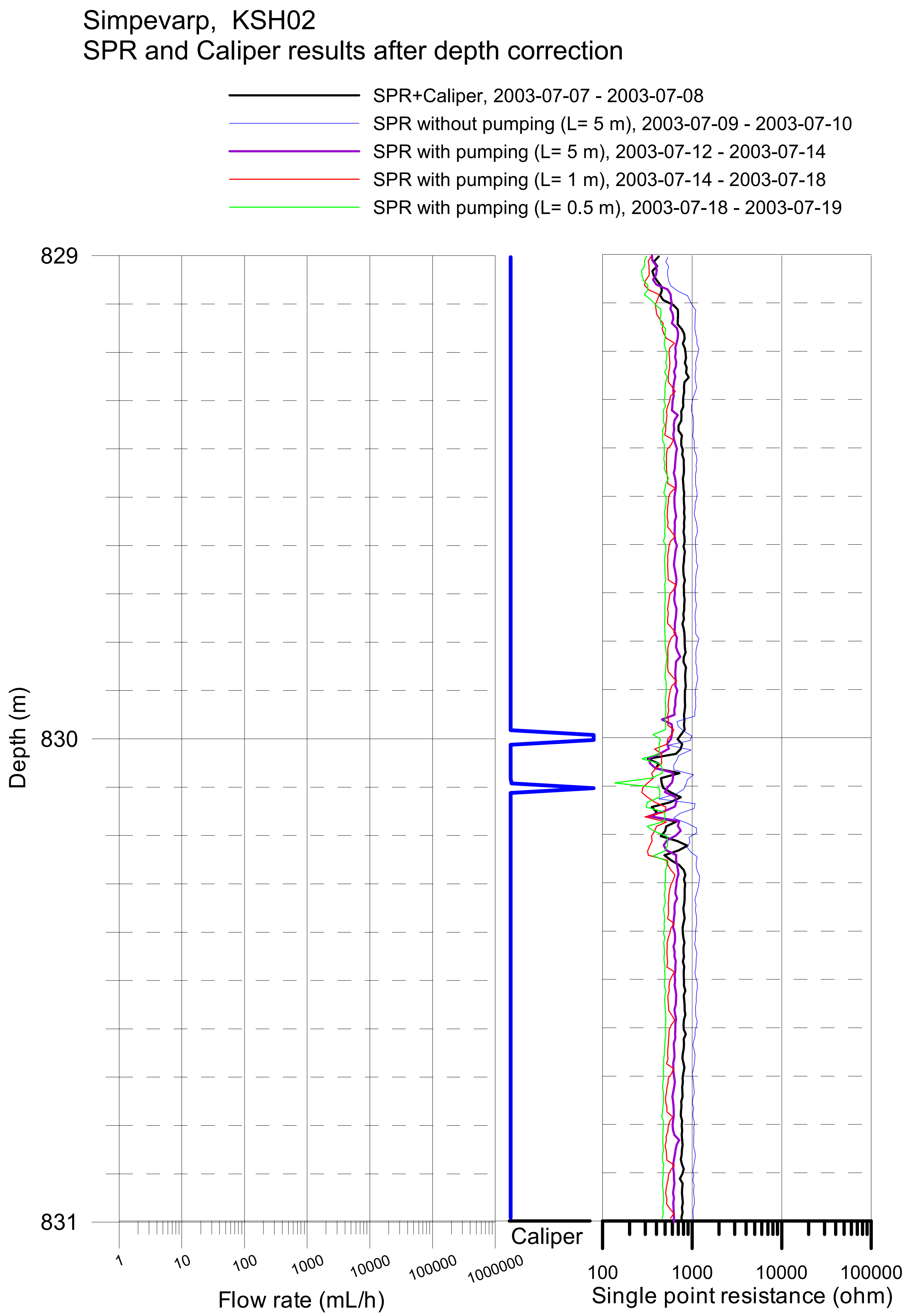
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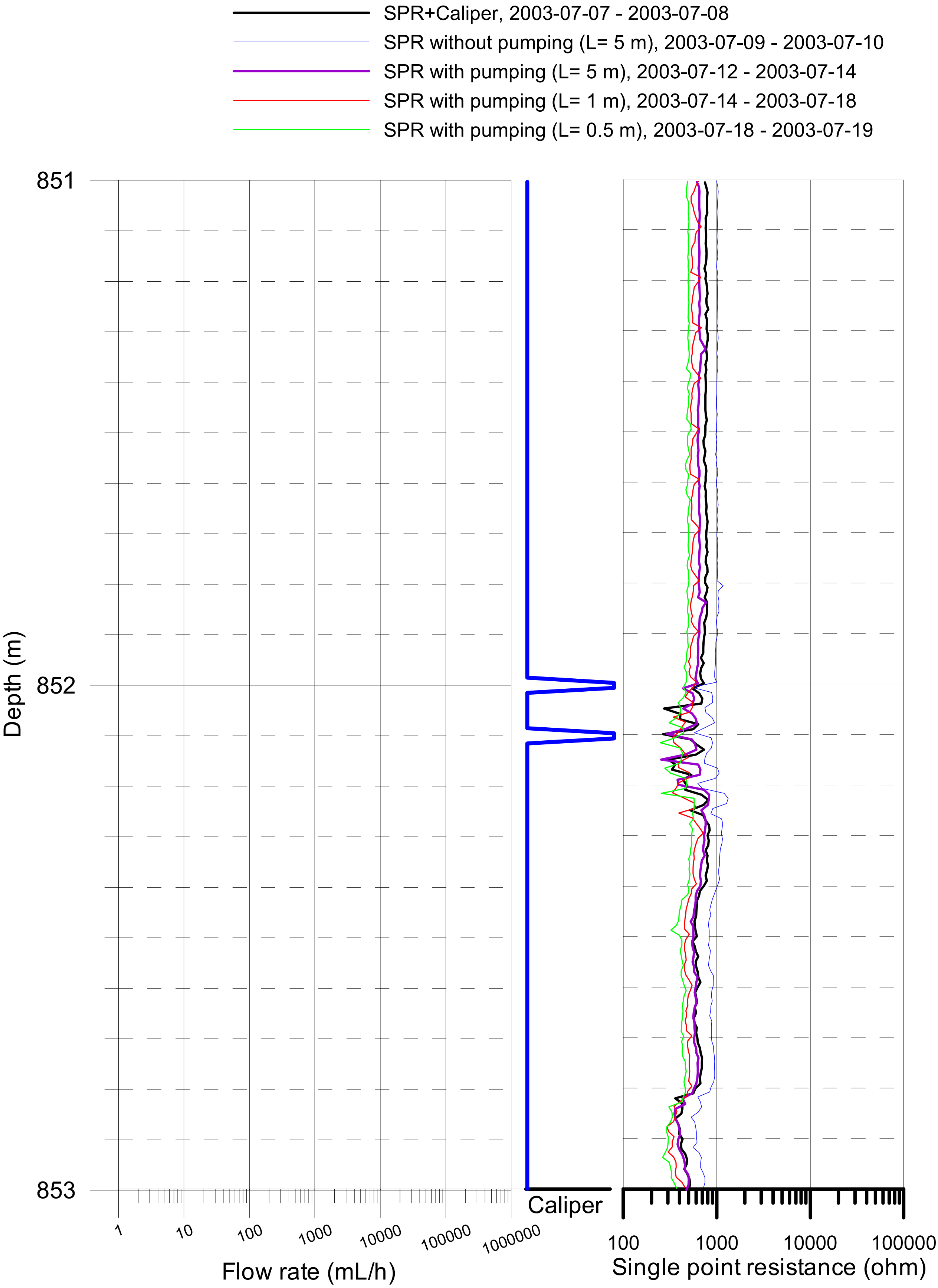
SPR with pumping (L= 5 m), 2003-07-12 - 2003-07-14
SPR with pumping (L= 1 m), 2003-07-14 - 2003-07-18
SPR with pumping (L= 0.5 m), 2003-07-18 - 2003-07-19
829
830
831
Depth (m)
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)

Simpevarp, KSH02
SPR and Caliper results after depth correction



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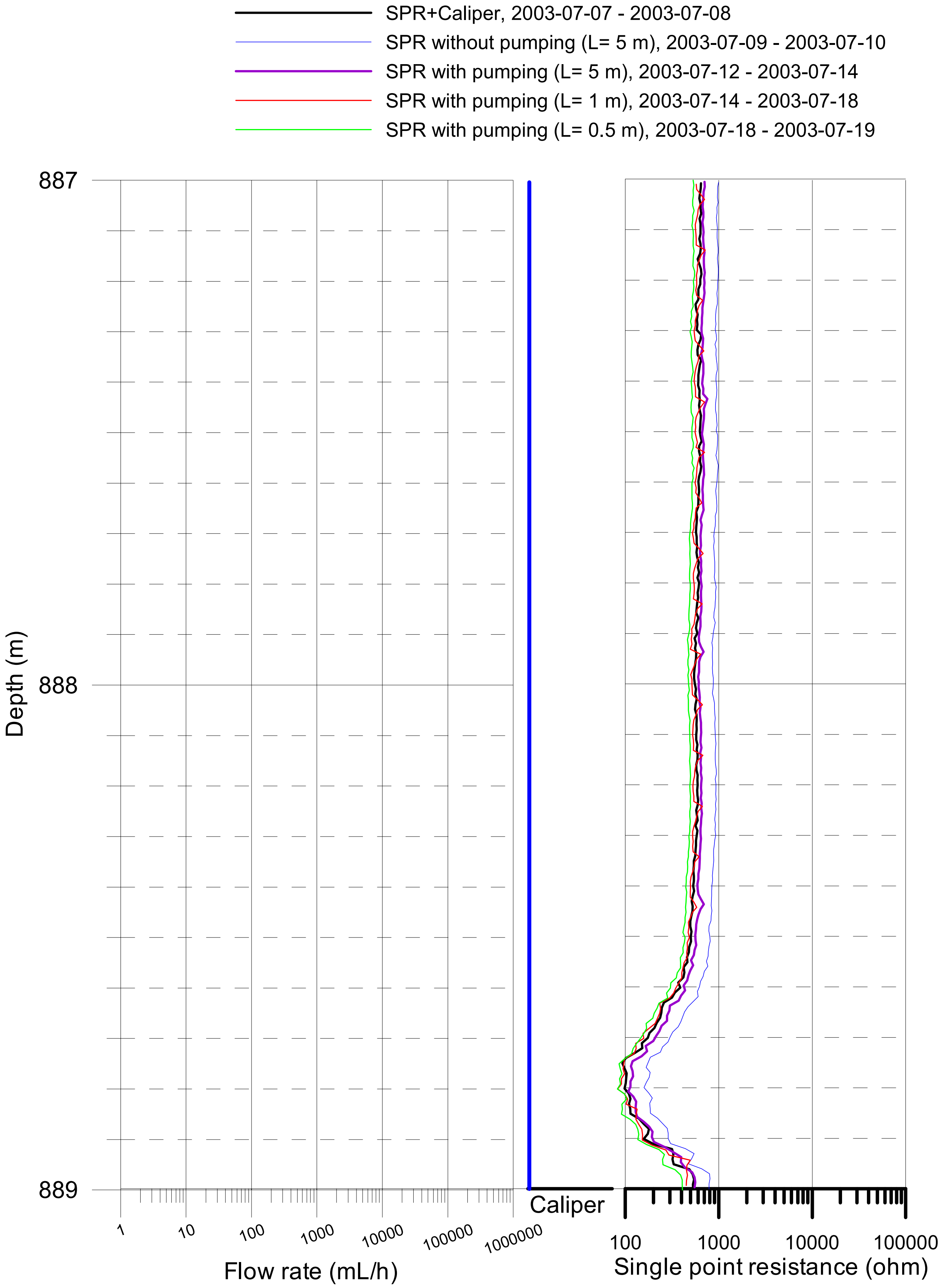
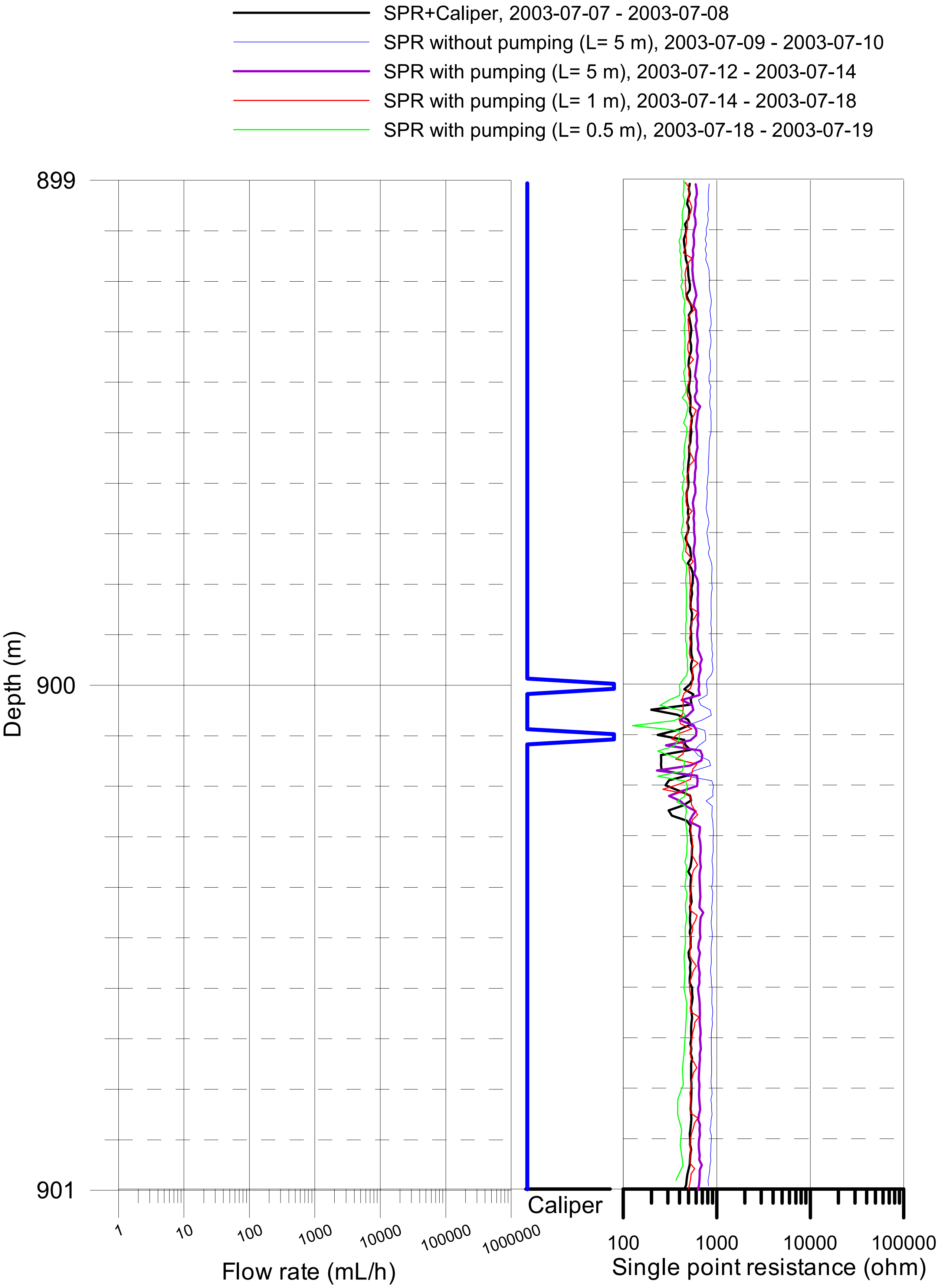
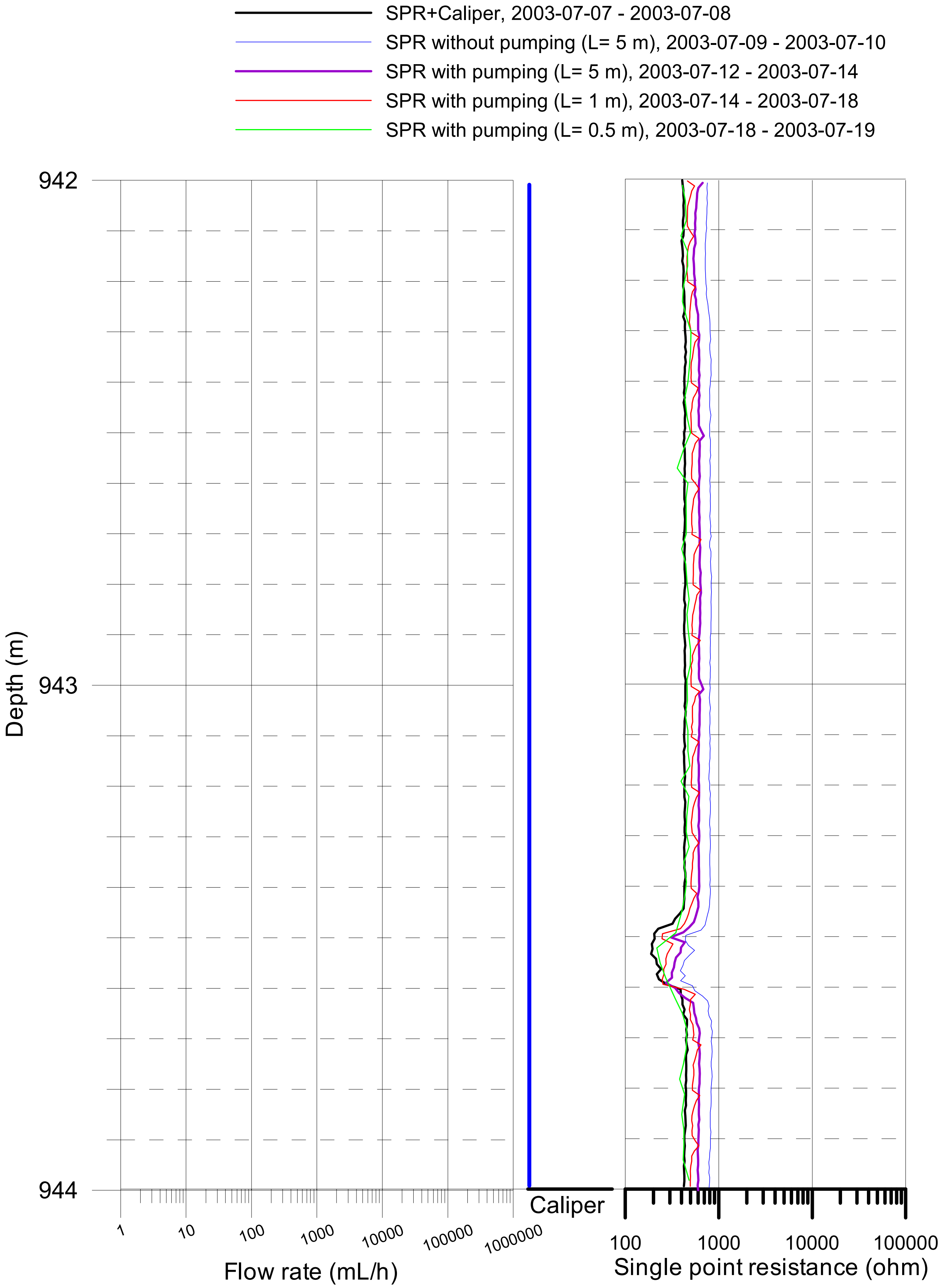


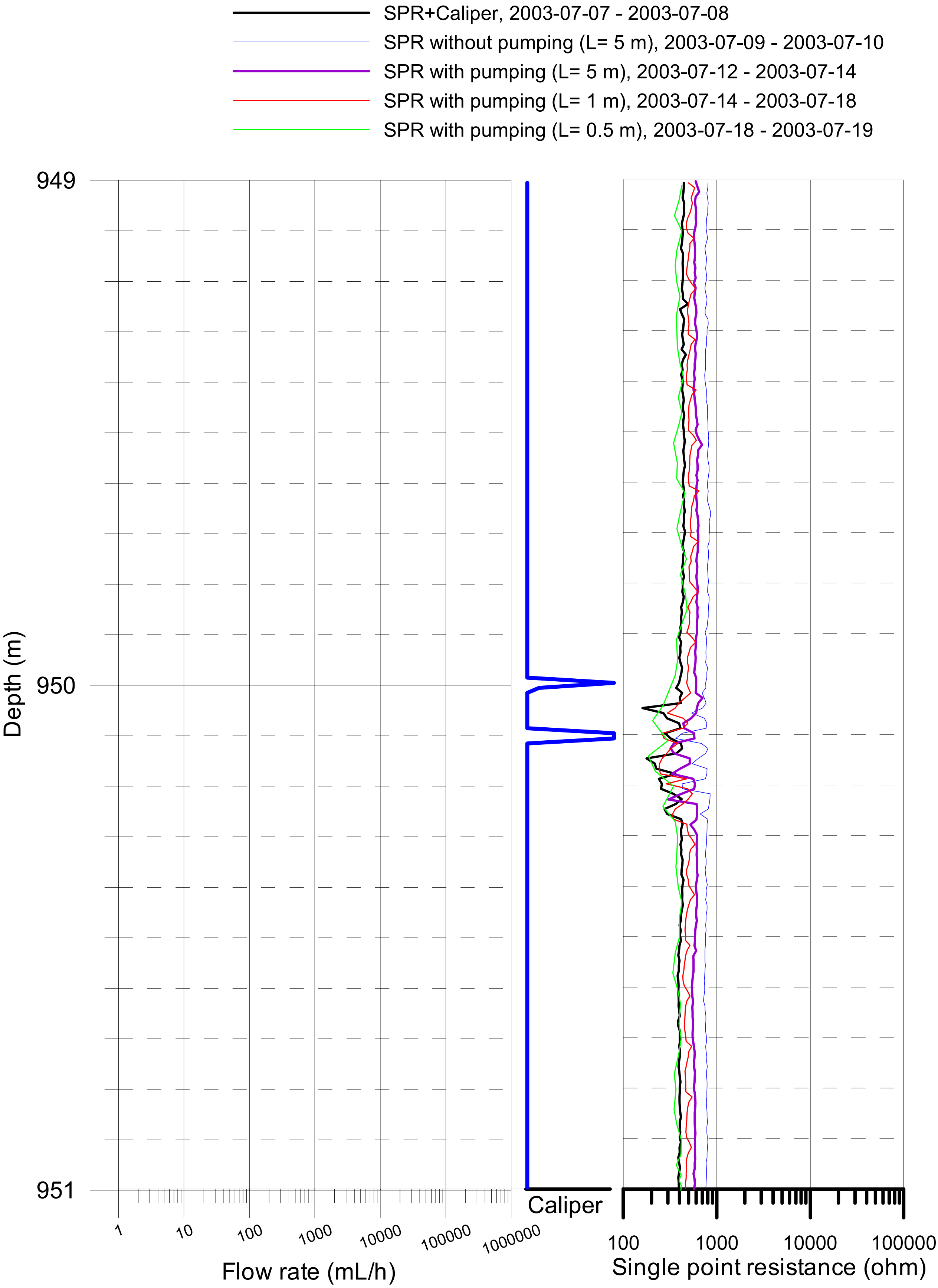
Simpevarp, KSH02
SPR and Caliper results after depth correction

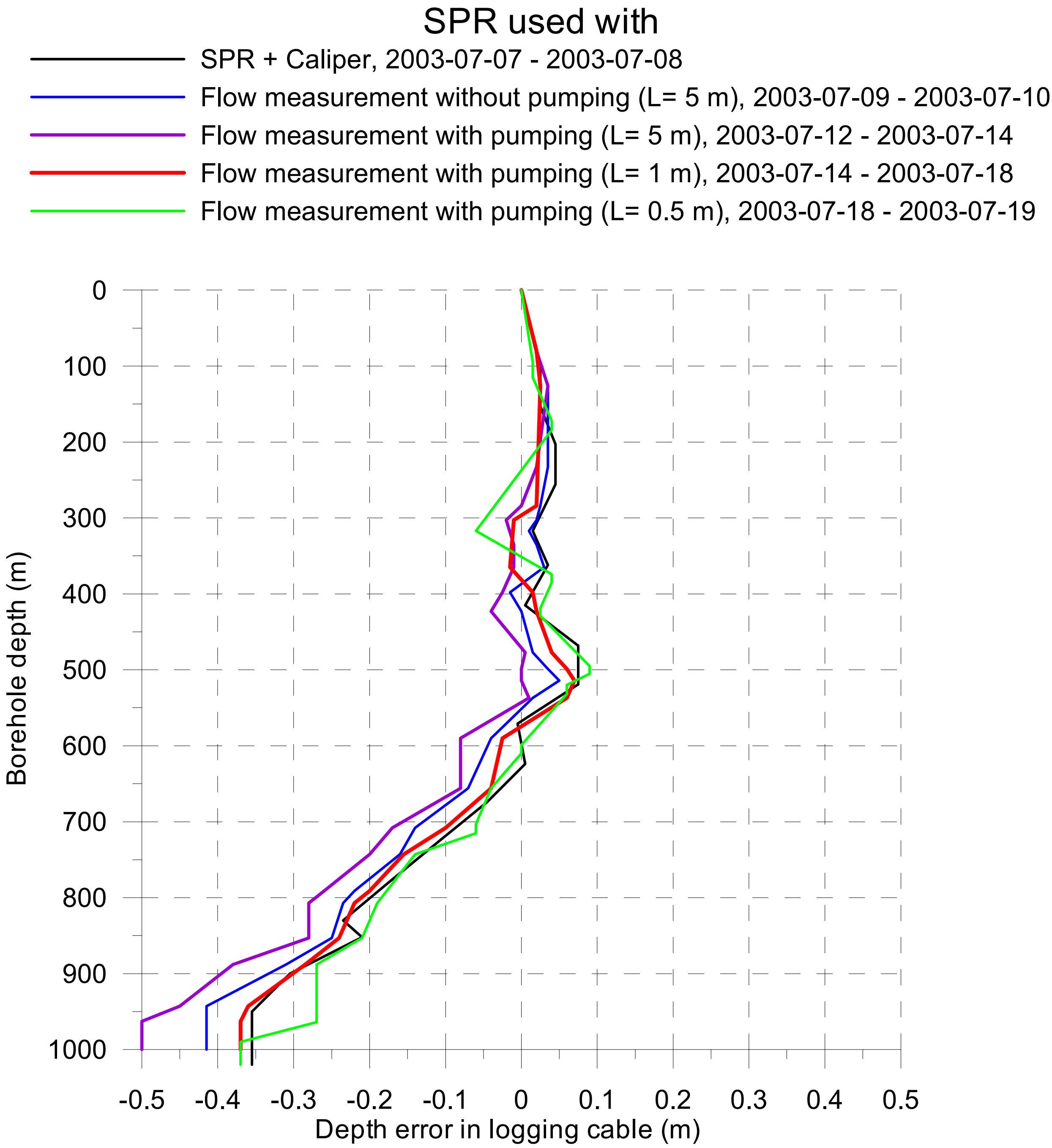


Simpevarp, KSH02
SPR and Caliper results after depth correction

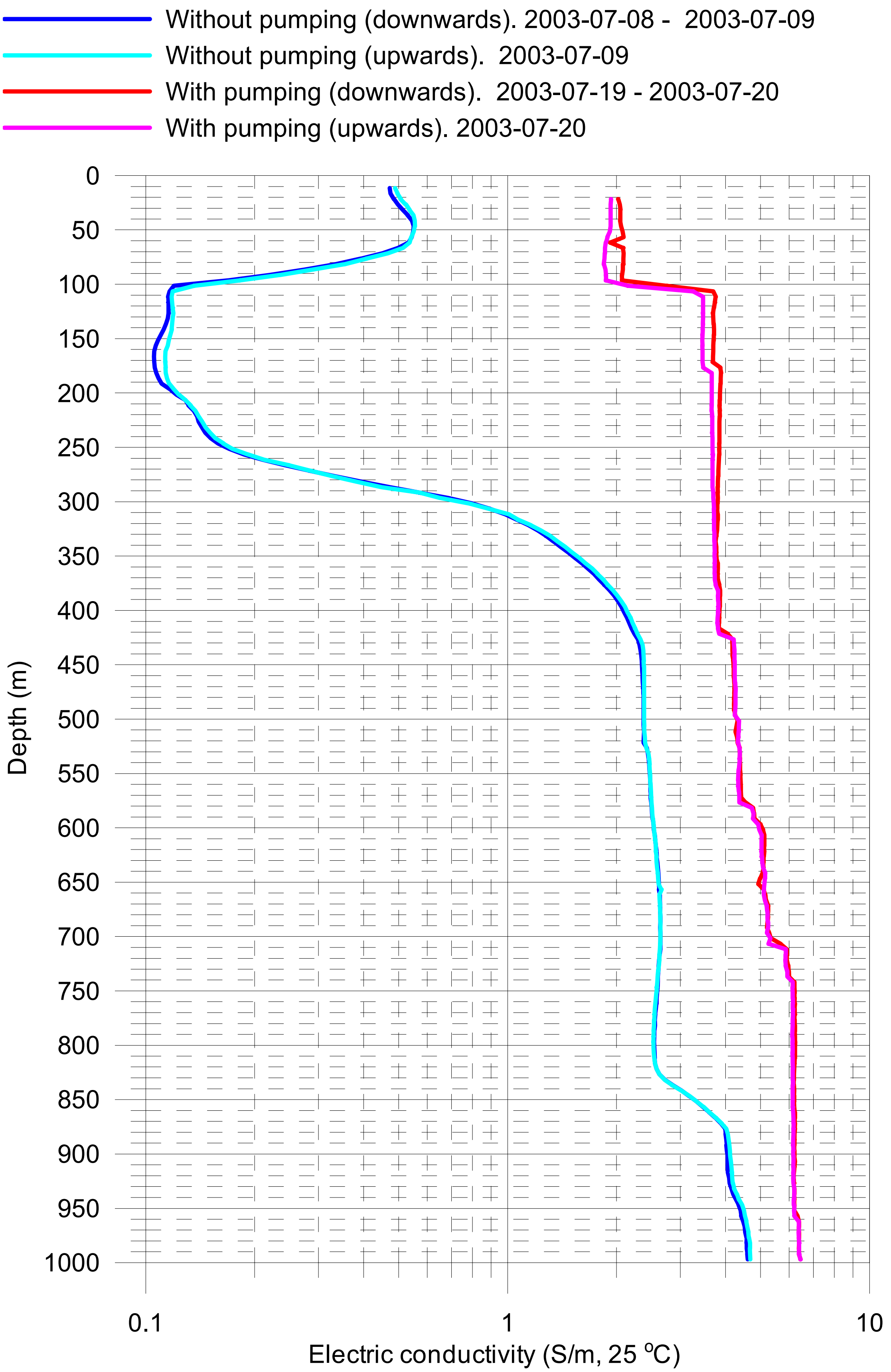


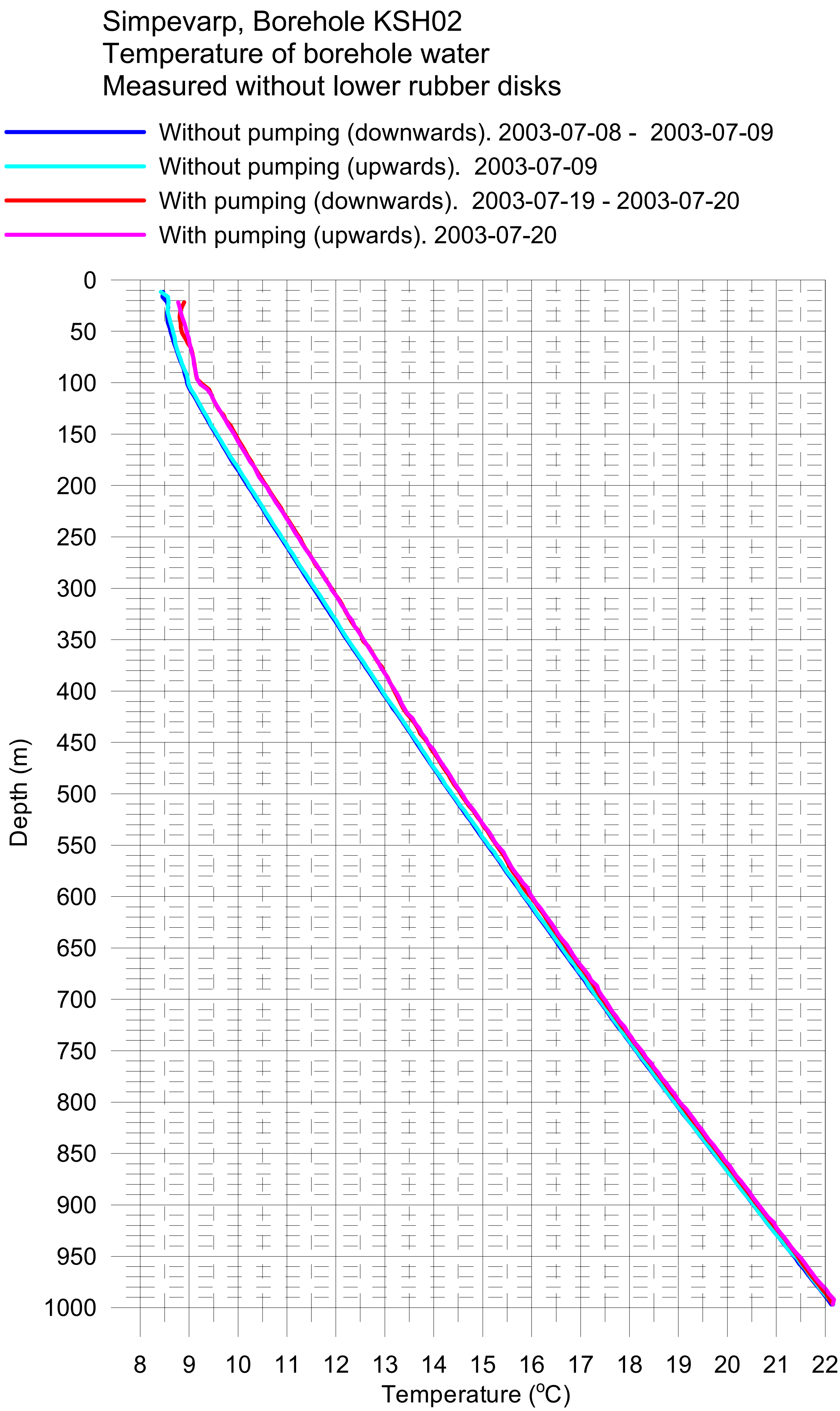
Simpevarp, KSH02
SPR and Caliper results after depth correction

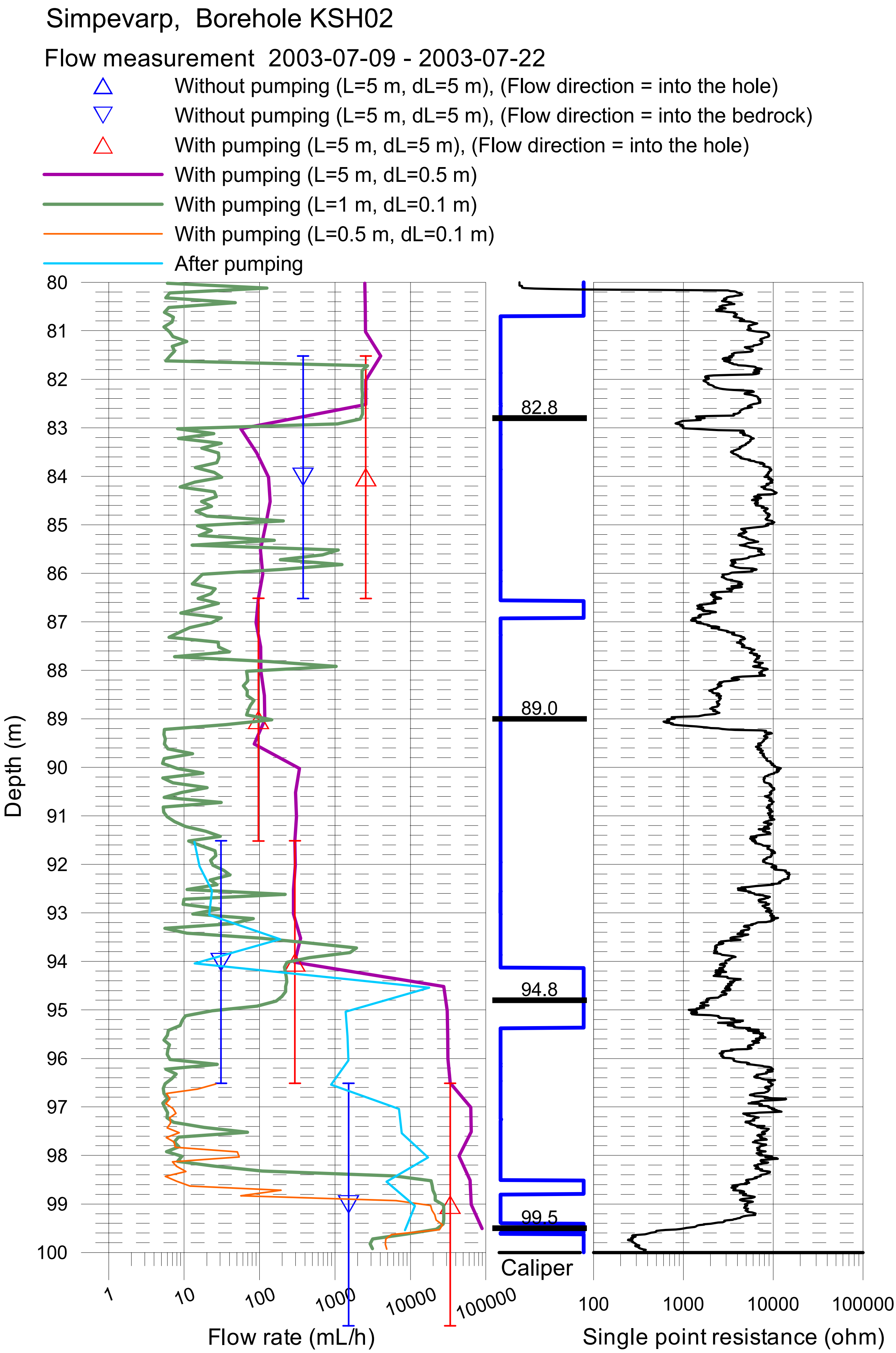



SPR used with
SPR + Caliper, 2003-07-07 - 2003-07-08
Flow measurement without pumping (L= 5 m), 2003-07-09 - 2003-07-10
Flow measurement with pumping (L= 5 m), 2003-07-12 - 2003-07-14
Flow measurement with pumping (L= 1 m), 2003-07-14 - 2003-07-18
Flow measurement with pumping (L= 0.5 m), 2003-07-18 - 2003-07-19
Borehole depth (m)
0
100
200
300
400
500
600
700
800
900
1000
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
Depth error in logging cable (m)

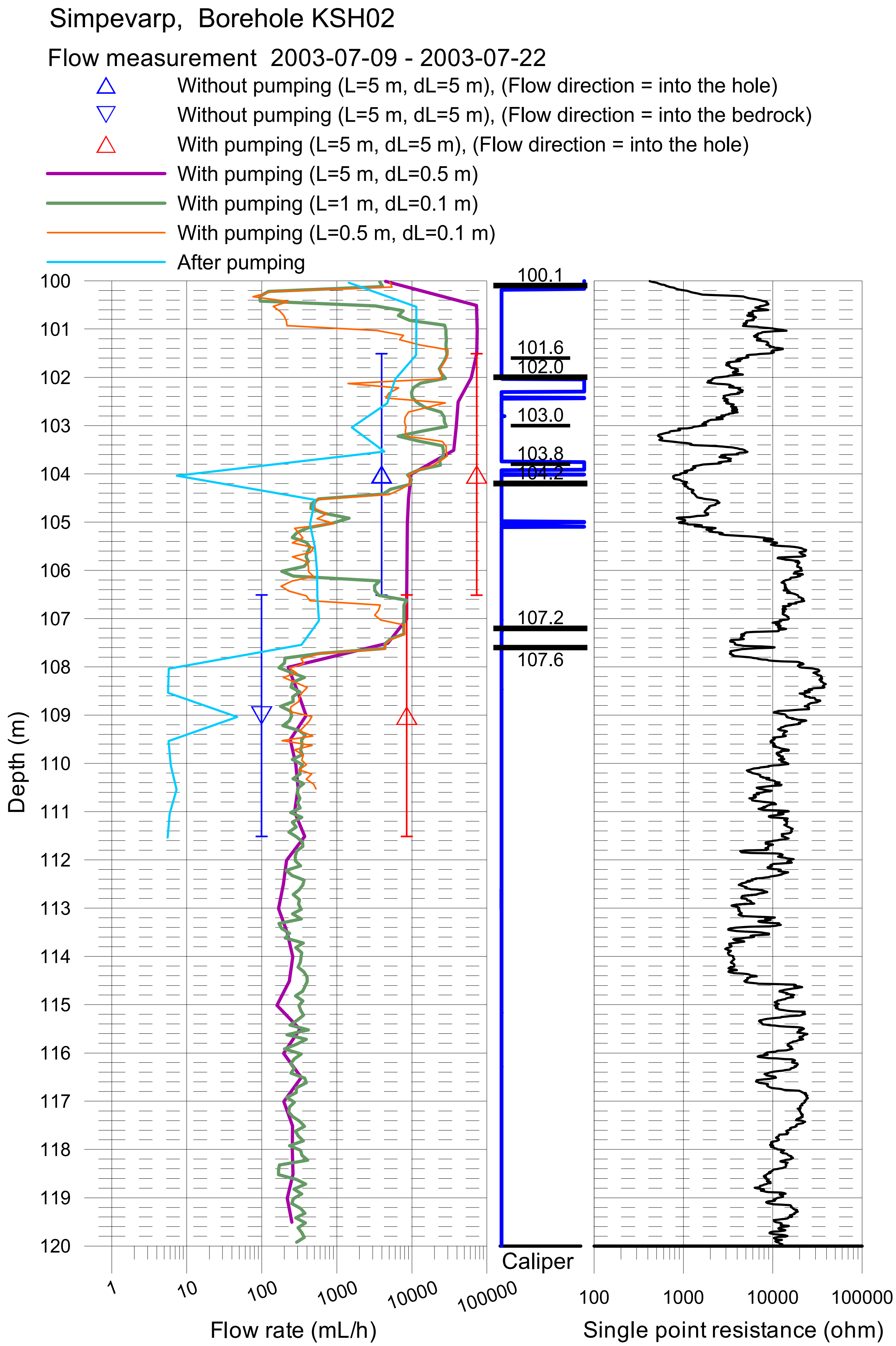
Simpevarp, Borehole KSH02
Electric conductivity of borehole water
Measured without lower rubber disks



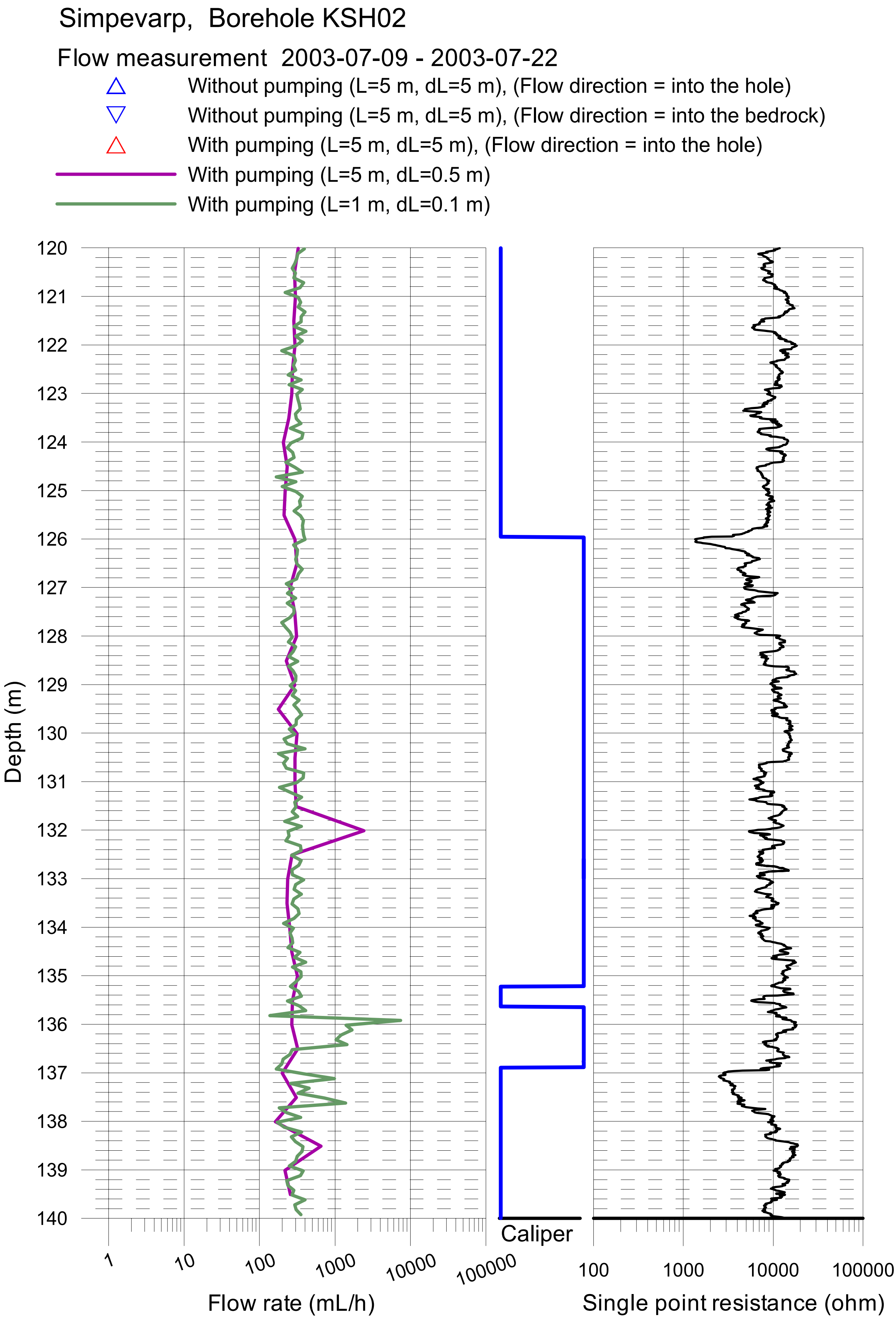

Simpevarp, Borehole KSH02
Temperature of borehole water
Measured without lower rubber disks
Without pumping (downwards). 2003-07-08 - 2003-07-09
Without pumping (upwards). 2003-07-09
With pumping (downwards). 2003-07-19 - 2003-07-20
With pumping (upwards). 2003-07-20
Depth (m)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
Temperature (°C)



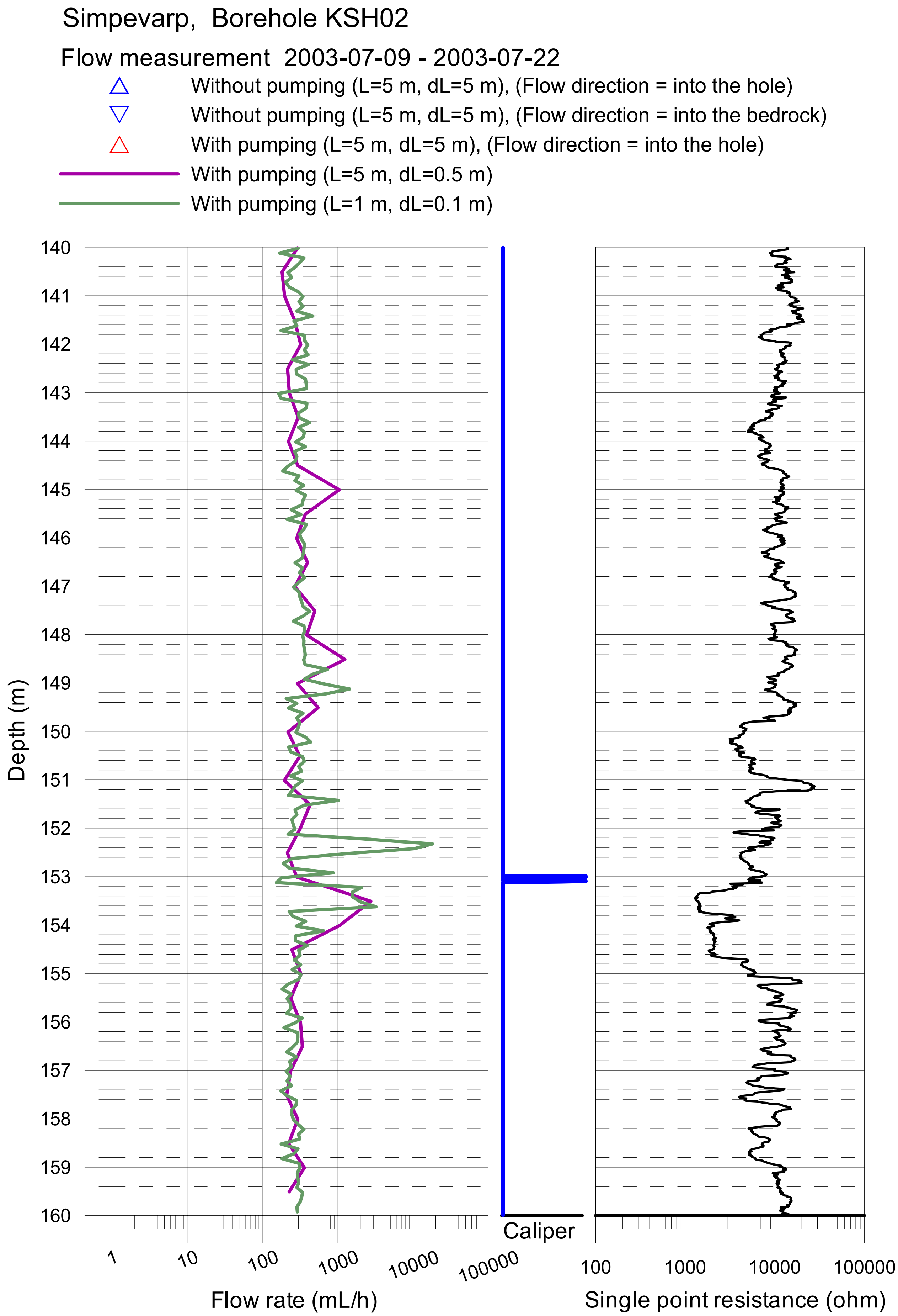
Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
After pumping
Depth (m)
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
82.8
89.0
94.8
99.5
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

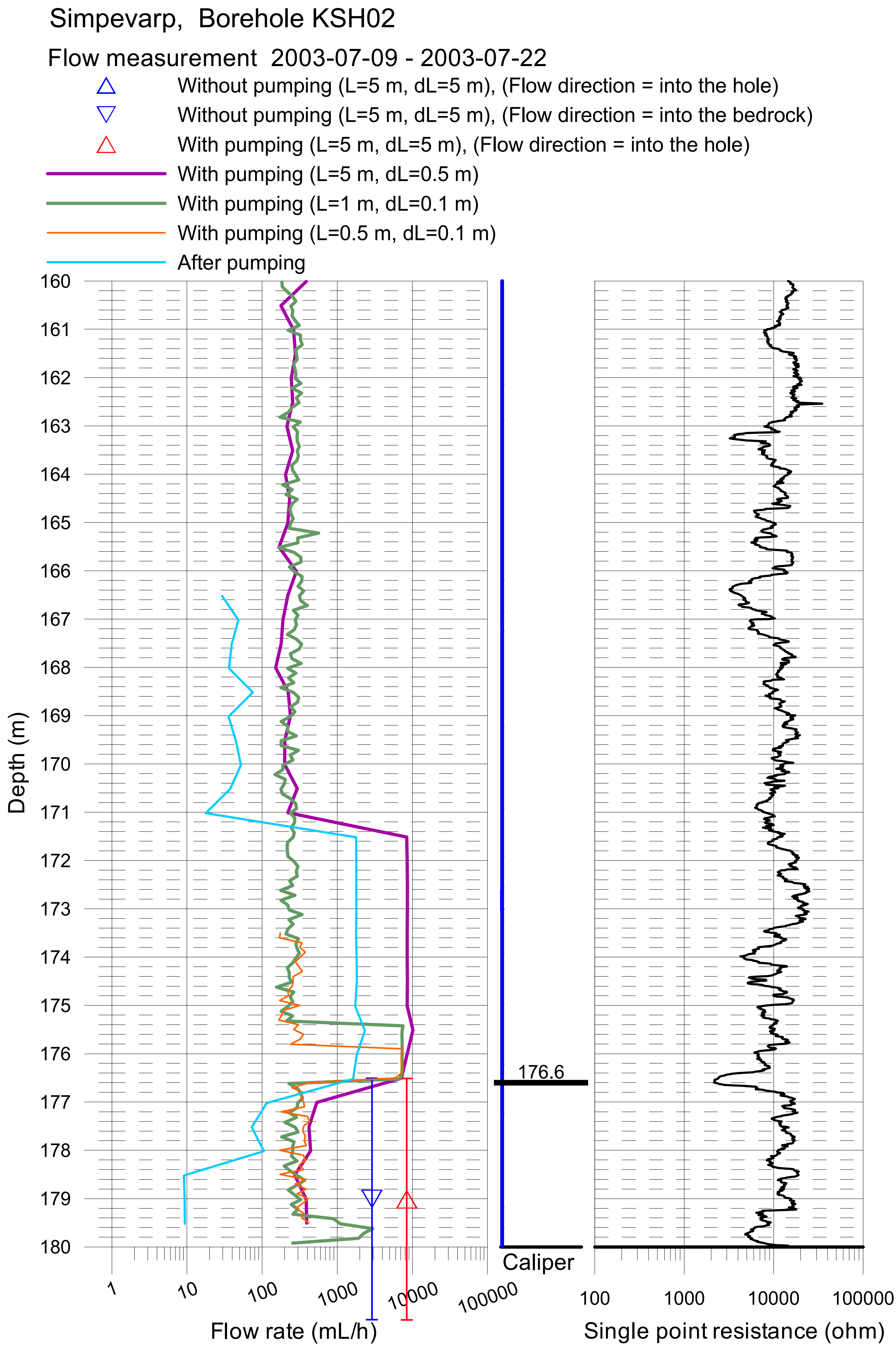


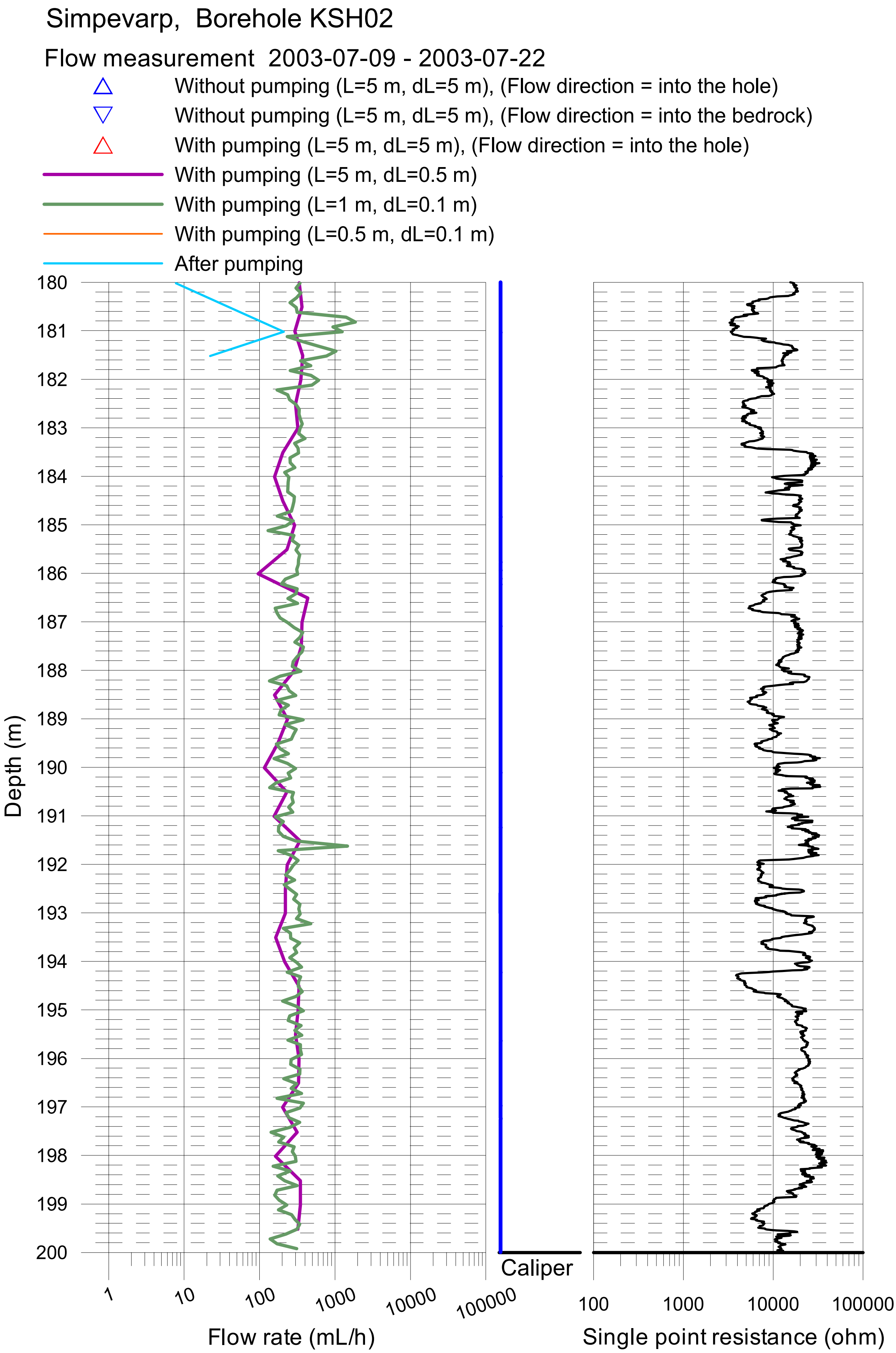
Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
After pumping
Depth (m)
100.1
101.6
102.0
103.0
103.8
104.2
107.2
107.6
Caliper
Flow rate (mL/h)
Single point resistance (ohm)

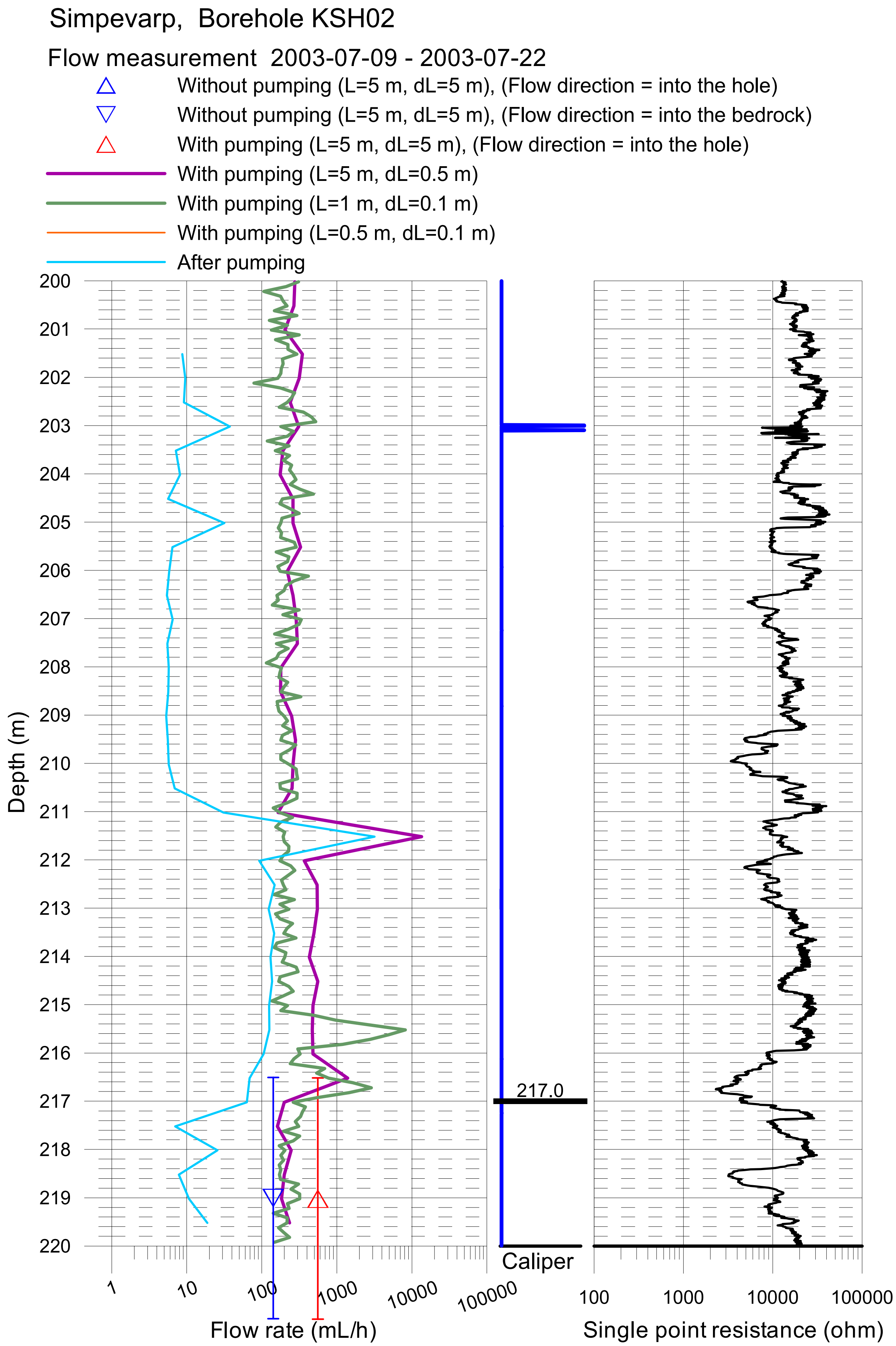


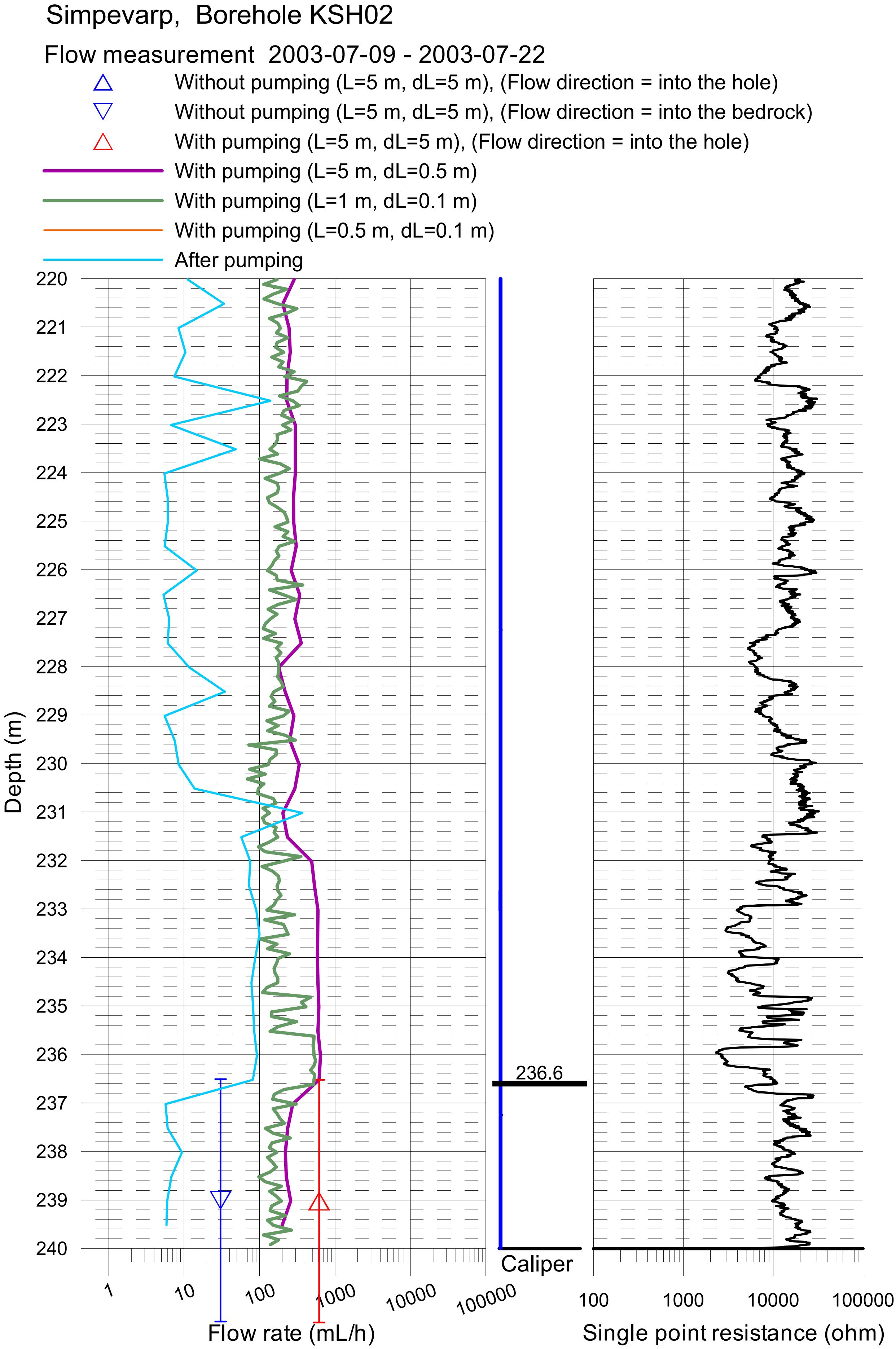
Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)


Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)


Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
After pumping
Depth (m)
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
176.6
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)


Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
After pumping
Depth (m)
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)

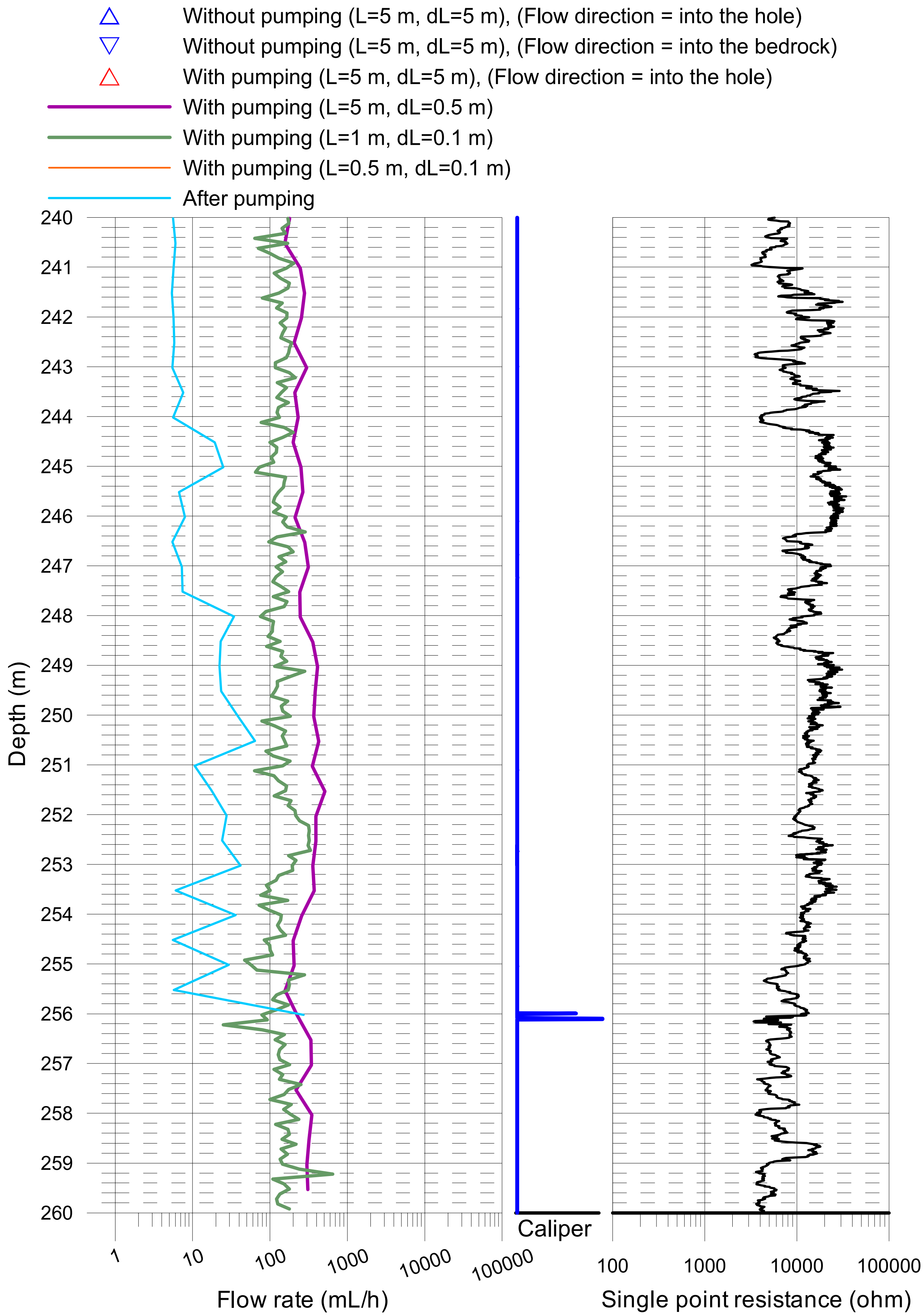

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
After pumping
Depth (m)
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
1
10
100
1000
10000
100000
Flow rate (mL/h)
217.0
Caliper
100
1000
10000
100000
Single point resistance (ohm)

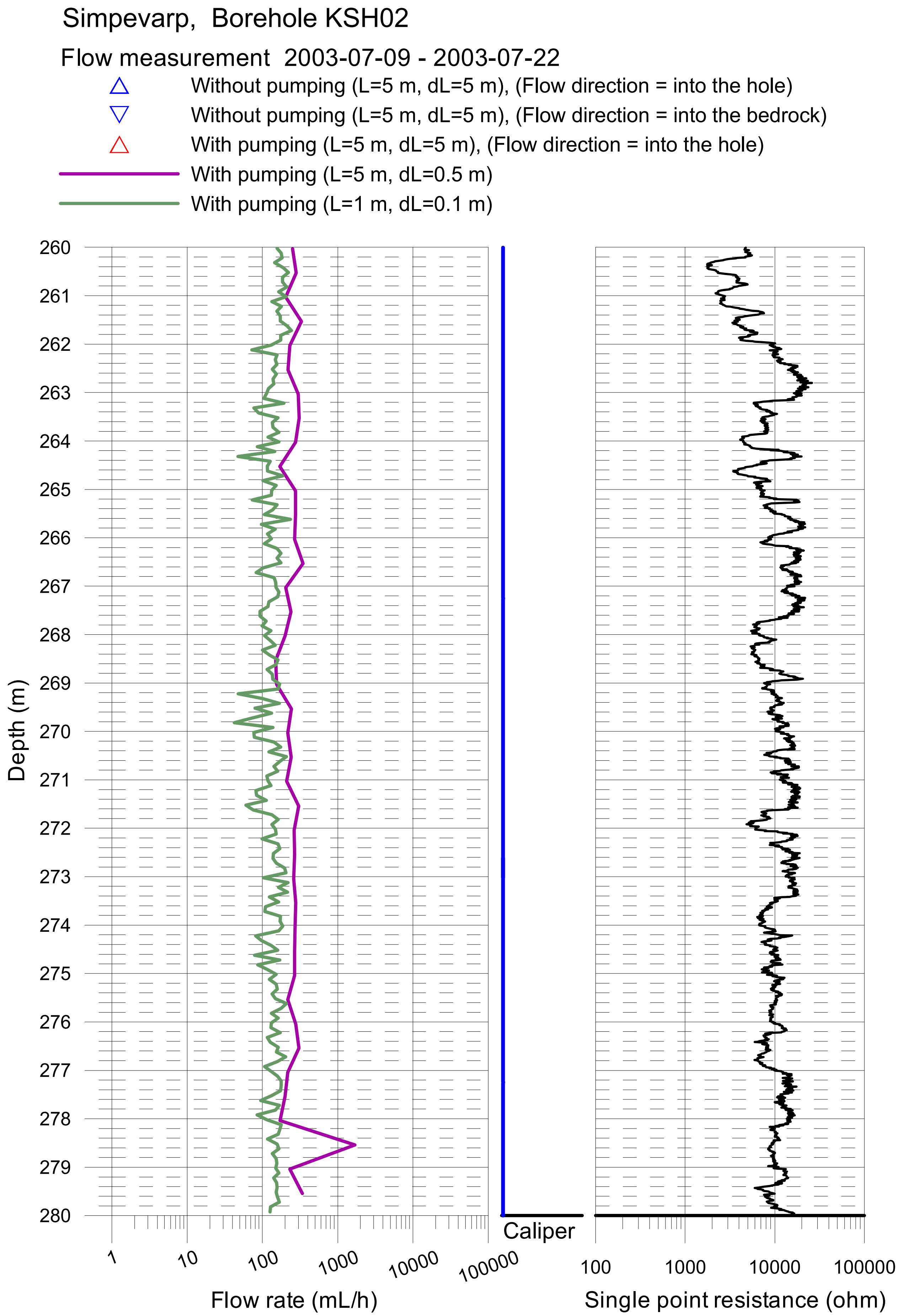


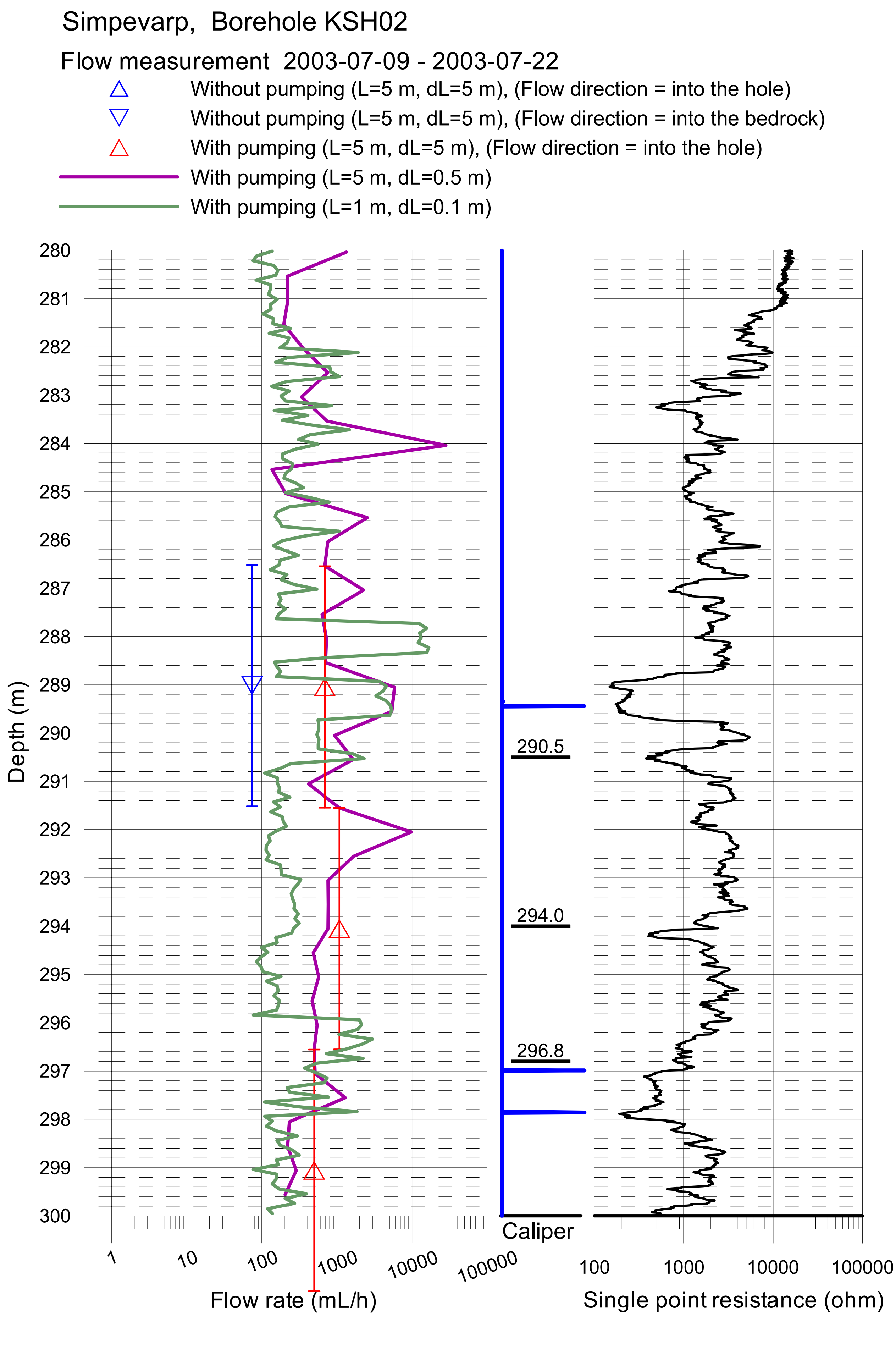
Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
After pumping
Depth (m)
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
236.6
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

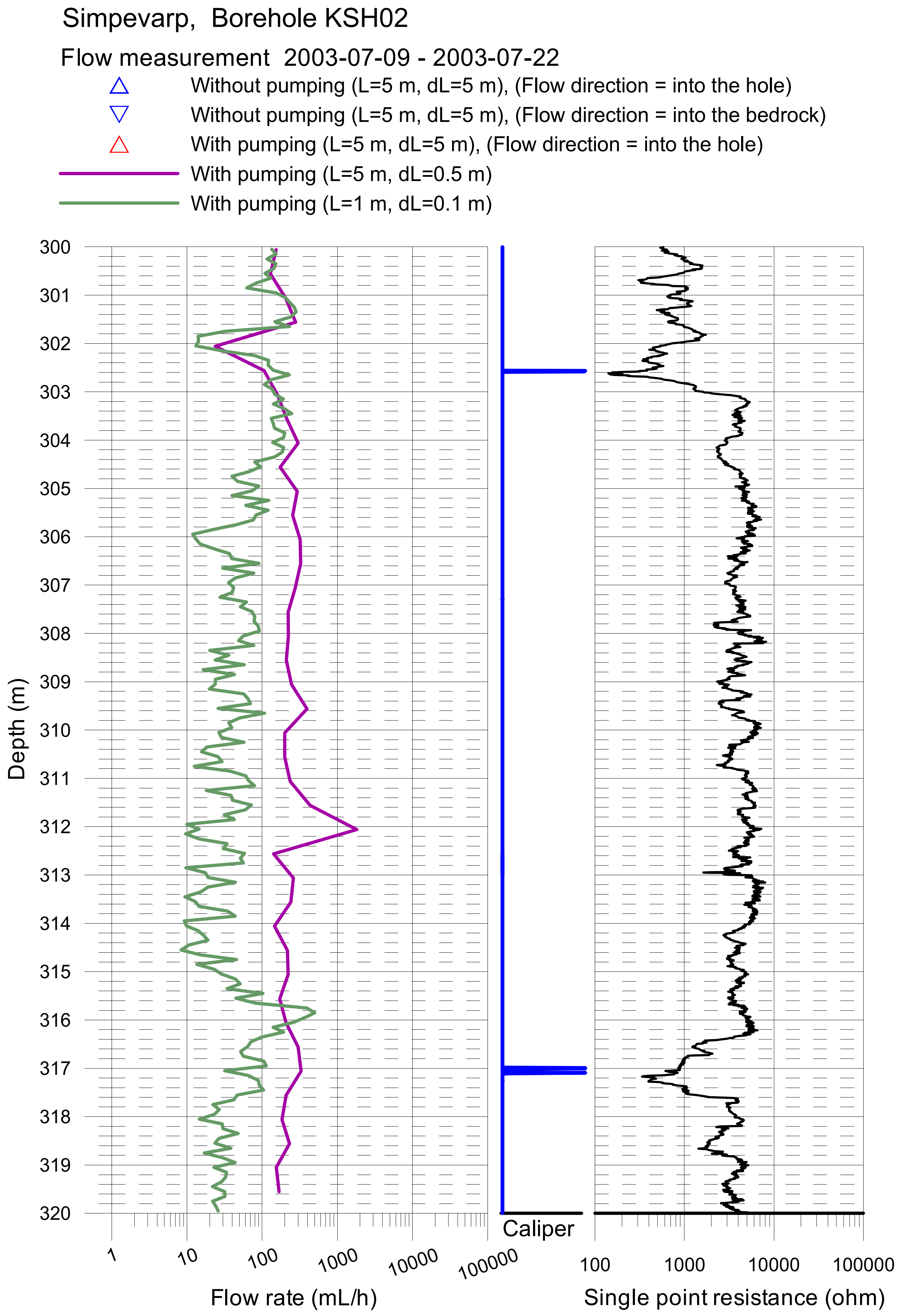
Simpevarp, Borehole KSH02

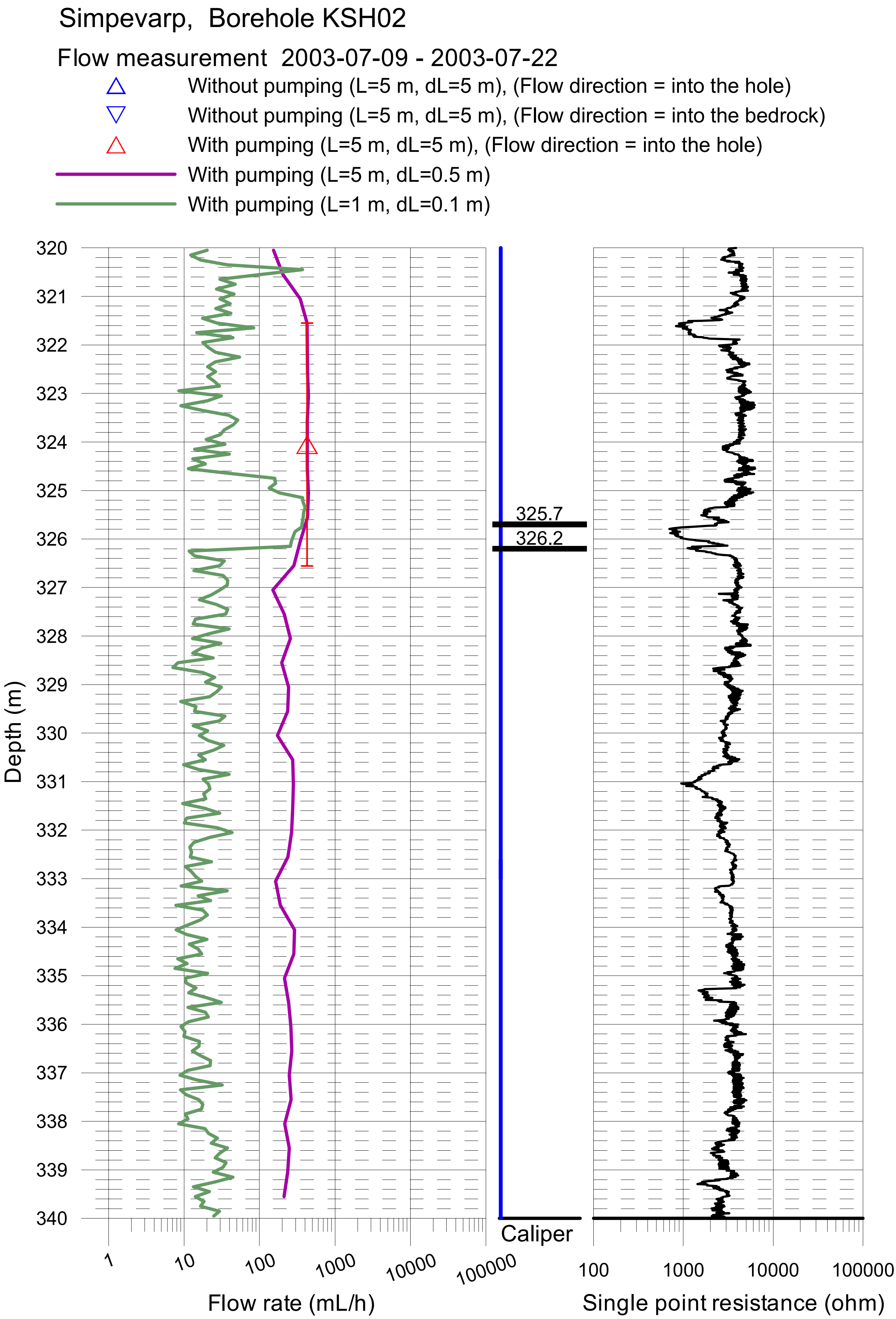
Flow measurement 2003-07-09 - 2003-07-22




Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)

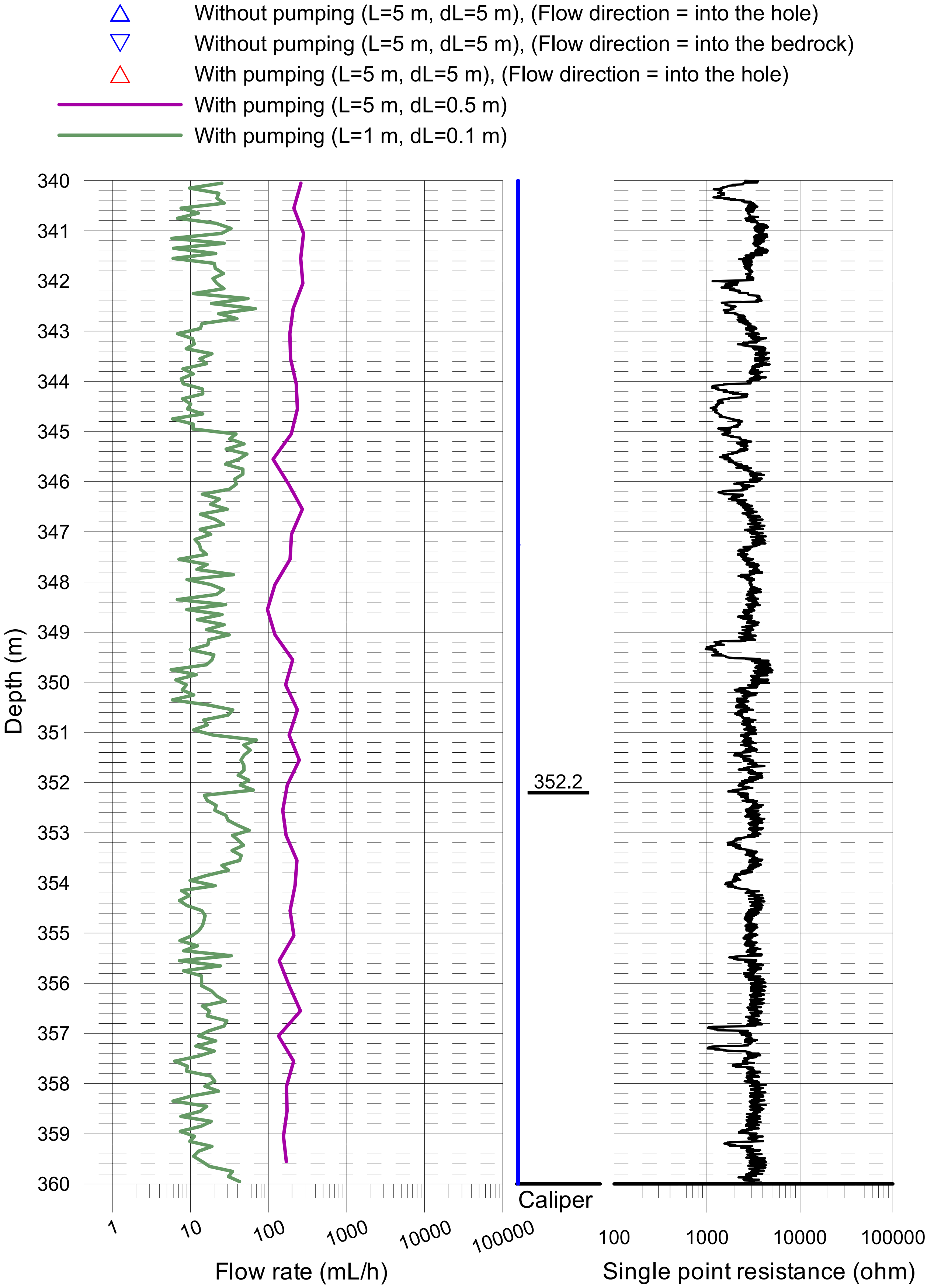

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
290.5
294.0
296.8
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

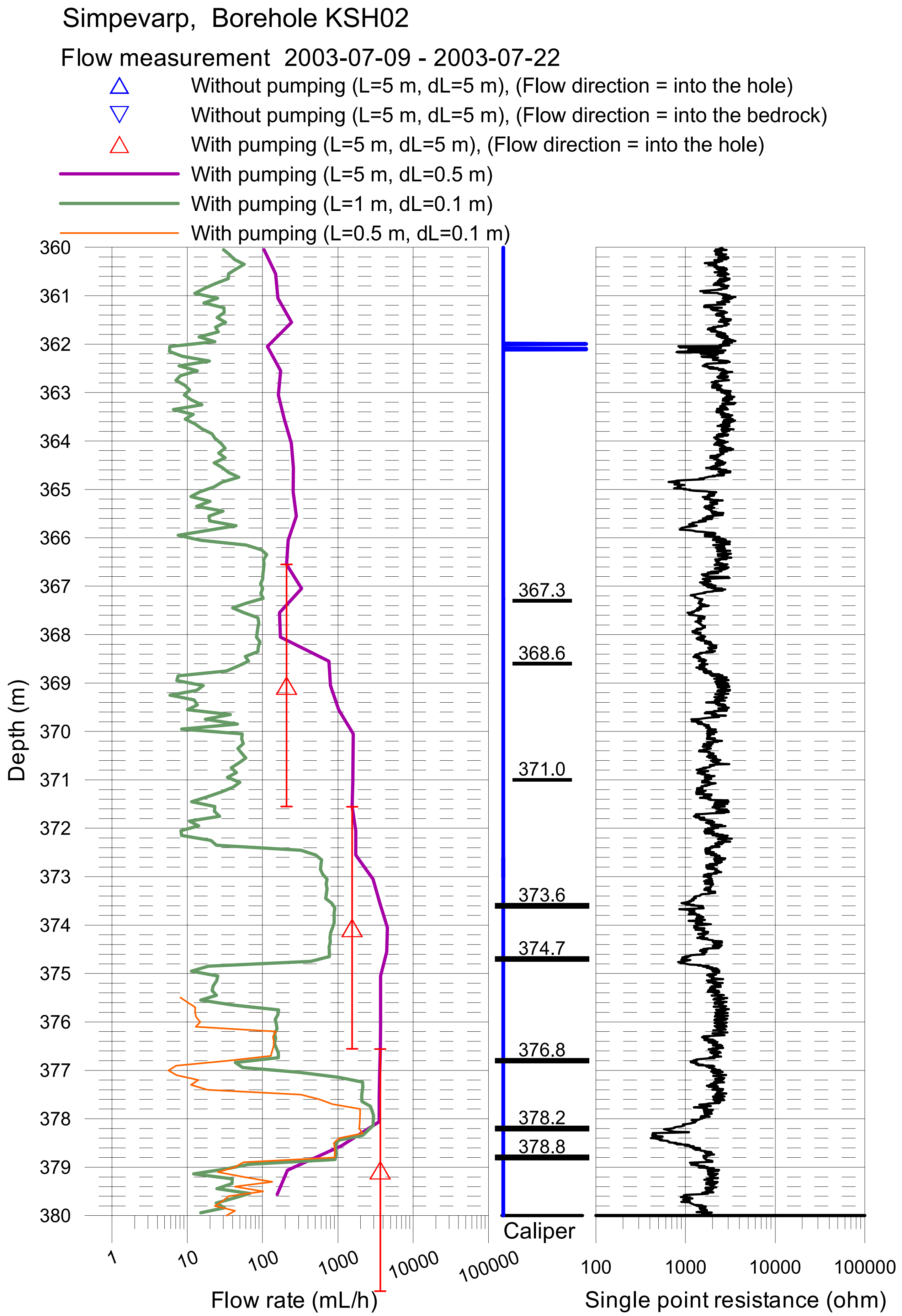

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)

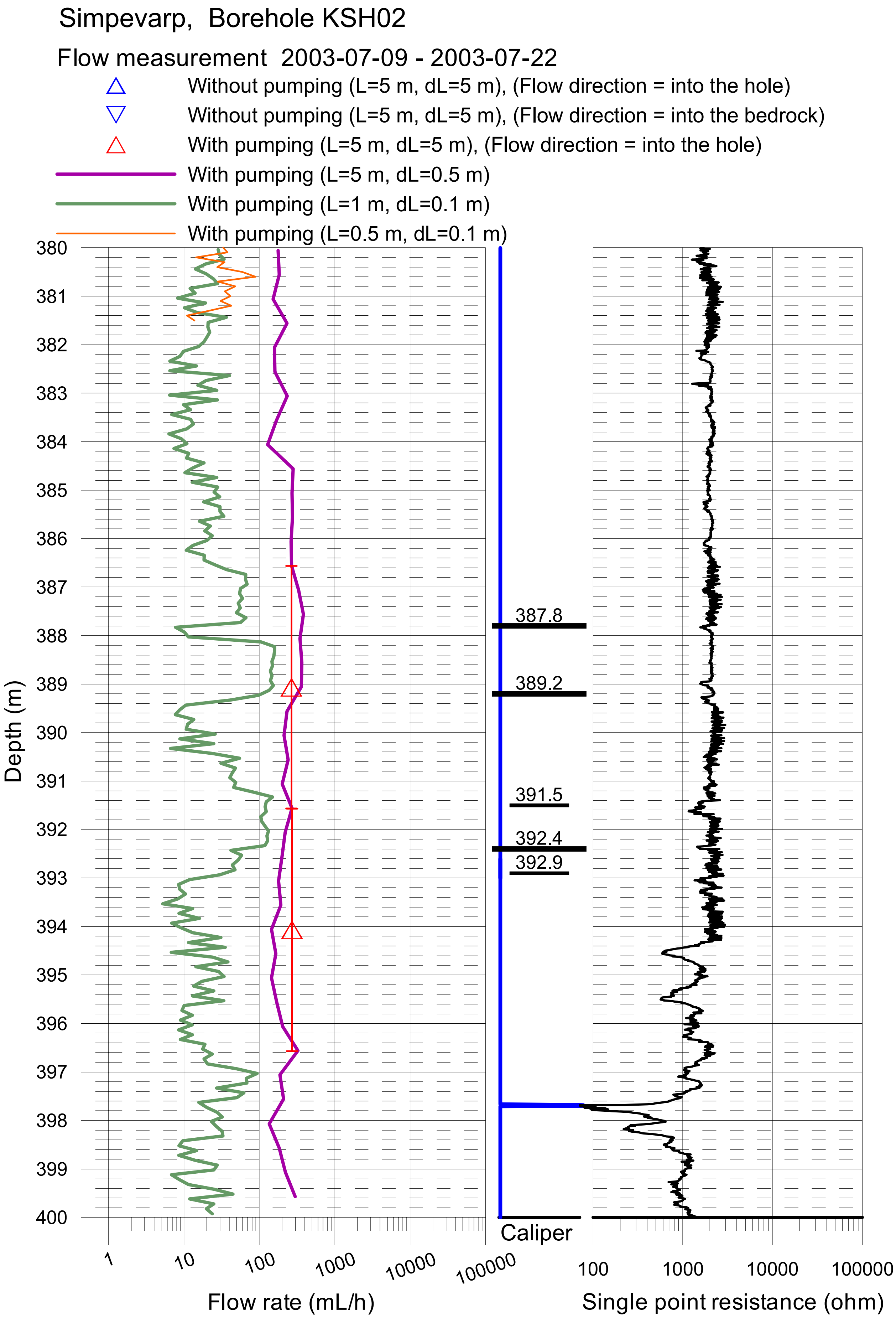

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
325.7
326.2
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

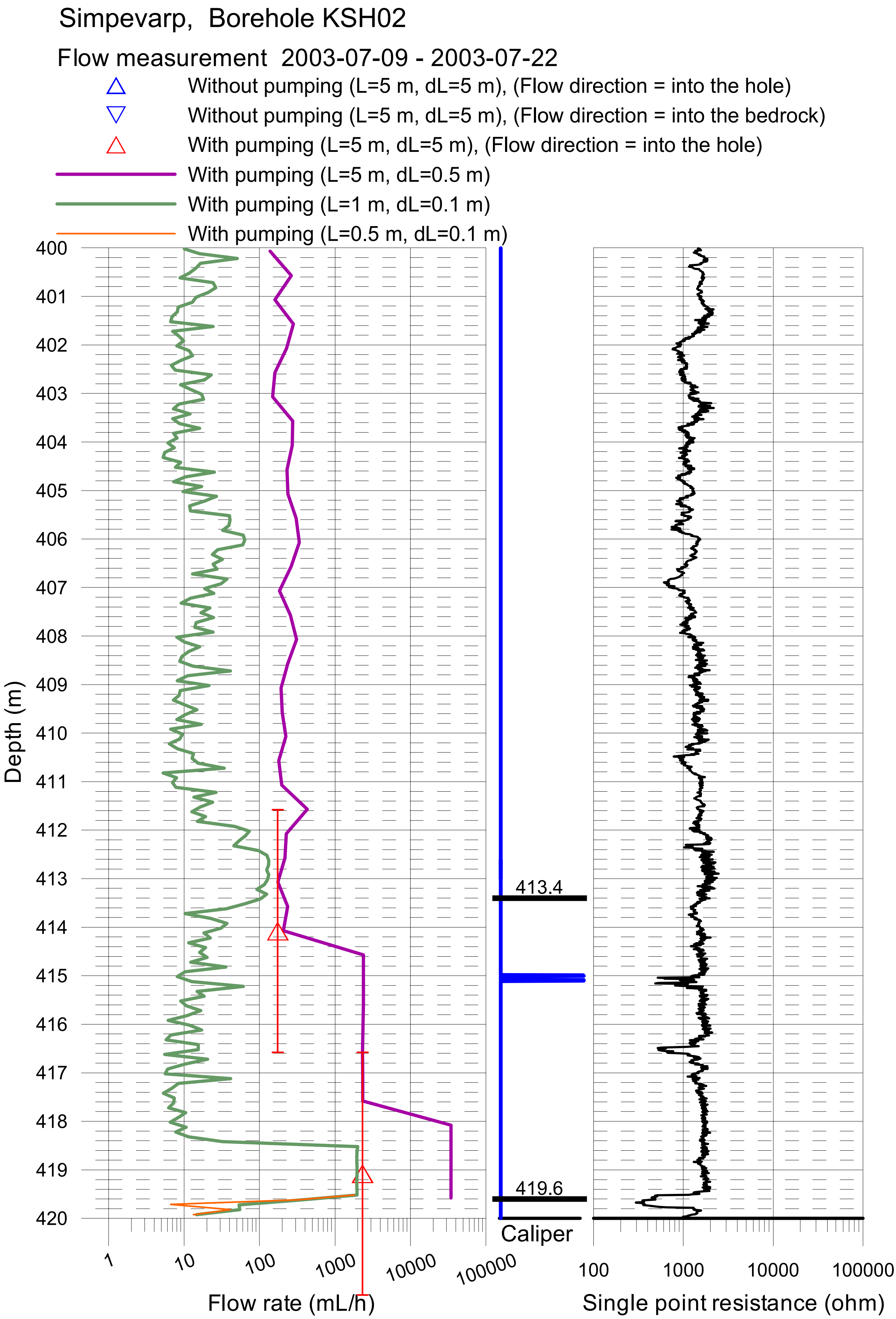
Simpevarp, Borehole KSH02

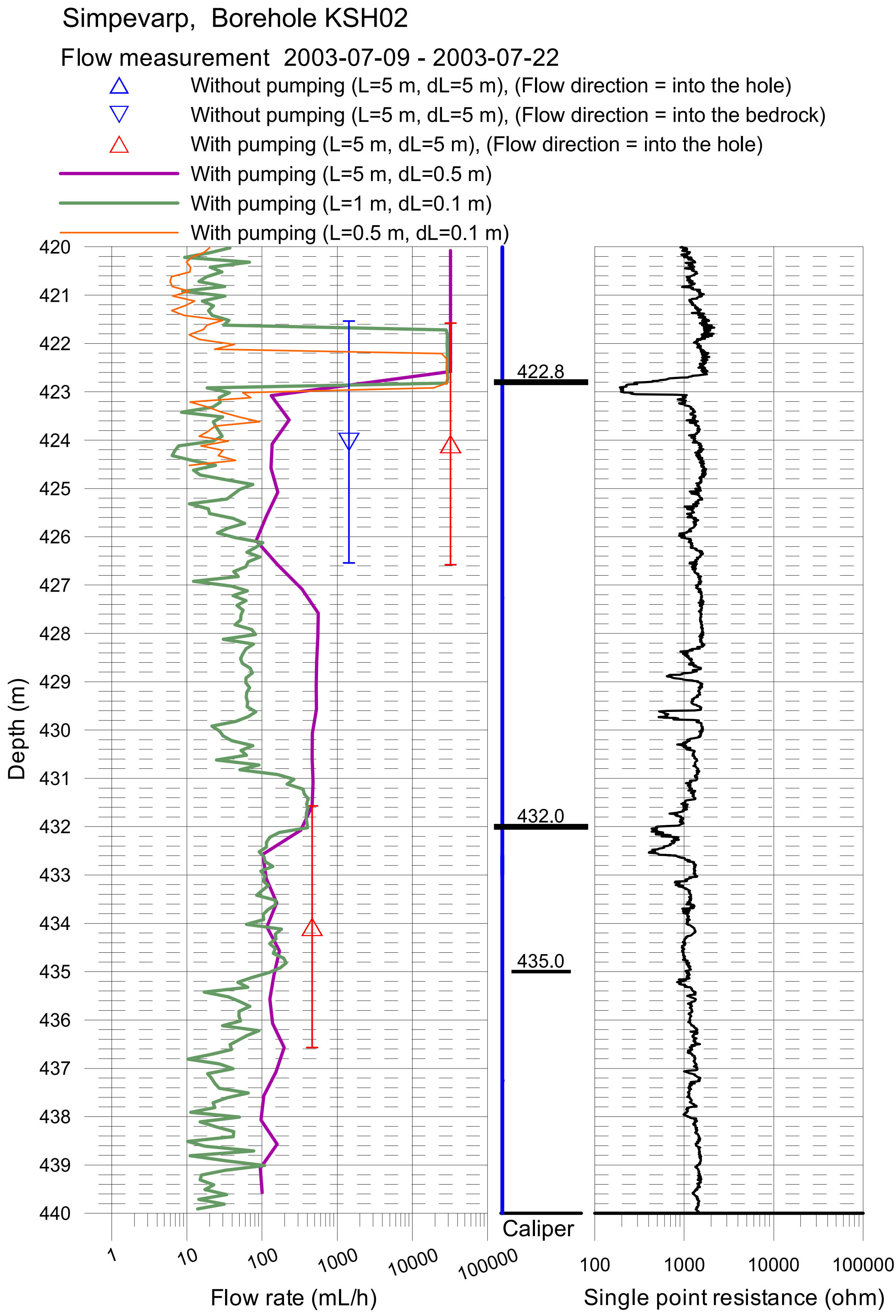
Flow measurement 2003-07-09 - 2003-07-22




Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
367.3
368.6
371.0
373.6
374.7
376.8
378.2
378.8
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

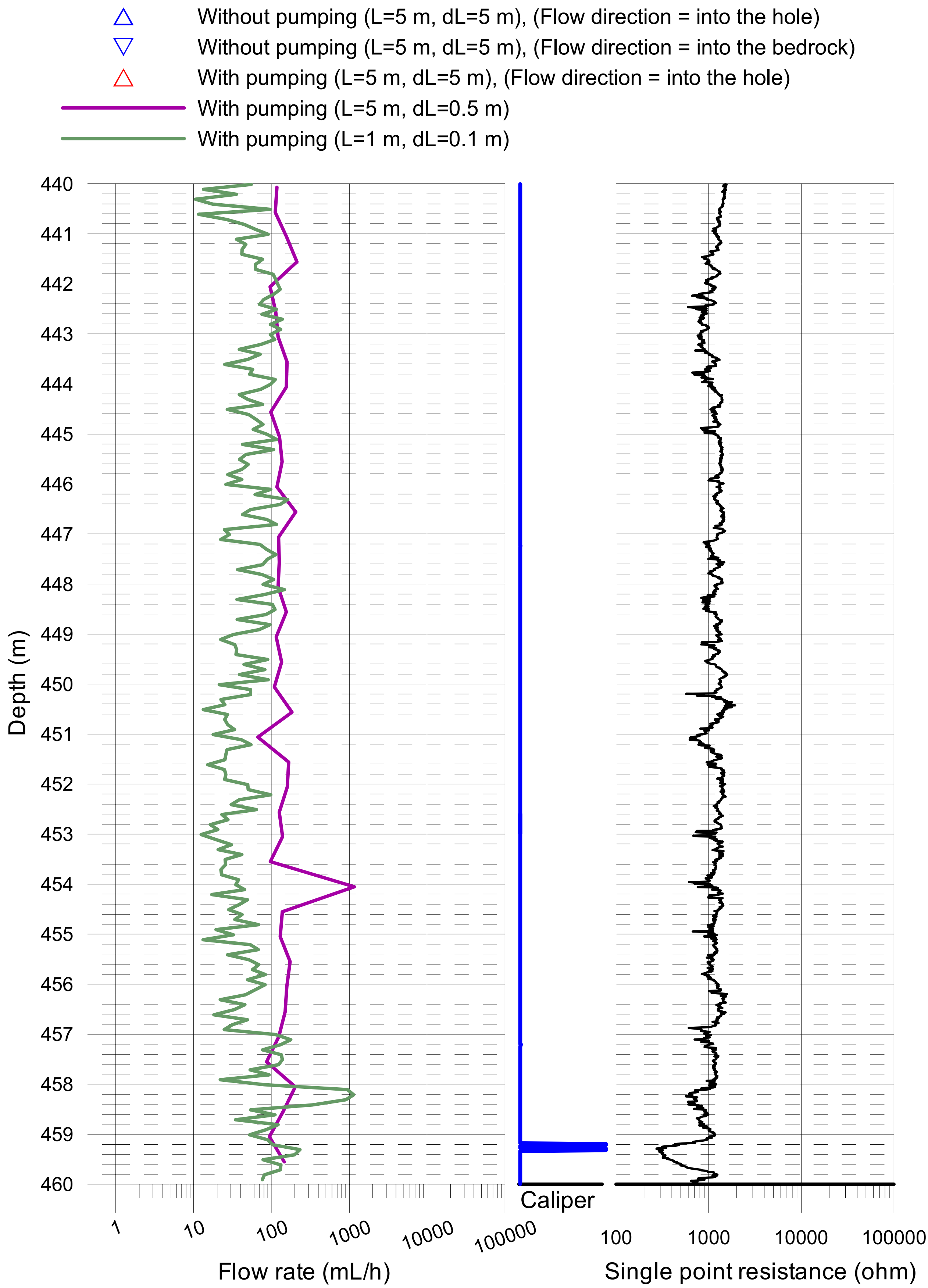

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
387.8
389.2
391.5
392.4
392.9
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

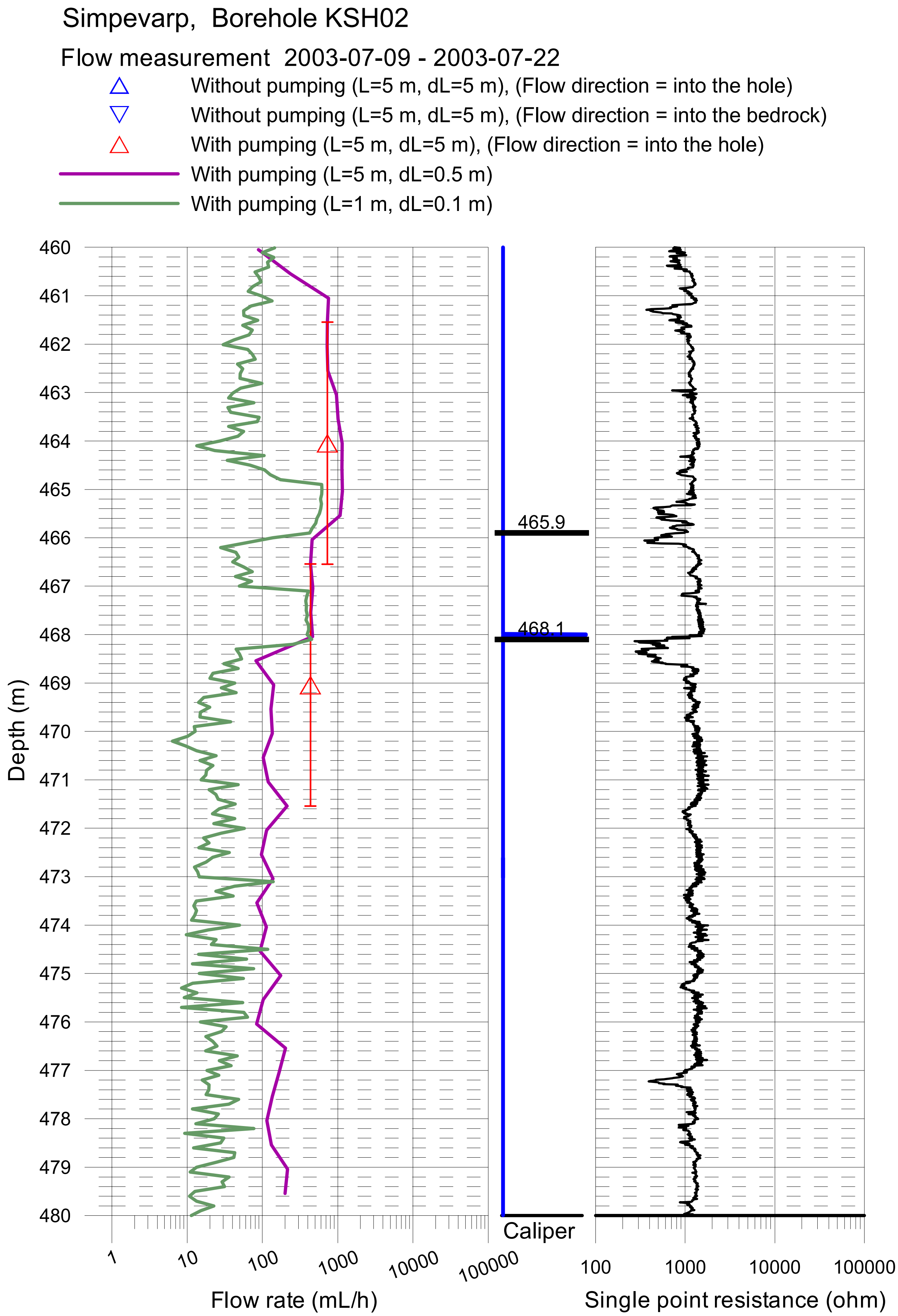

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
413.4
419.6
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)


Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
422.8
432.0
435.0
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

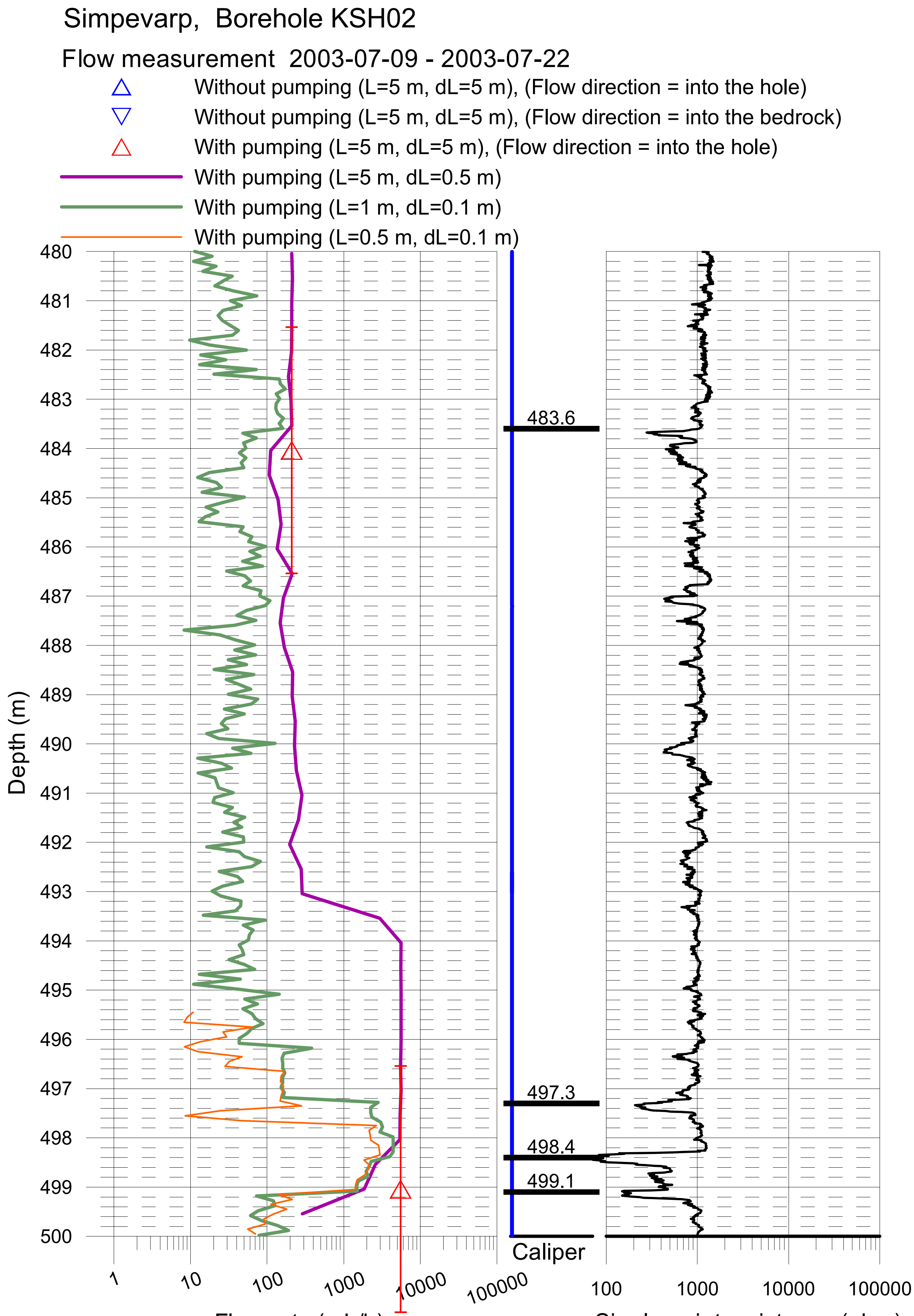
Simpevarp, Borehole KSH02

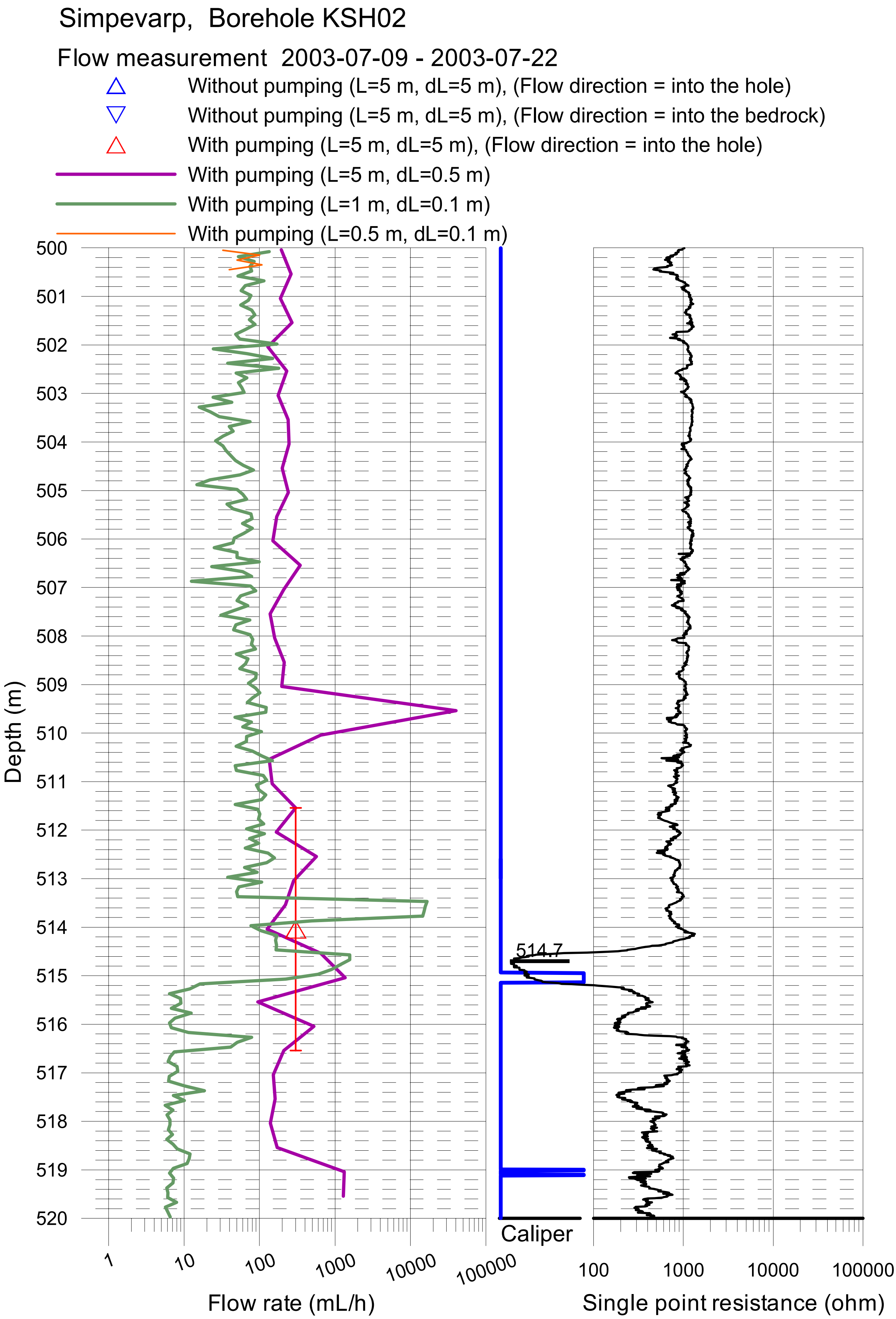
Flow measurement 2003-07-09 - 2003-07-22





Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
465.9
468.1
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

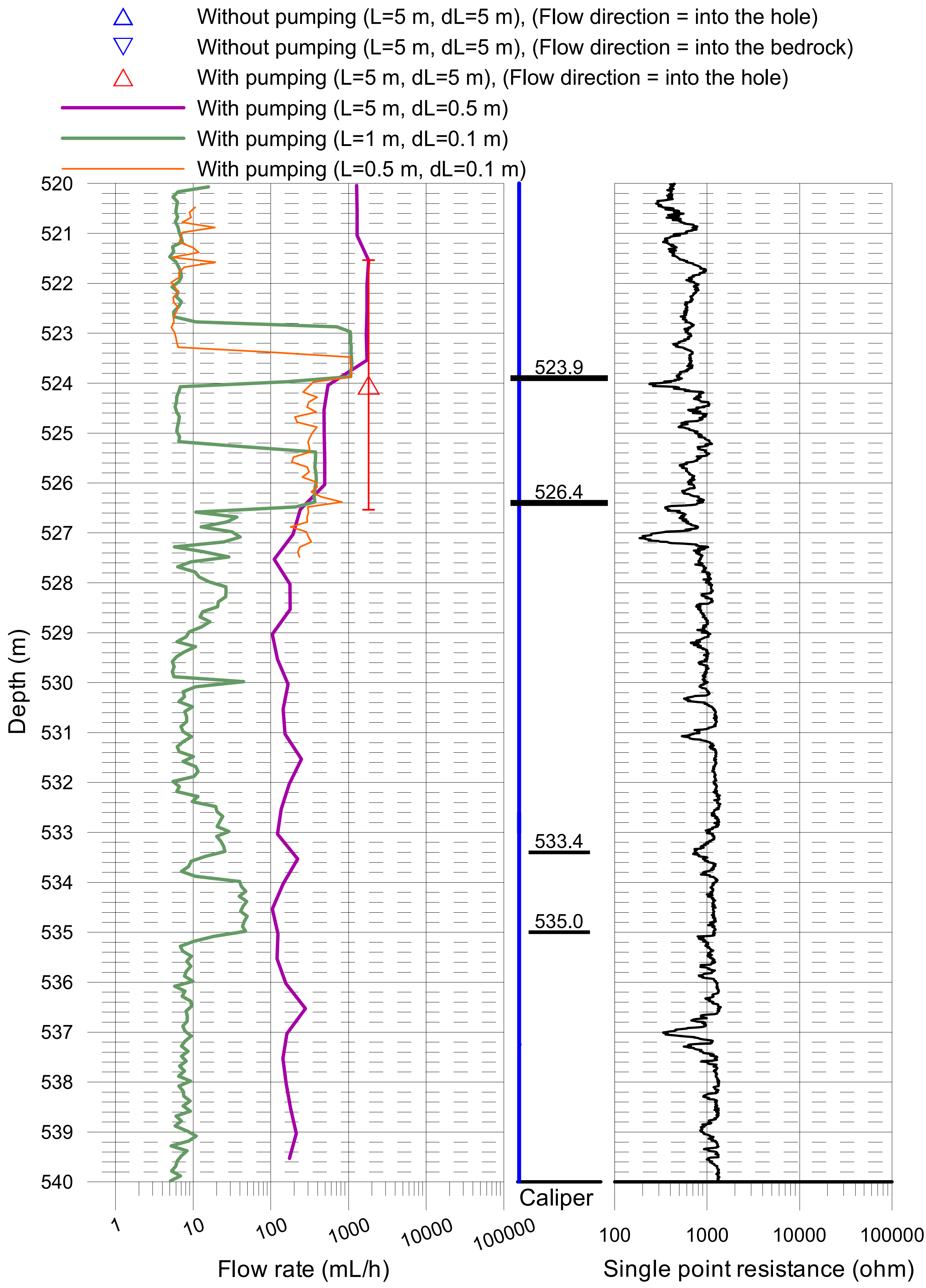

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
483.6
497.3
498.4
499.1
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)



Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
514.7
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

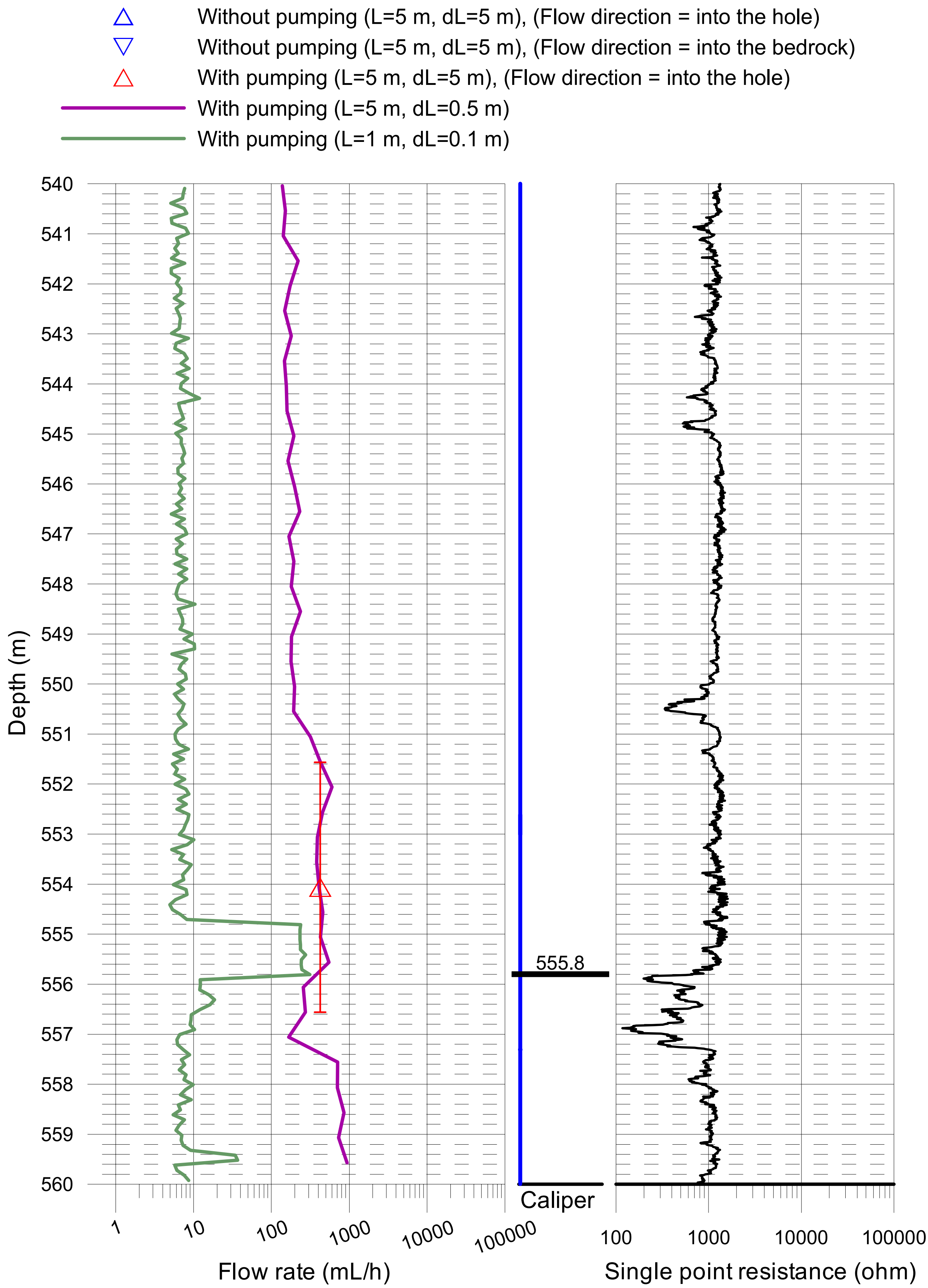
Simpevarp, Borehole KSH02

Flow measurement 2003-07-09 - 2003-07-22



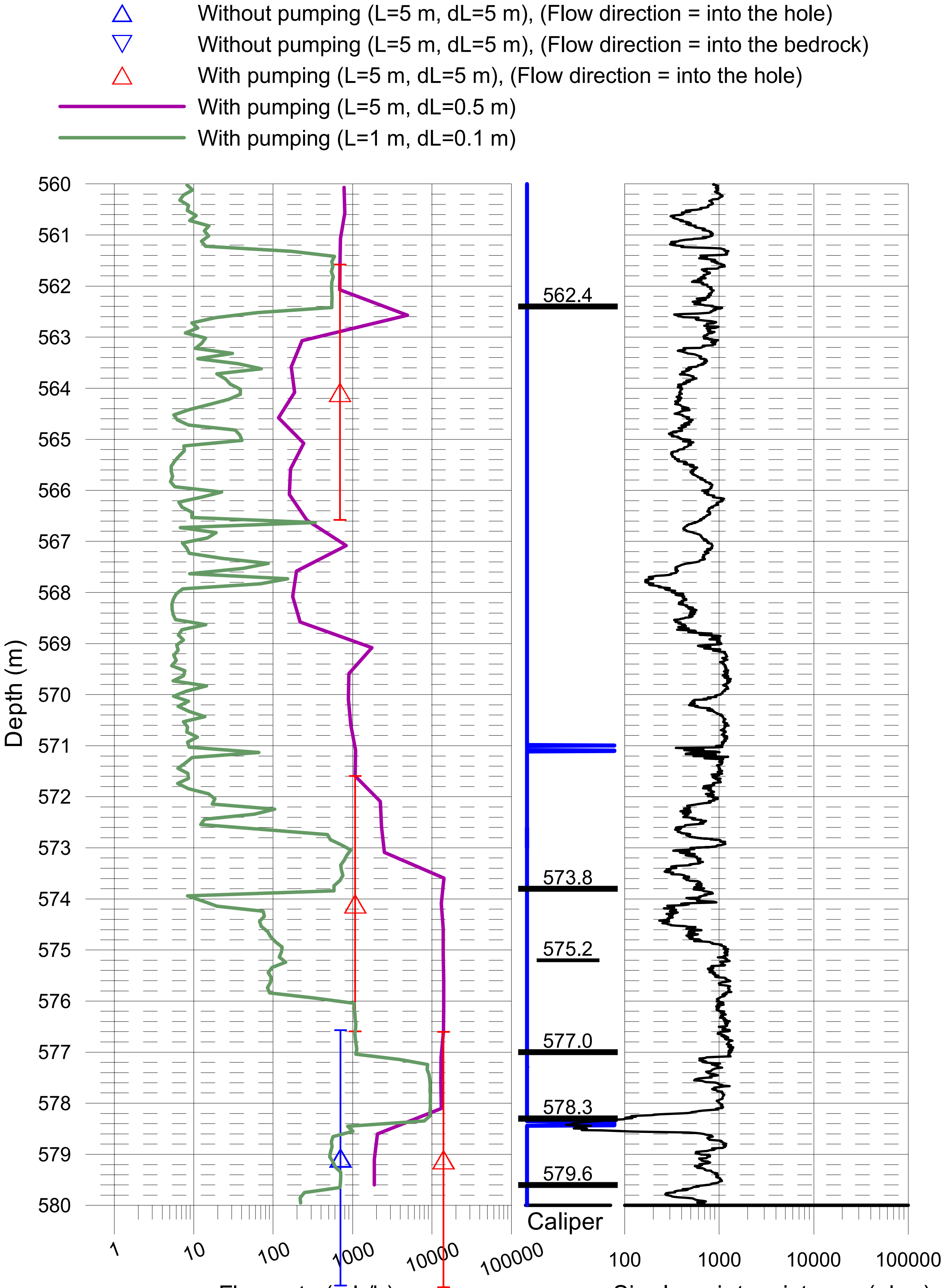
Simpevarp, Borehole KSH02

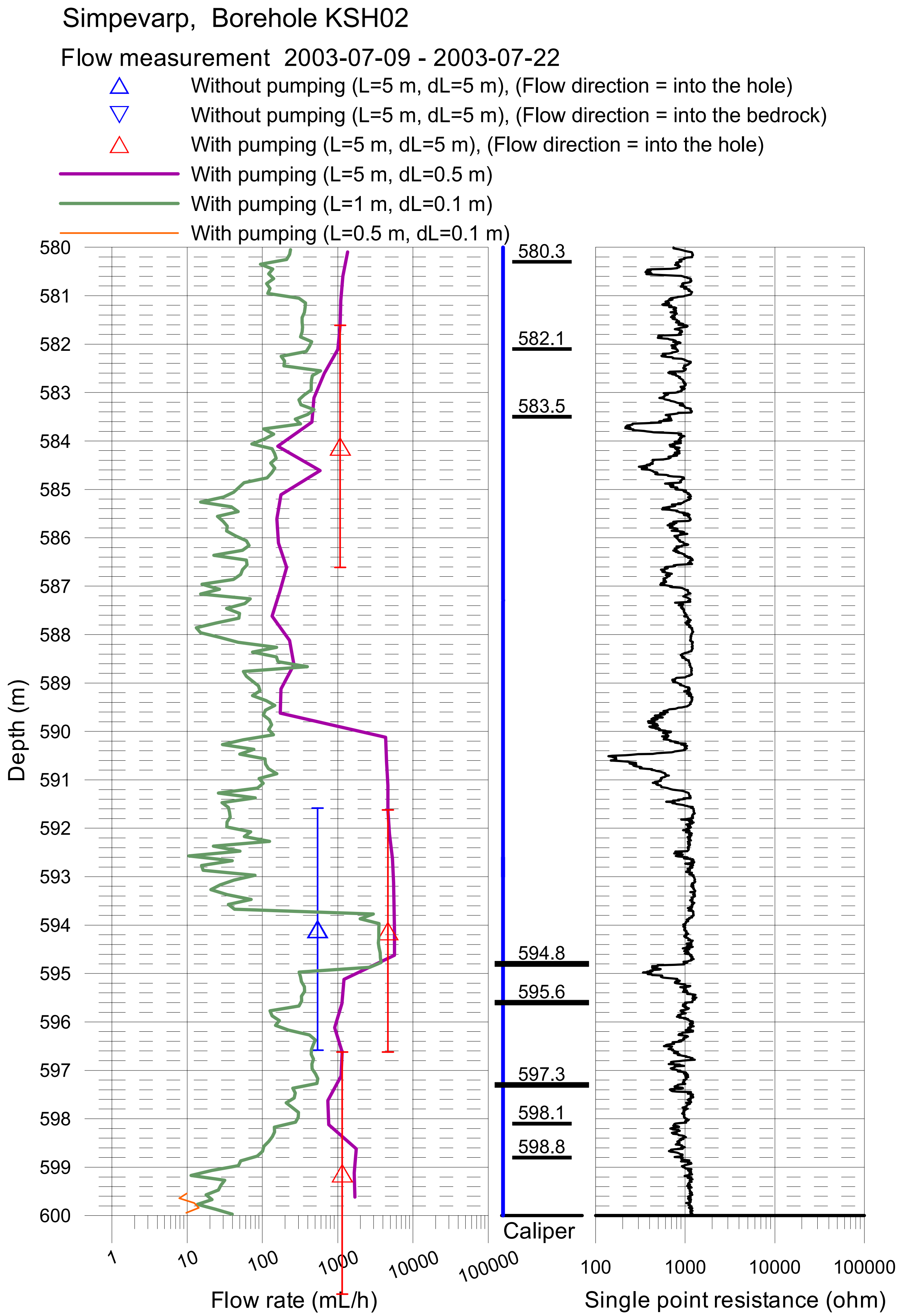
Flow measurement 2003-07-09 - 2003-07-22



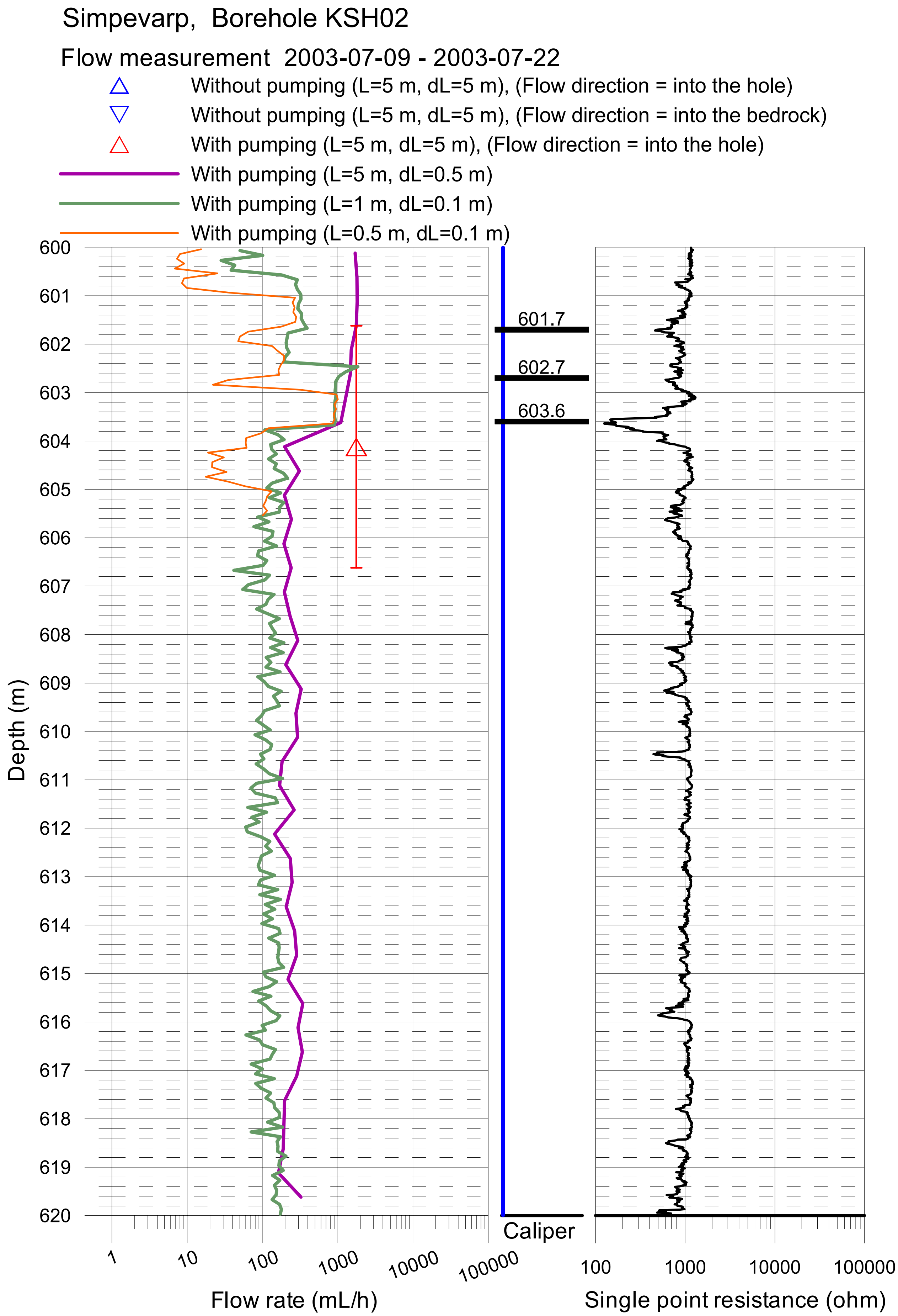
Simpevarp, Borehole KSH02

Flow measurement 2003-07-09 - 2003-07-22



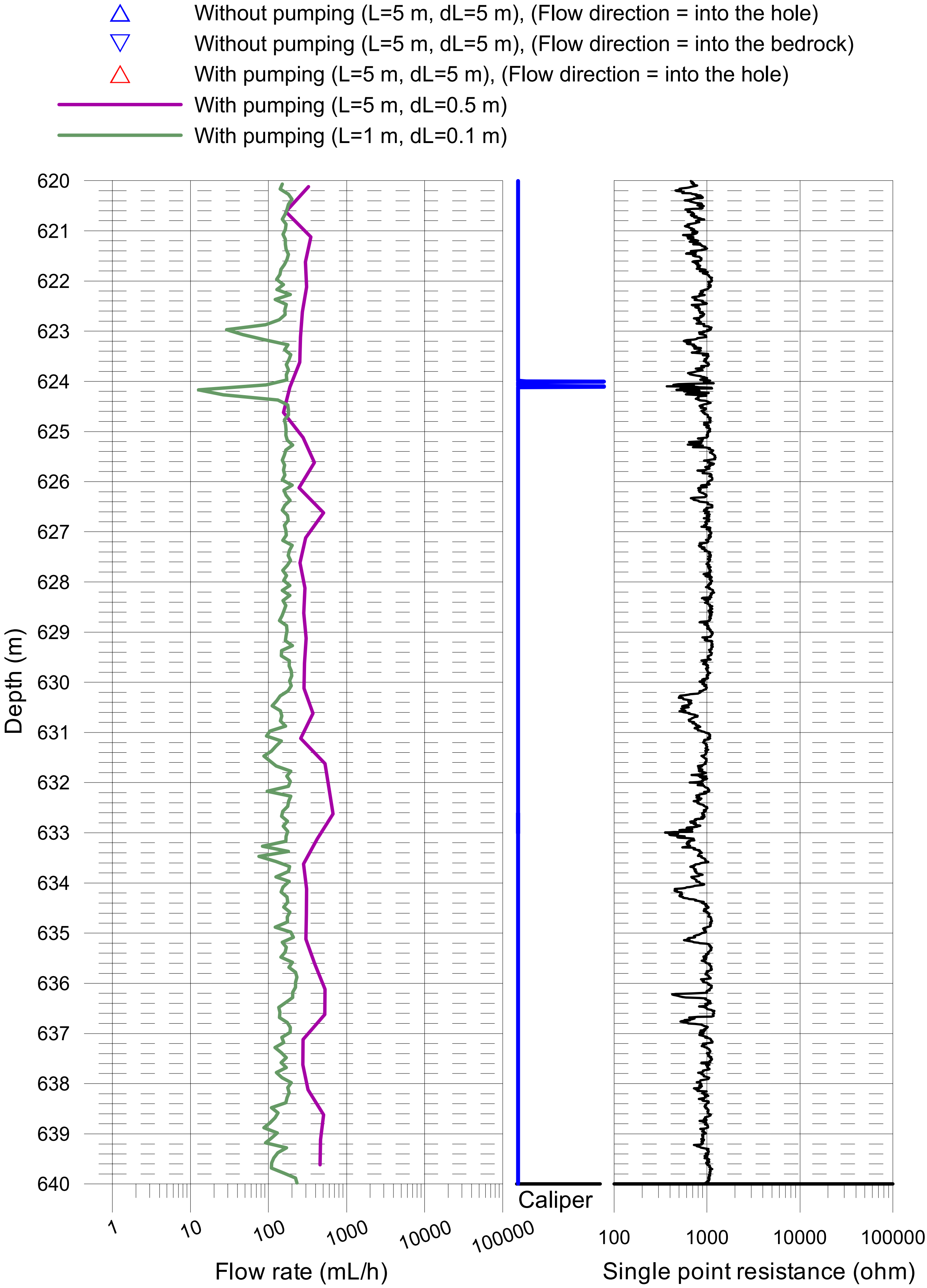


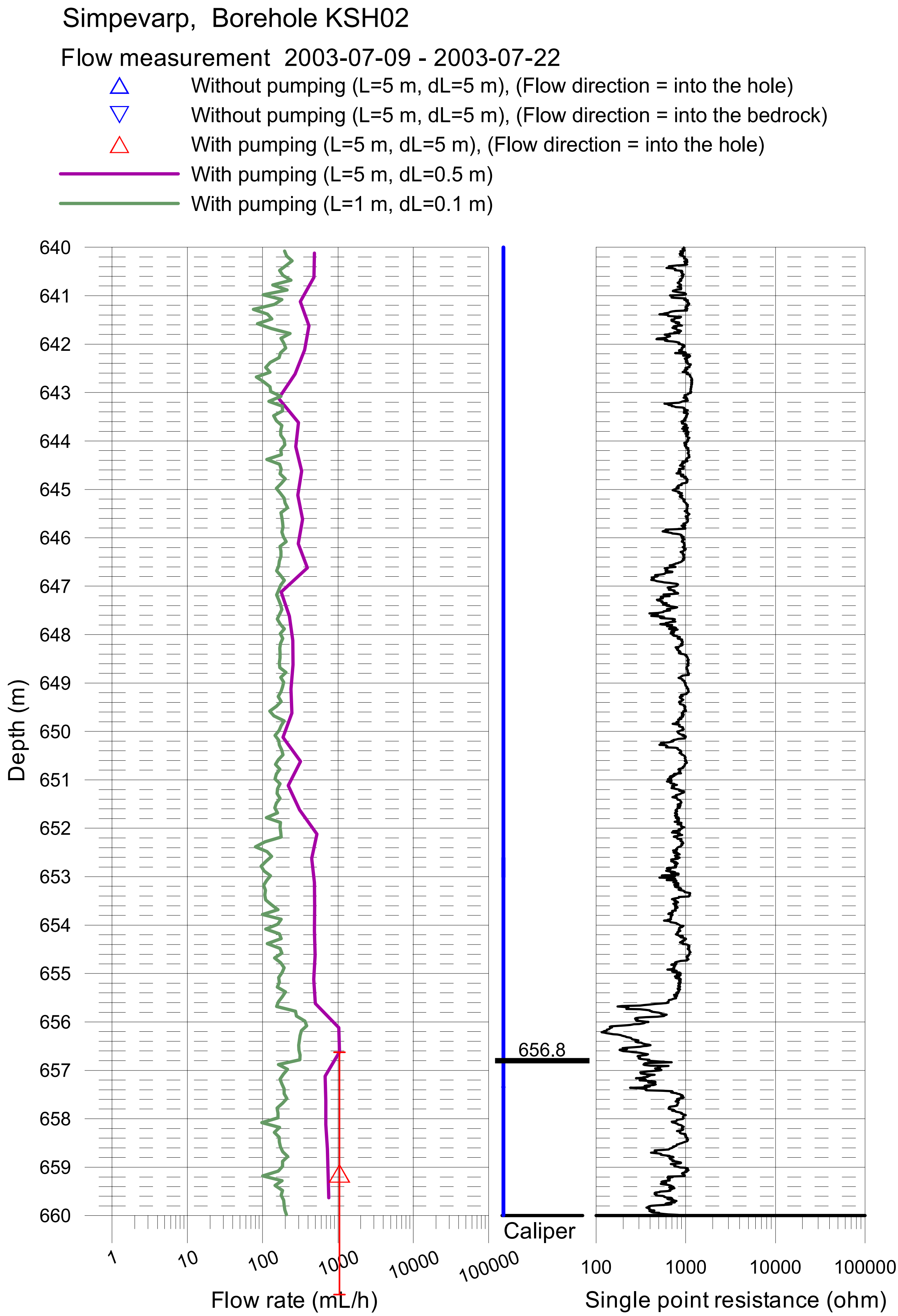
Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
580.3
582.1
583.5
594.8
595.6
597.3
598.1
598.8
Caliper
Flow rate (mL/h)
Single point resistance (ohm)

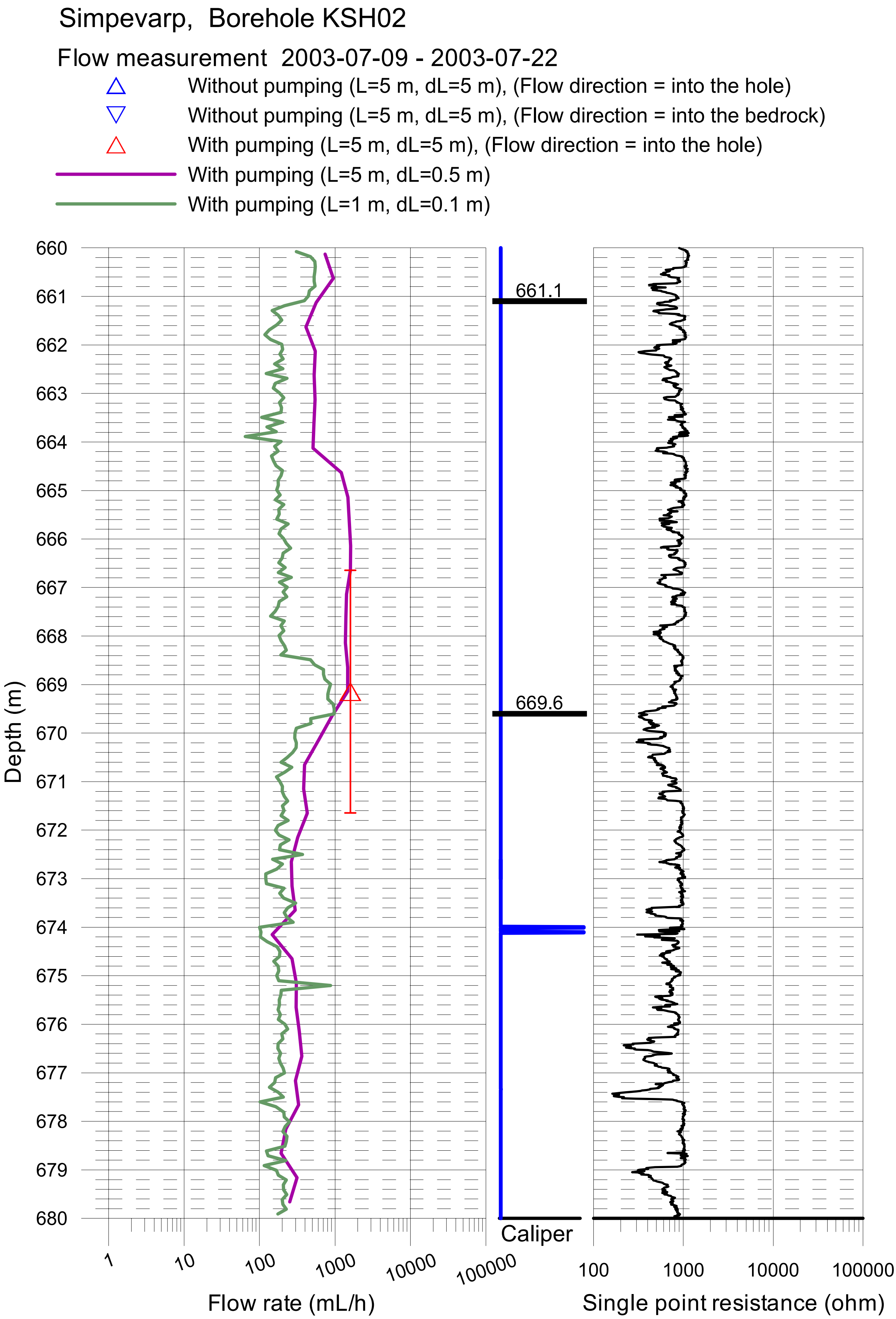

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
601.7
602.7
603.6
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

Simpevarp, Borehole KSH02

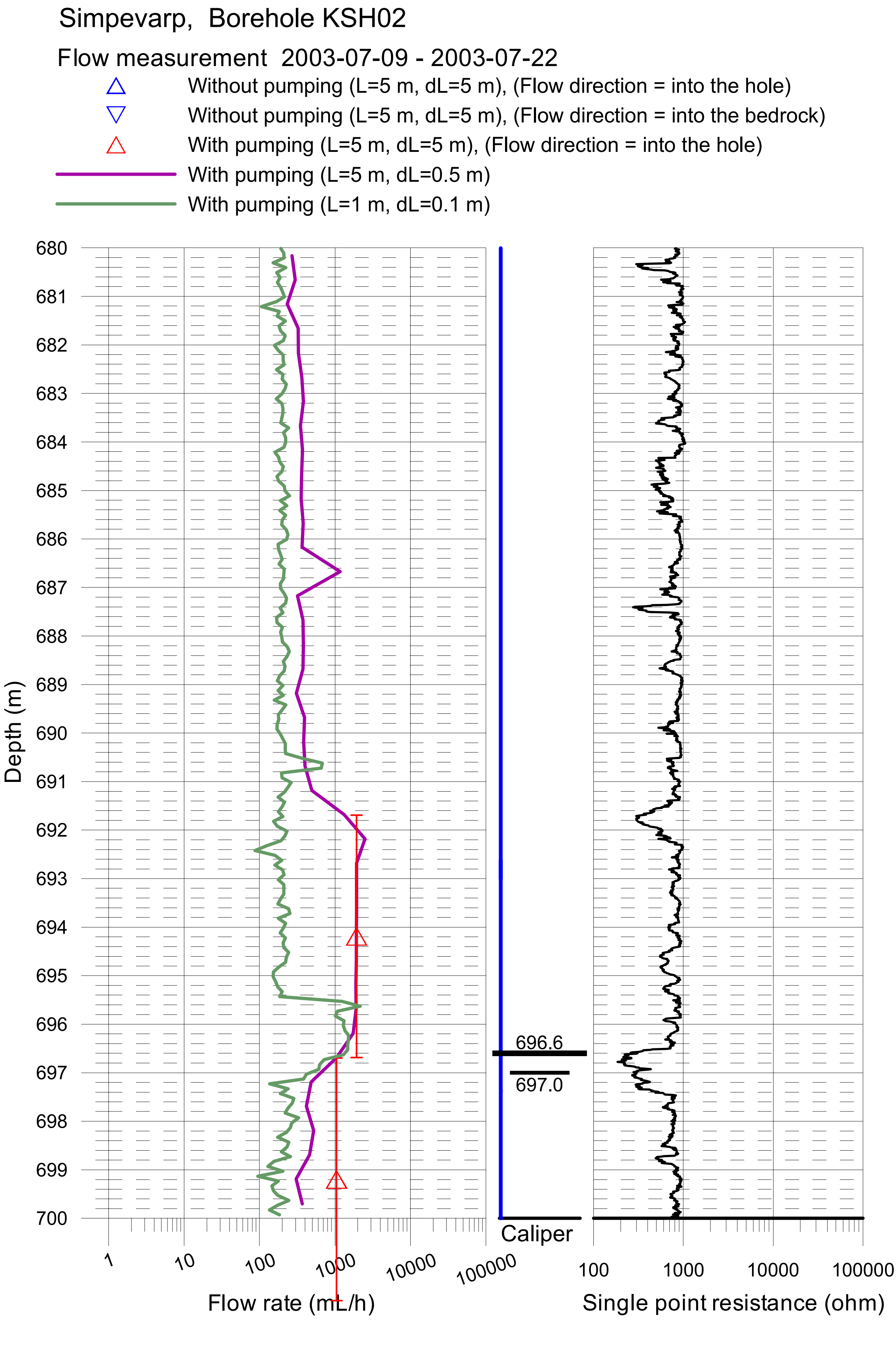
Flow measurement 2003-07-09 - 2003-07-22

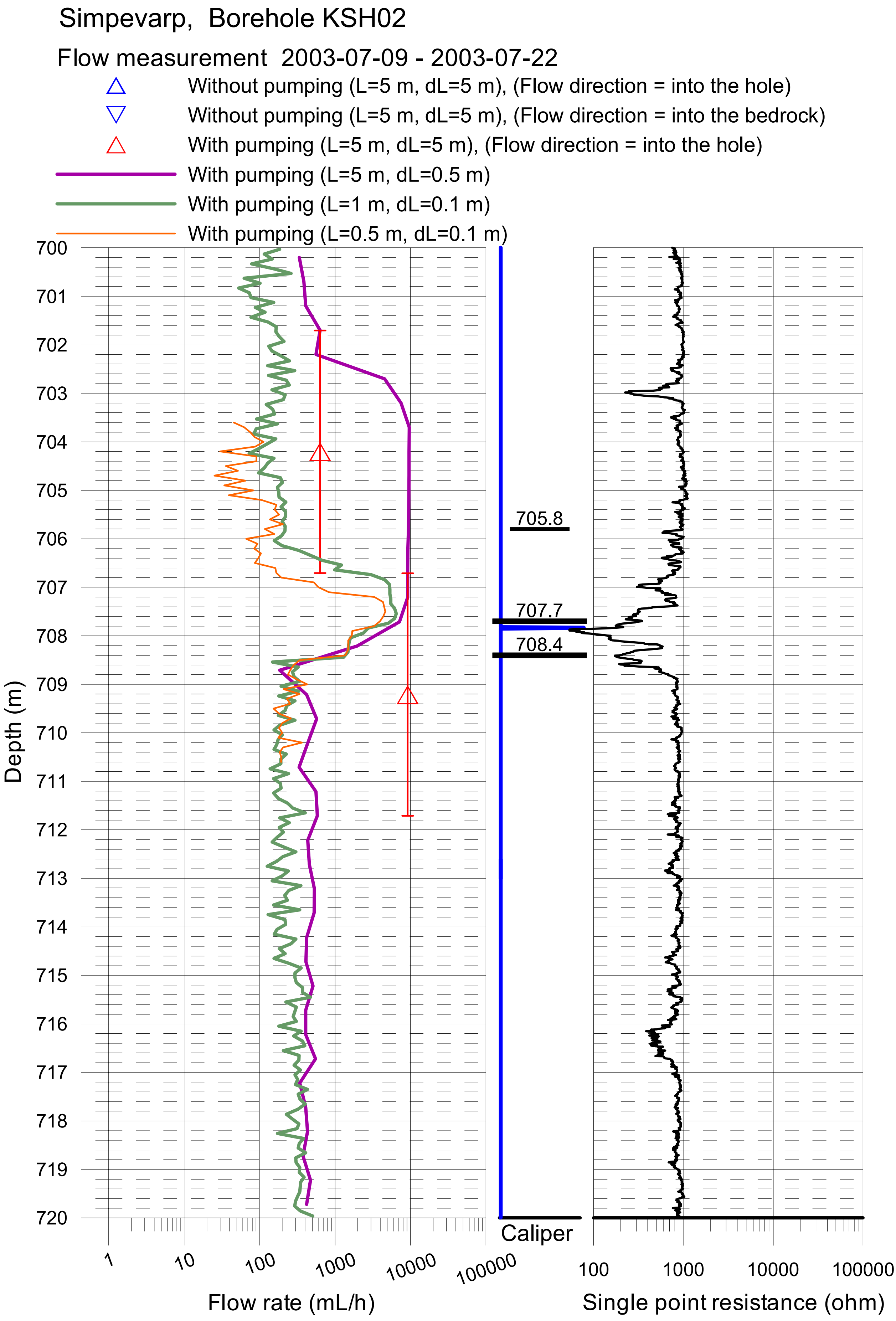


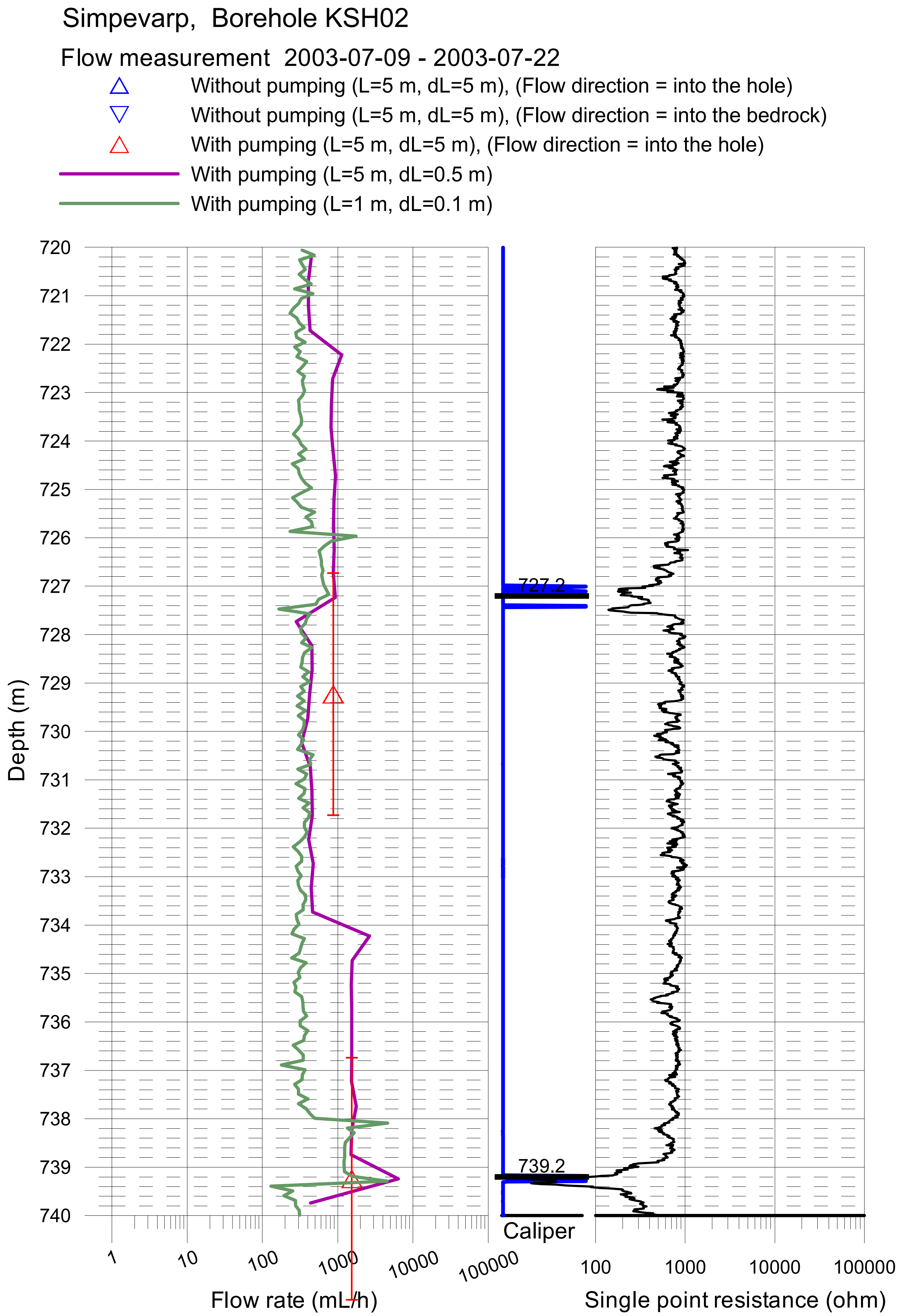

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
656.8
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)



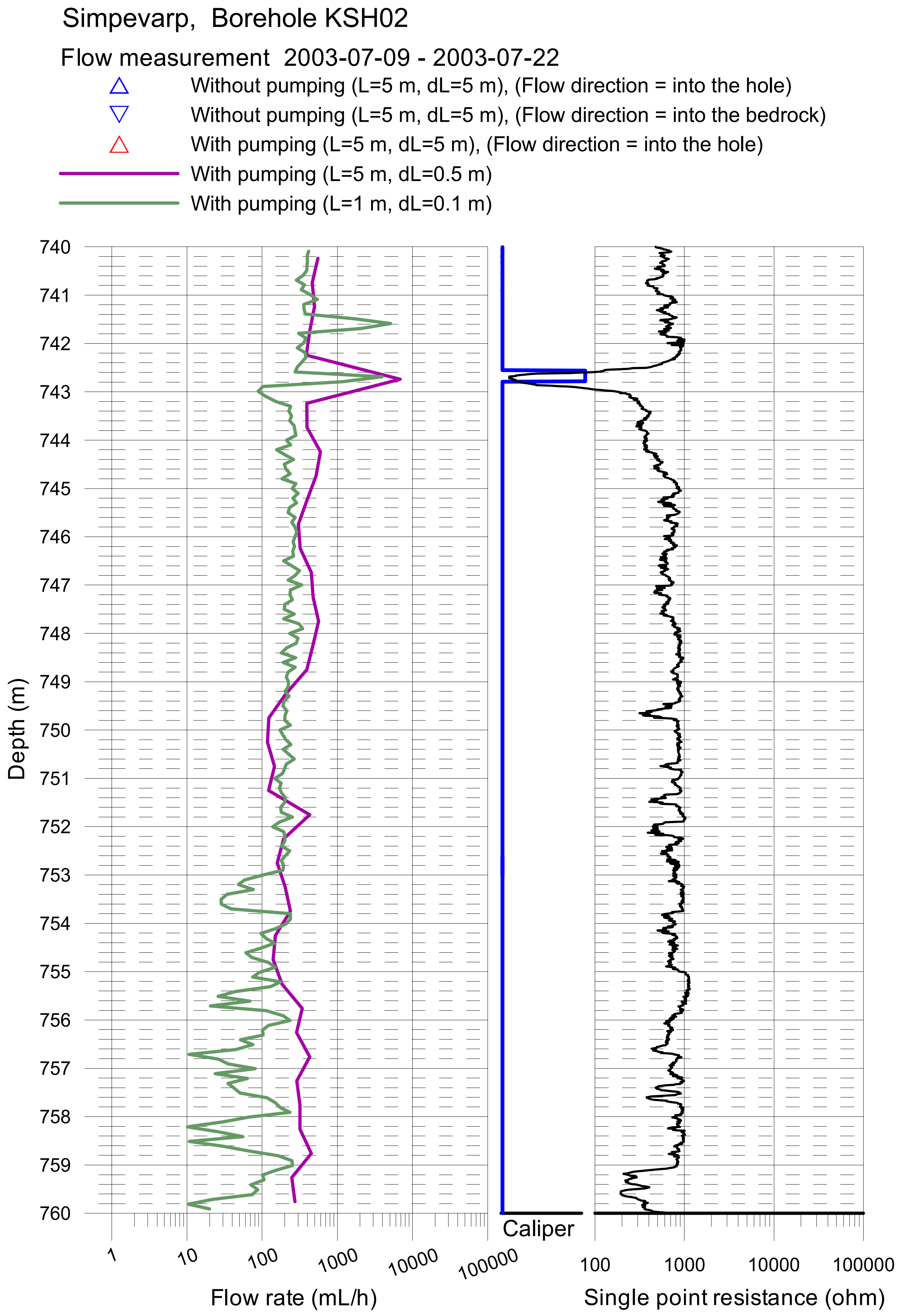
Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
661.1
669.6
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

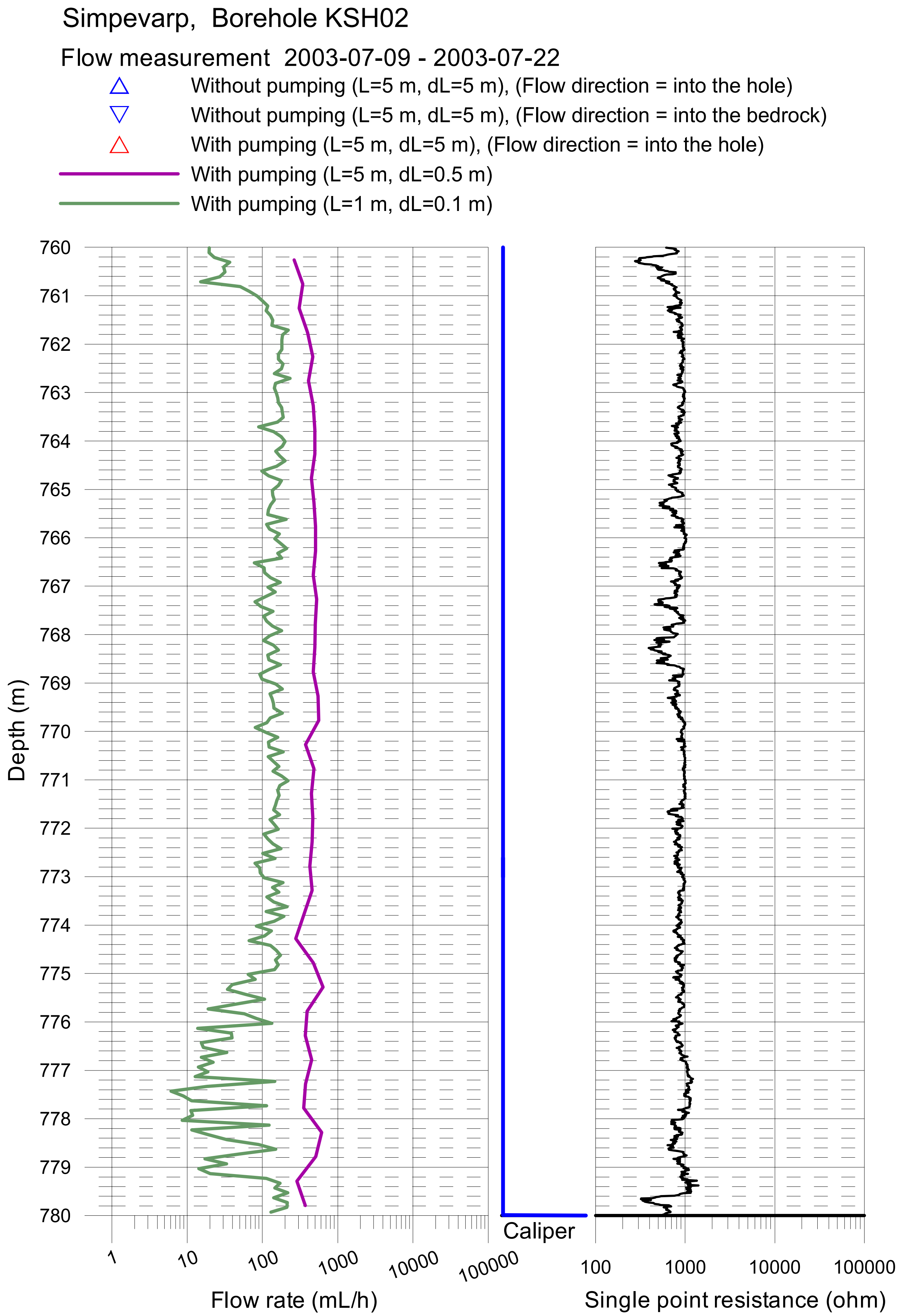

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
1
10
100
1000
10000
100000
Flow rate (mL/h)
696.6
697.0
Caliper
100
1000
10000
100000
Single point resistance (ohm)


Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
705.8
707.7
708.4
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)



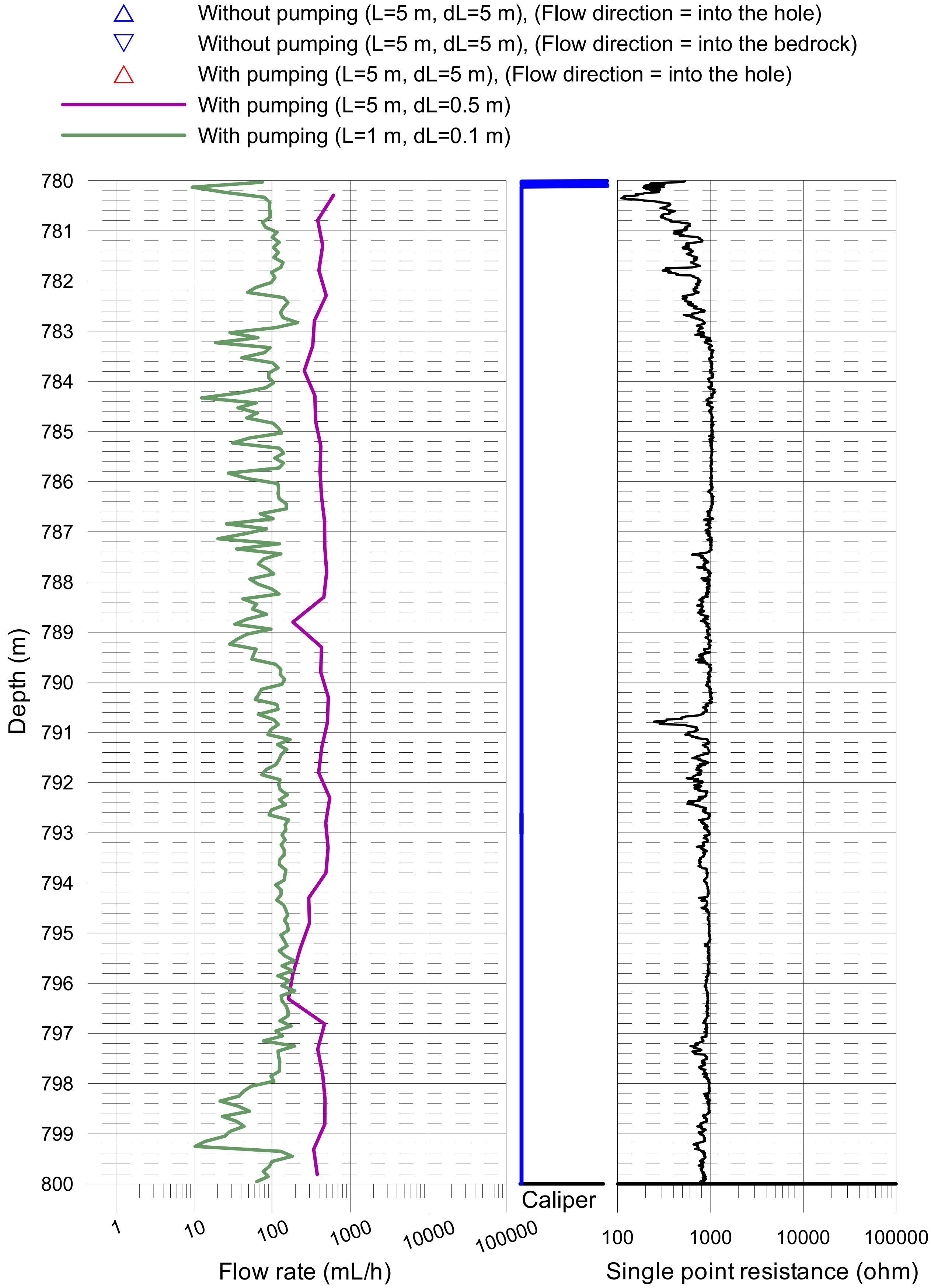
Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
727.2
739.2
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

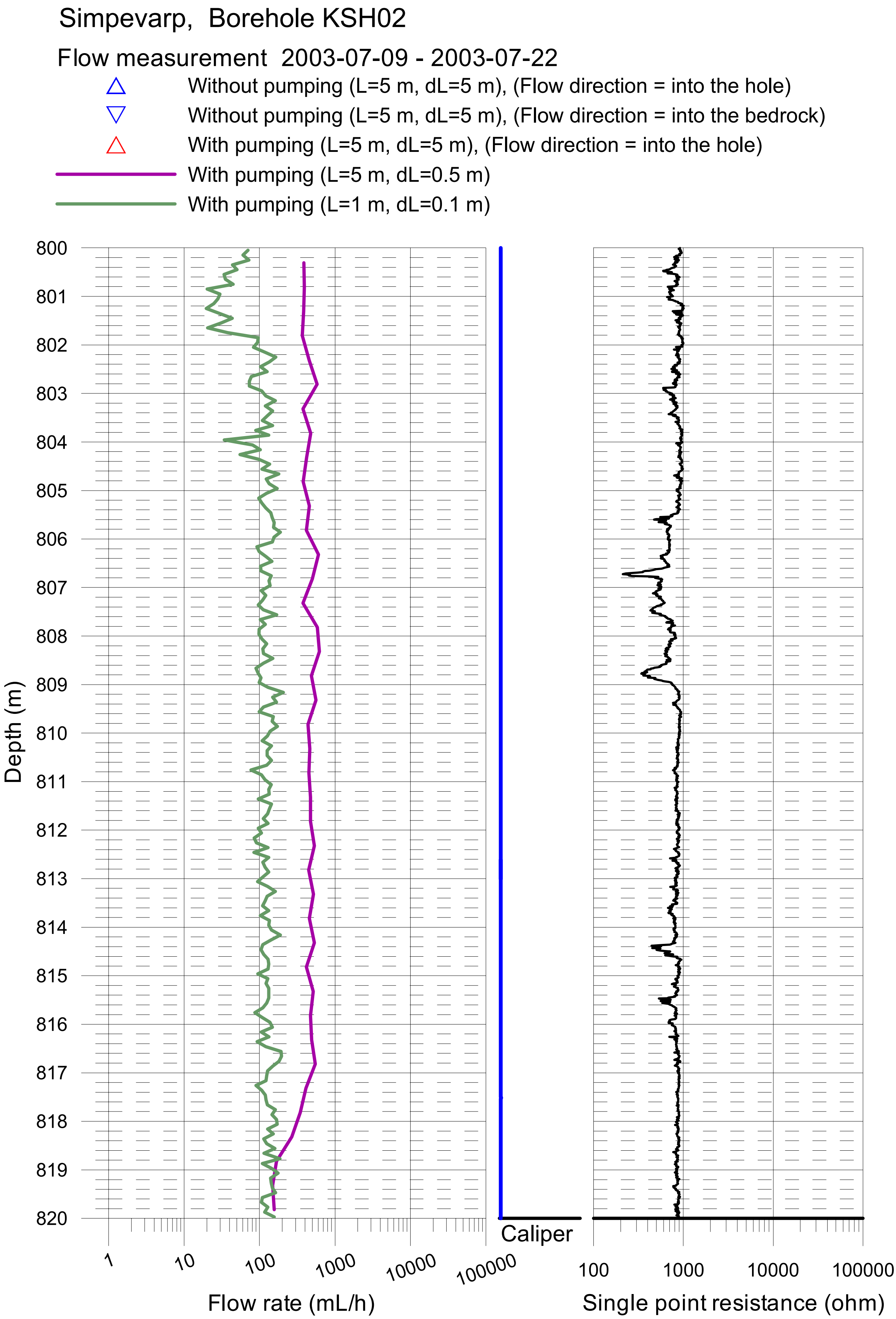

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)


Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)

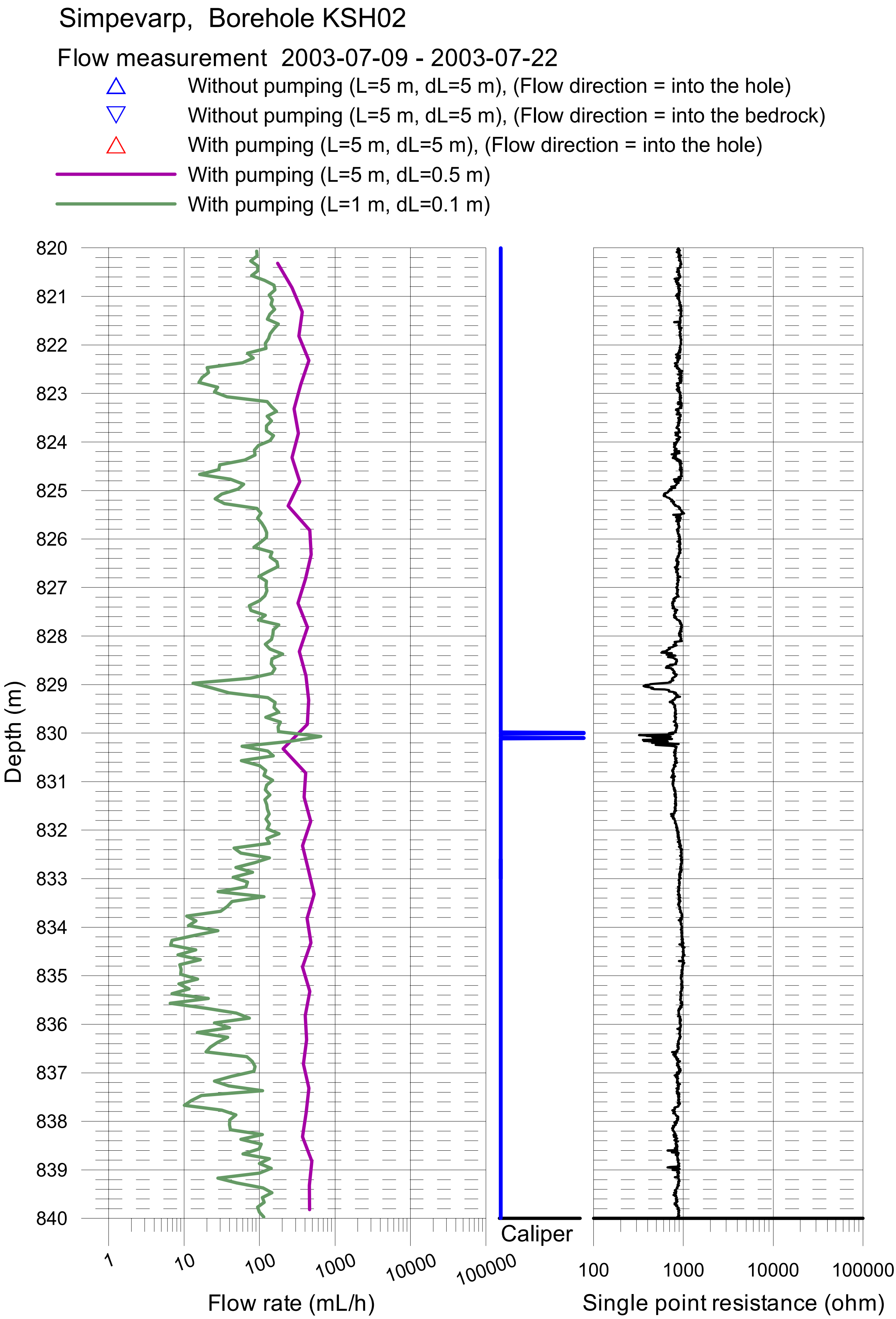
Simpevarp, Borehole KSH02

Flow measurement 2003-07-09 - 2003-07-22





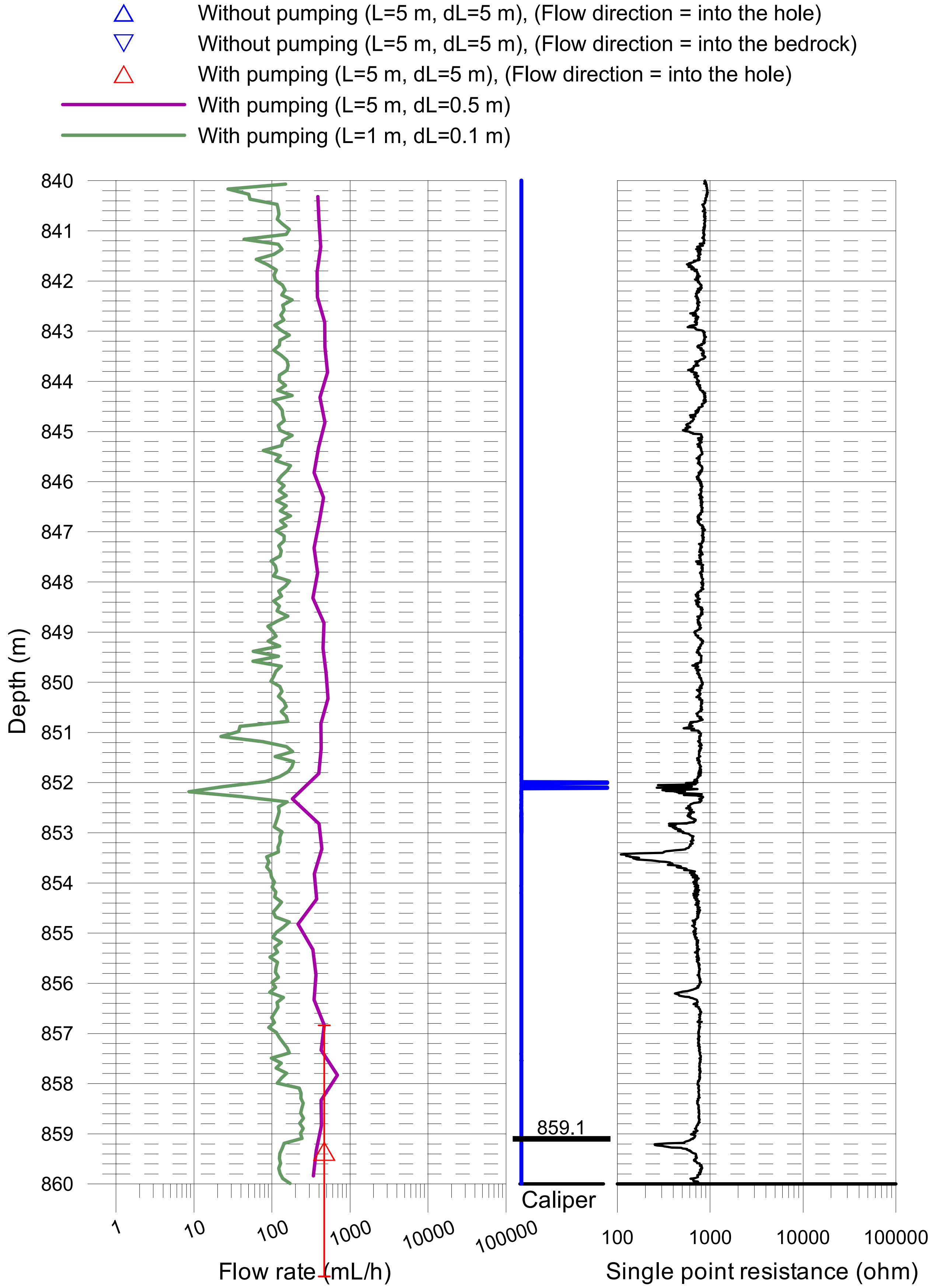
Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)



Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)

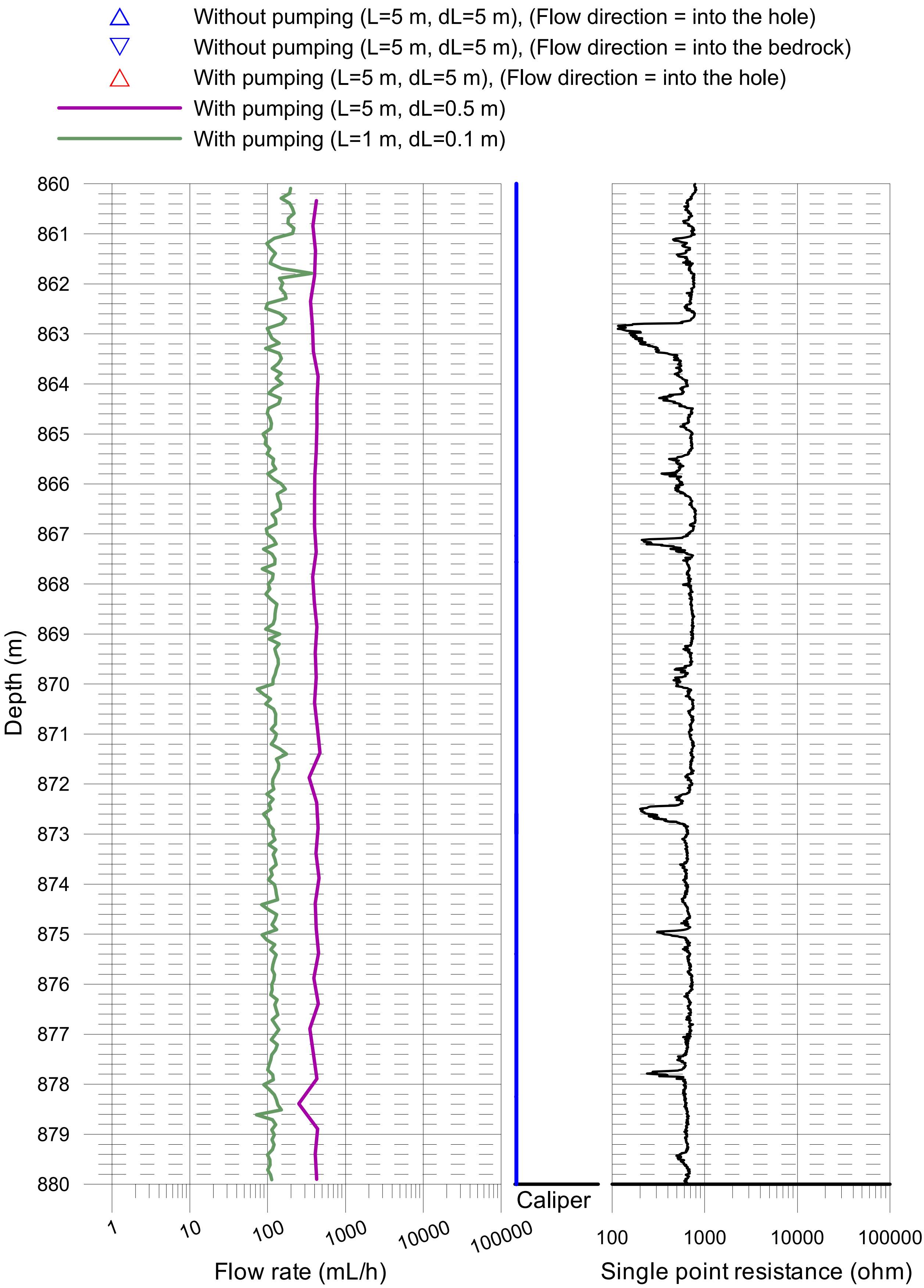
Simpevarp, Borehole KSH02

Flow measurement 2003-07-09 - 2003-07-22



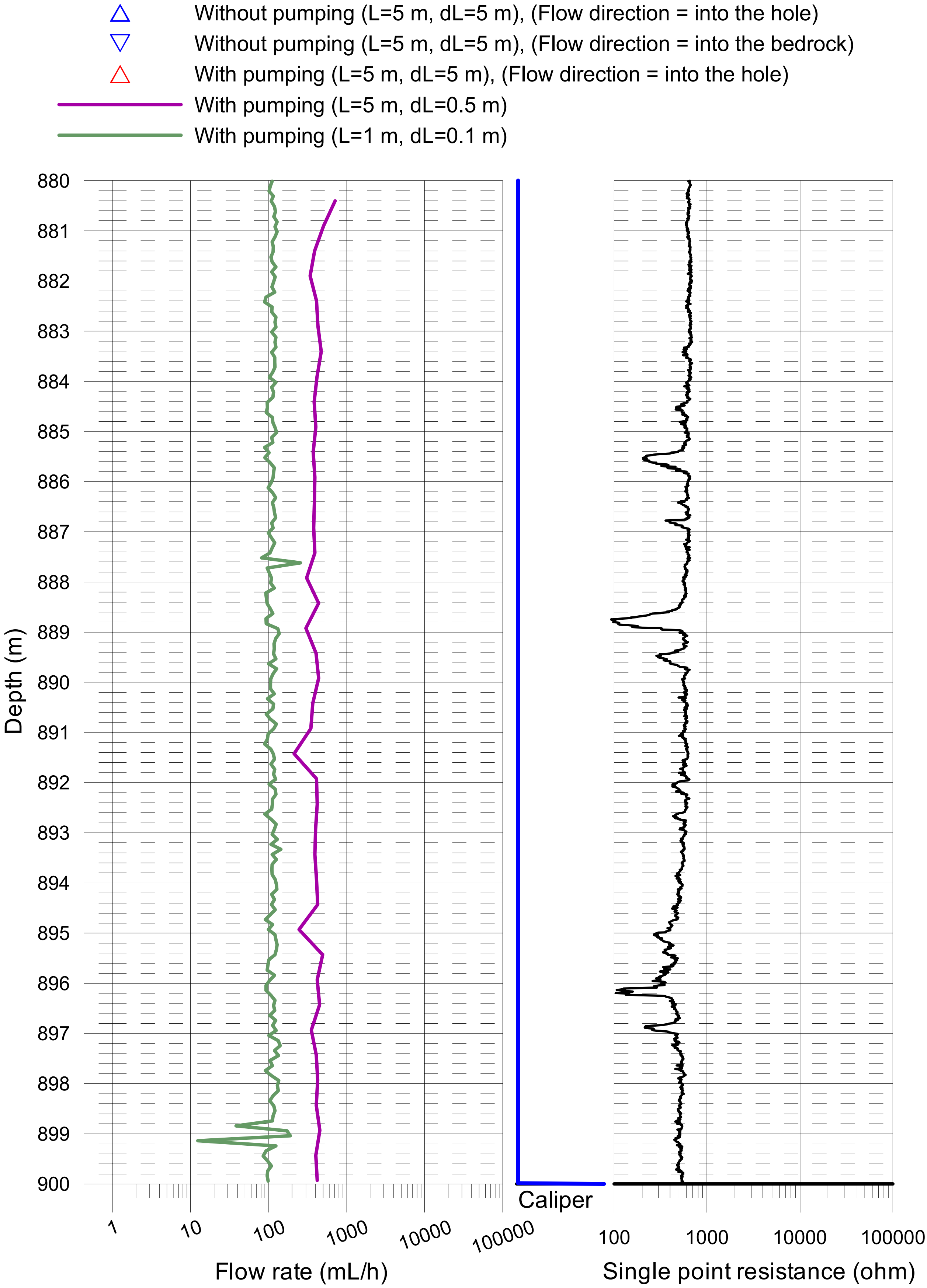
Simpevarp, Borehole KSH02

Flow measurement 2003-07-09 - 2003-07-22



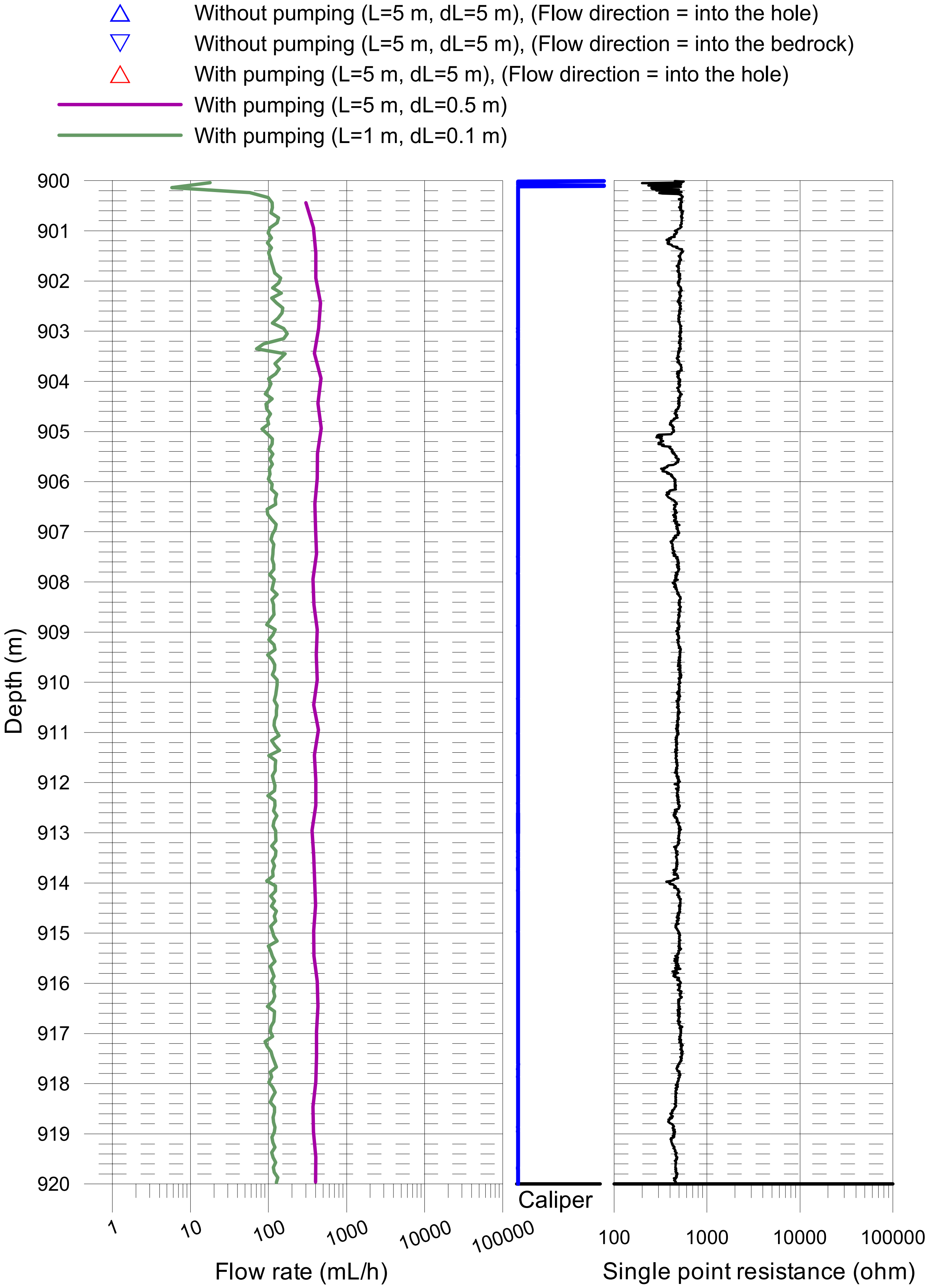
Simpevarp, Borehole KSH02

Flow measurement 2003-07-09 - 2003-07-22



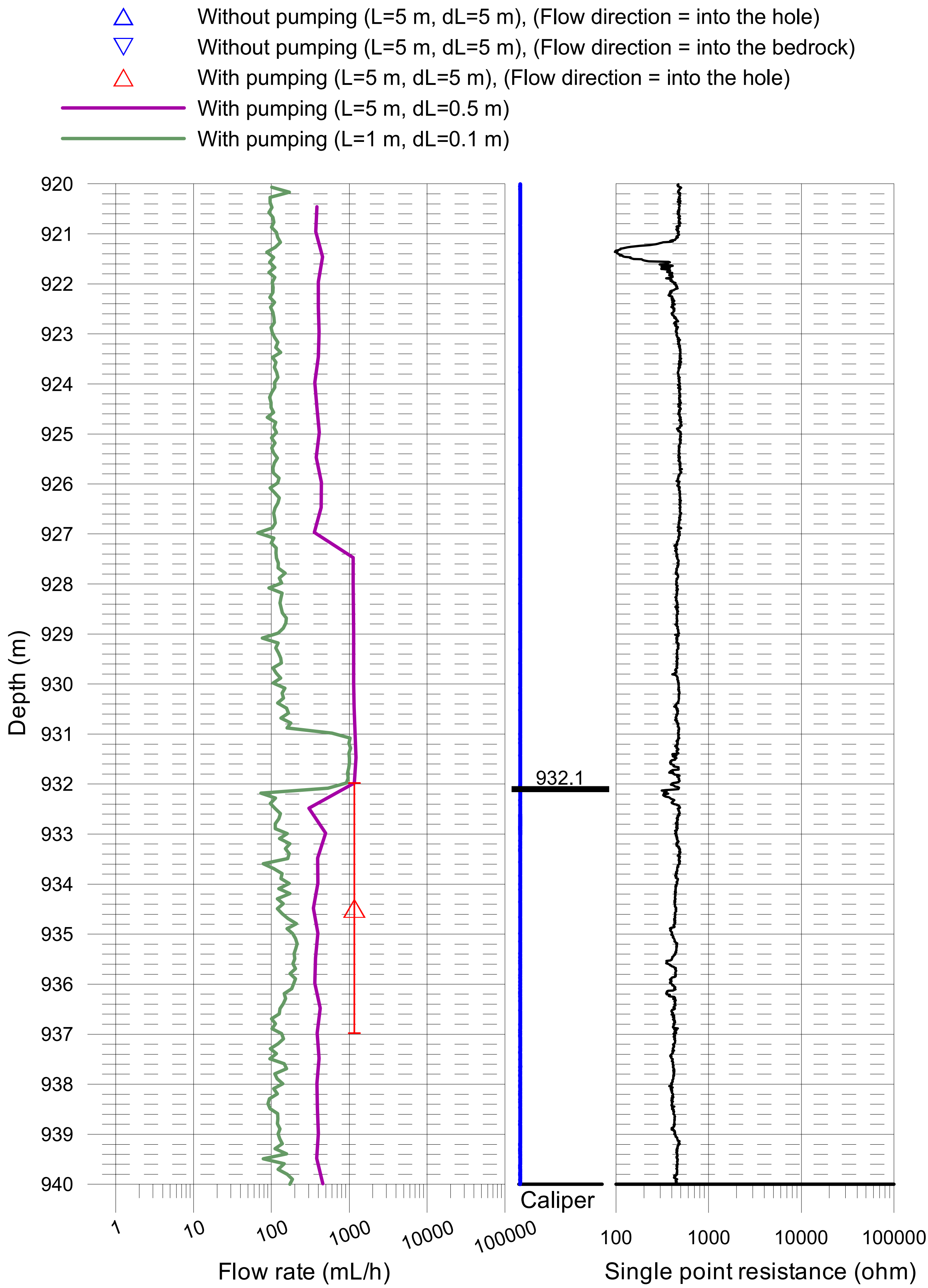
Simpevarp, Borehole KSH02

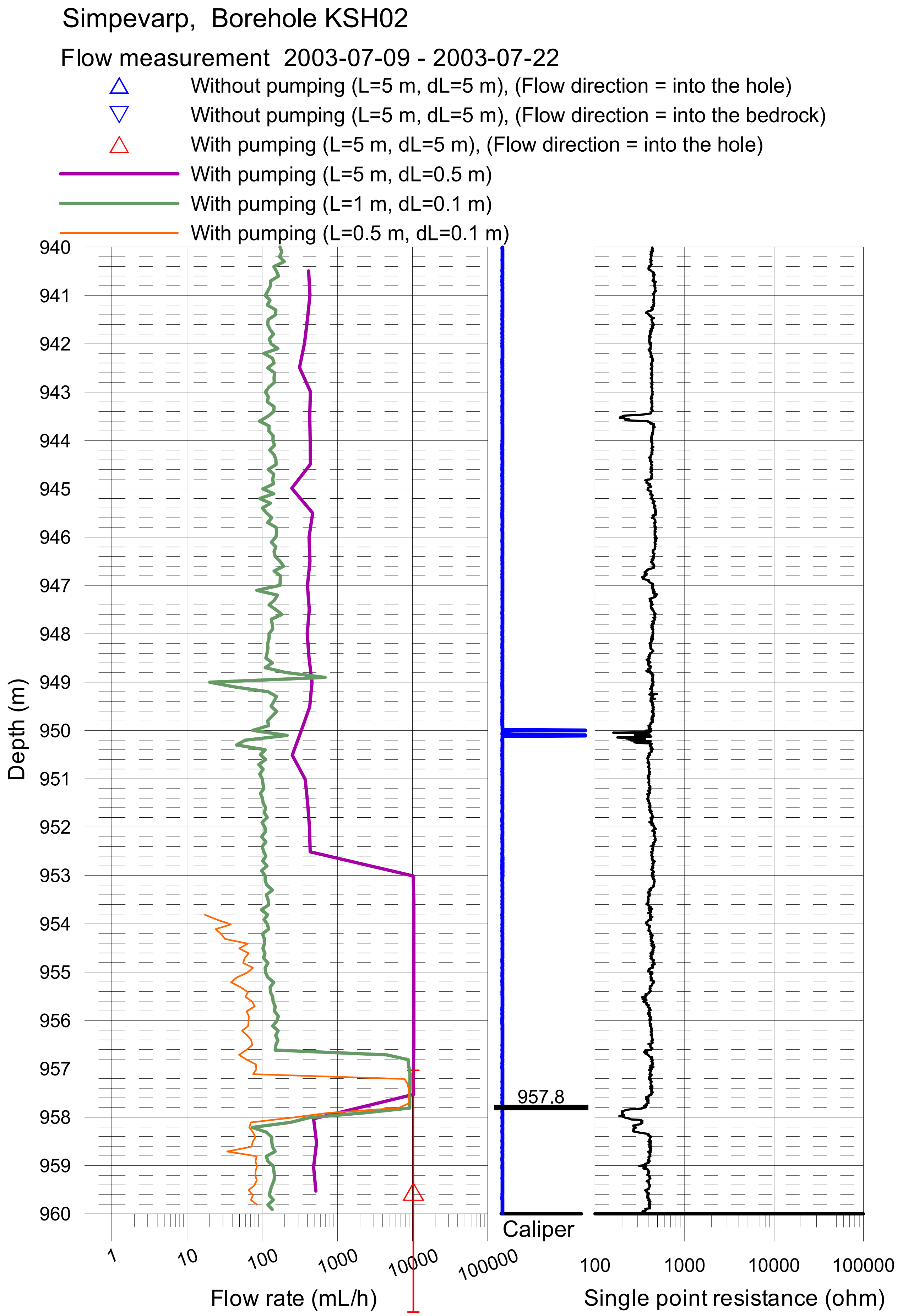
Flow measurement 2003-07-09 - 2003-07-22

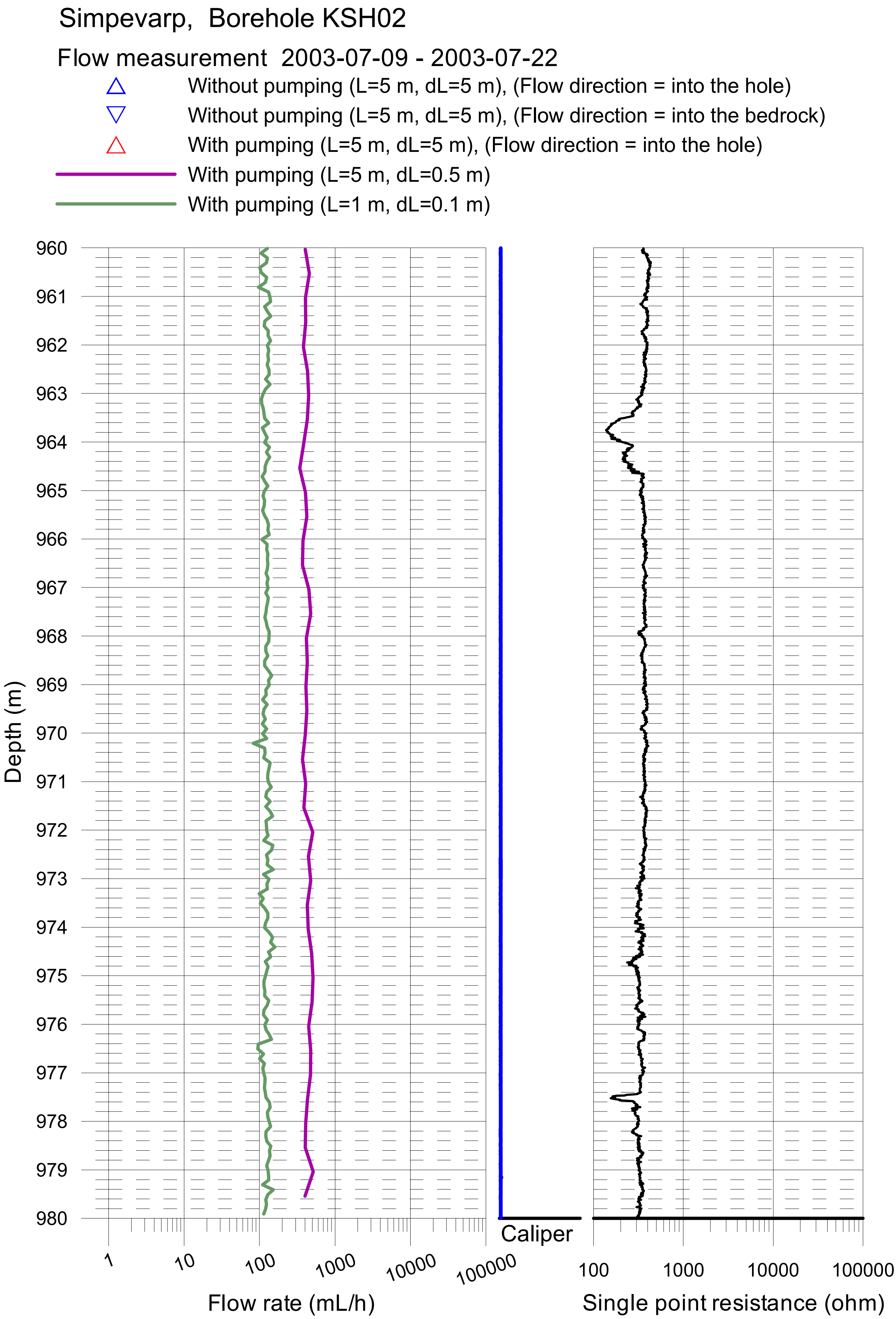


Simpevarp, Borehole KSH02

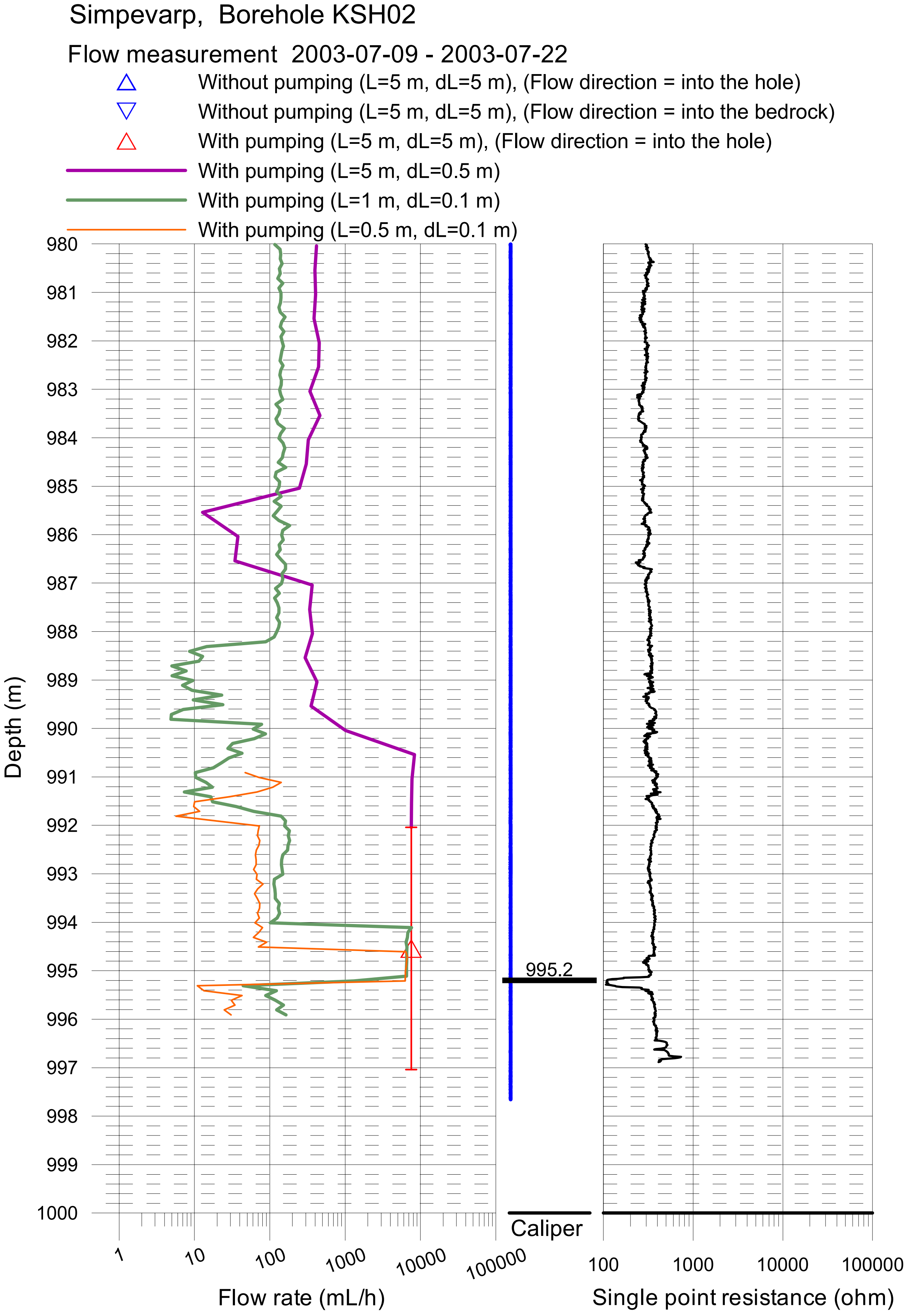
Flow measurement 2003-07-09 - 2003-07-22




Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
957.8
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

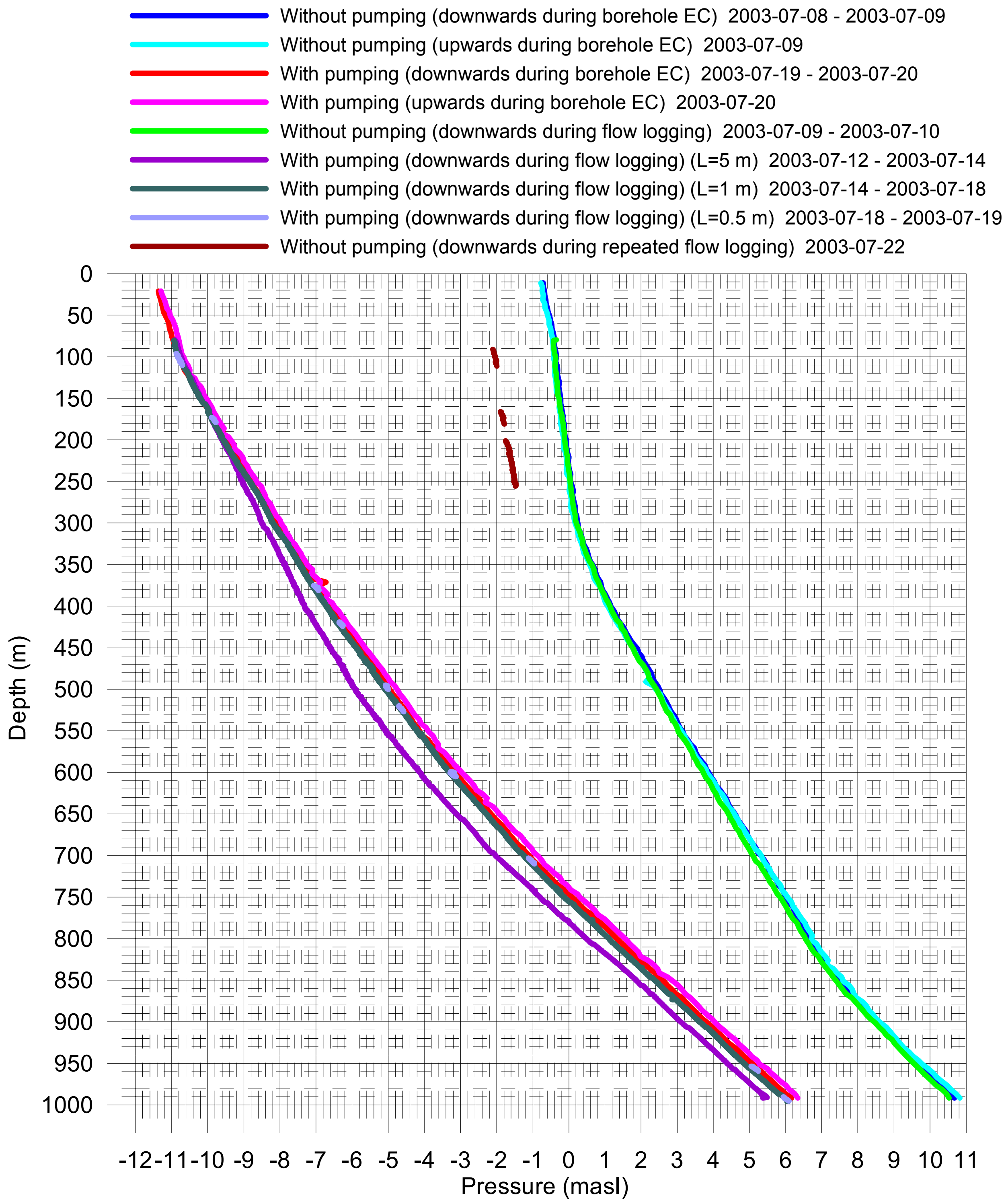


Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
Depth (m)
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)

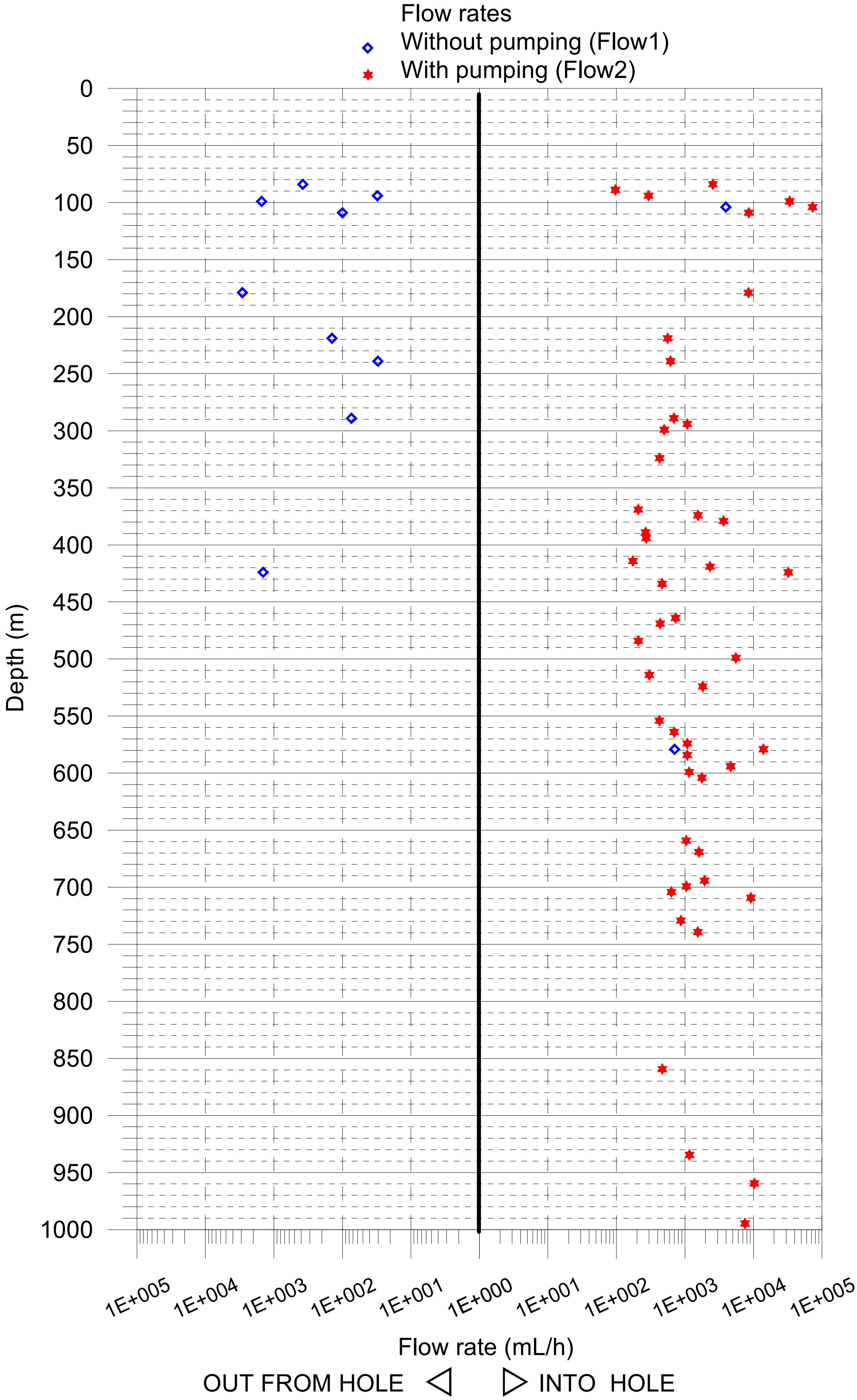

Simpevarp, Borehole KSH02
Flow measurement 2003-07-09 - 2003-07-22
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m)
With pumping (L=0.5 m, dL=0.1 m)
Depth (m)
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
995.2
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

Head during flow logging in borehole KSH02

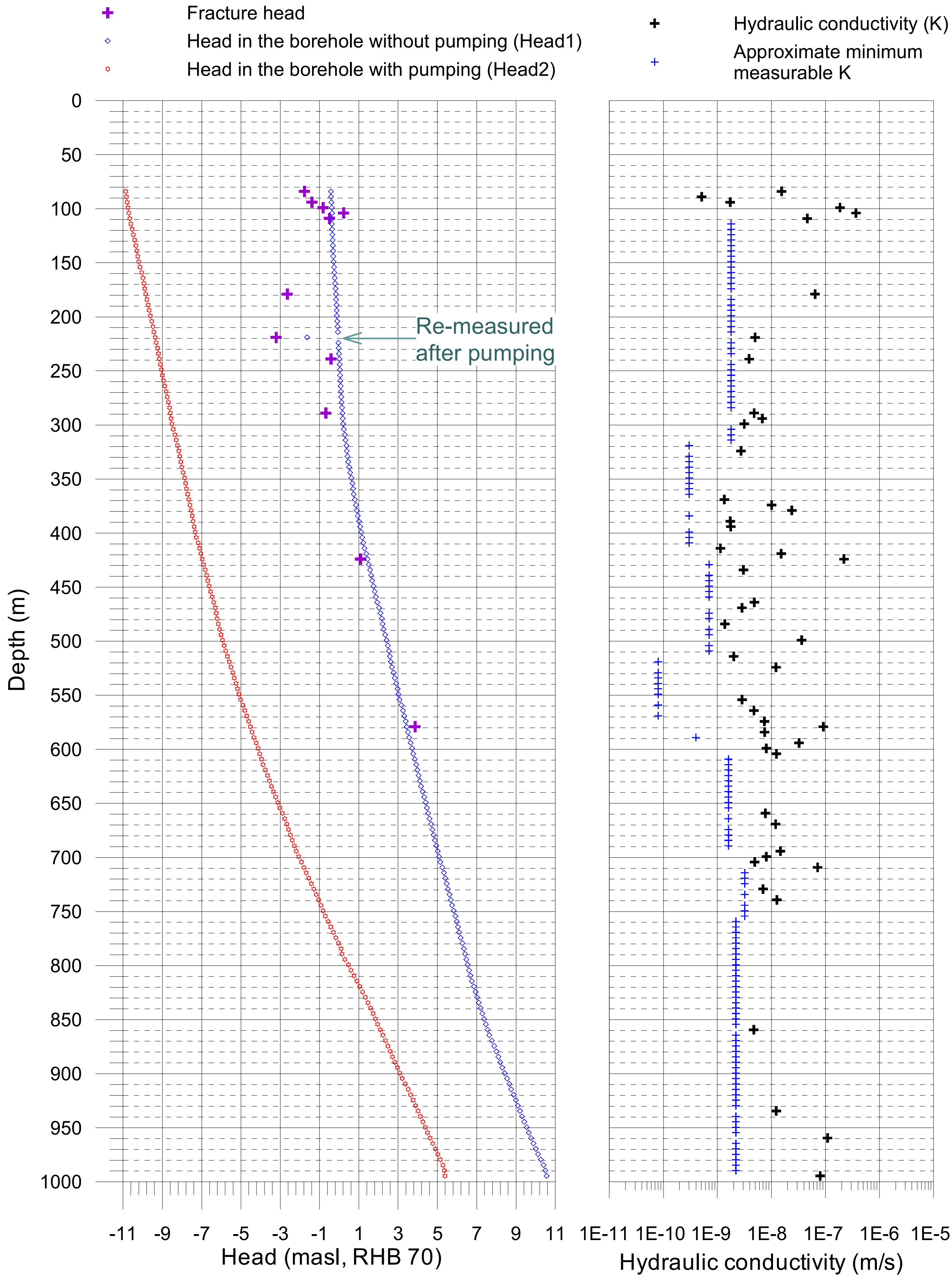
Head(masl)= (Absolute pressure (Pa) - Airpressure (Pa) + Offset) /(1000 kg/m^3 * 9.80065 m/s^2) + Elevation (m)
Offset = 13500 Pa (Correction for absolut pressure sensor)



Simpevarp, Borehole KSH02
Difference flow measurement with thermal pulse 2003-07-09 - 2003-07-22
Length of section 5 m, depth increment 5 m



Simpevarp, Borehole KSH02
Difference flow measurement with thermal pulse 2003-07-09 - 2003-07-22
Length of section 5 m, depth increment 5 m



5. PFL-DIFFERENCE FLOW LOGGING - Basic test data													
Borehole	**Logged interval**		**Test type**	**Date of**	**Time of**	**Date of**	**Time of**	**Date of**	**Time of**	**L_w**	**dL**	**Q_{p1}**	**Q_{p2}**
ID	Secup	Seclow		**test, start**	**test, start**	**flowl., start**	**flowl., start**	**test, stop**	**test, stop**				
	(m)	(m)	(1-6)	YYYYMMDD	hh:mm	YYYYMMDD	hh:mm	YYYYMMDD	hh:mm	(m)	(m)	(m^3/s)	(m^3/s)
KSH02	**80.00**	**1001.11**	**1B**	**20030711**	**12:00**	**20030712**	**13:15**	**20030722**	**16:16**	**921.11**		**5.67E-5**	
KSH02	**81.52**	**997.00**	**5A**	**20030709**	**11:57**	**20030711**	**12:00**	**20030711**	**10:43**	**5**	**5**		
KSH02	**82.8**	**995.2**	**5B**	**20030714**	**12:55**	**20030714**	**19:00**	**20030719**	**14:11**	**1**	**0.1**		

T_{Ss} : From semilog evaluation of recovery.

5. PFL-DIFFERENCE FLOW LOGGING - Basic test data, continued											
t_{p1}	**t_{p2}**	**t_{F1}**	**t_{F2}**	**h_0**	**h_1**	**h_2**	**s_1**	**s_2**	**T_{Ss}**	Reference	Comments
									Entire hole		
(s)	(s)	(s)	(s)	(m)	(m)	(m)	(m)	(m)	(m2/s)	(-)	(-)
781980		**157920**		**-0.6**	**-11.35**		**-10.75**		**2.9 E-6**		

5A. PFL - DIFFERENCE FLOW LOGGING -Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	L_w (m)	Test type (1-6)	Q_0 (m3/s)	Q_1 (m3/s)	Q_2 (m3/s)	dh_0 (m)	dh_1 (m)	dh_2 (m)	T_D (m2/s)	T_D-measl (m2/s)	h_i (m)	EC_{w1} (S/m)	EC_{w2} (S/m)	Te_{w1} (C)	Te_{w2} (C)	Comments
KSH02	81.52	86.52	5	5A	-1.1E-07	7.12E-07	-	-0.43	-10.87	-	7.75E-08	-	-1.8	0.23	1.80	8.90	9.13	
KSH02	86.52	91.52	5	5A	0	2.68E-08	-	-0.42	-10.83	-	3.04E-10	-	-	0.18	1.74	8.93	9.17	
KSH02	91.52	96.52	5	5A	-8.58E-09	8.17E-08	-	-0.40	-10.79	-	8.6E-09	-	-1.4	0.13	1.76	8.96	9.13	
KSH02	96.51	101.51	5	5A	-4.21E-07	9.35E-06	-	-0.38	-10.75	-	9.3E-07	-	-0.8	0.40	0.85	8.97	9.11	
KSH02	101.51	106.51	5	5A	1.10E-06	2.03E-05	-	-0.37	-10.71	-	1.84E-06	-	0.22	0.12	1.42	9.05	9.30	
KSH02	106.51	111.51	5	5A	-2.77E-08	2.37E-06	-	-0.38	-10.66	-	2.31E-07	-	-0.5	0.12	2.36	9.08	9.53	
KSH02	111.51	116.51	5	5A	0	0	-	-0.38	-10.61	-	-	1.61E-10	-	0.12	2.34	9.14	9.59	
KSH02	116.51	121.51	5	5A	0	0	-	-0.36	-10.54	-	-	1.62E-10	-	0.12	2.58	9.21	9.63	
KSH02	121.51	126.51	5	5A	0	0	-	-0.35	-10.48	-	-	1.63E-10	-	0.12	2.70	9.25	9.69	
KSH02	126.51	131.51	5	5A	0	0	-	-0.33	-10.42	-	-	1.64E-10	-	0.12	3.27	9.31	9.75	
KSH02	131.51	136.51	5	5A	0	0	-	-0.32	-10.35	-	-	1.65E-10	-	0.12	3.21	9.37	9.79	
KSH02	136.51	141.51	5	5A	0	0	-	-0.31	-10.30	-	-	1.65E-10	-	0.12	3.04	9.44	9.88	
KSH02	141.51	146.51	5	5A	0	0	-	-0.30	-10.26	-	-	1.66E-10	-	0.12	2.88	9.50	9.93	
KSH02	146.51	151.51	5	5A	0	0	-	-0.28	-10.21	-	-	1.66E-10	-	0.12	2.37	9.56	10.00	
KSH02	151.51	156.51	5	5A	0	0	-	-0.26	-10.14	-	-	1.67E-10	-	0.12	2.39	9.63	10.06	
KSH02	156.51	161.51	5	5A	0	0	-	-0.25	-10.05	-	-	1.68E-10	-	0.11	2.93	9.71	10.12	
KSH02	161.51	166.51	5	5A	0	0	-	-0.23	-9.99	-	-	1.69E-10	-	0.11	3.14	9.76	10.19	
KSH02	166.51	171.51	5	5A	0	0	-	-0.21	-9.94	-	-	1.7E-10	-	0.11	1.67	9.85	10.14	
KSH02	171.51	176.51	5	5A	0	0	-	-0.19	-9.90	-	-	1.7E-10	-	0.11	1.46	9.93	10.17	
KSH02	176.51	181.51	5	5A	-8.02E-07	2.35E-06	-	-0.17	-9.85	-	3.22E-07	-	-2.6	0.12	3.04	9.95	10.39	
KSH02	181.51	186.51	5	5A	0	0	-	-0.15	-9.79	-	-	1.71E-10	-	0.11	2.96	10.02	10.46	
KSH02	186.51	191.51	5	5A	0	0	-	-0.14	-9.72	-	-	1.72E-10	-	0.12	2.62	10.08	10.52	
KSH02	191.51	196.51	5	5A	0	0	-	-0.13	-9.67	-	-	1.73E-10	-	0.12	2.58	10.15	10.58	
KSH02	196.51	201.51	5	5A	0	0	-	-0.12	-9.61	-	-	1.74E-10	-	0.13	2.55	10.22	10.64	
KSH02	201.51	206.51	5	5A	0	0	-	-0.10	-9.55	-	-	1.75E-10	-	0.13	2.59	10.29	10.71	
KSH02	206.51	211.51	5	5A	0	0	-	-0.09	-9.49	-	-	1.76E-10	-	0.14	1.63	10.40	10.65	
KSH02	211.51	216.51	5	5A	0	0	-	-0.07	-9.43	-	-	1.76E-10	-	0.14	2.72	10.44	10.82	
KSH02	216.51	221.51	5	5A	-3.94E-08	1.55E-07	-	-1.64	-9.37	-	2.5E-08	-	-3.2	0.14	3.30	10.49	10.90	
KSH02	221.51	226.51	5	5A	0	0	-	-0.04	-9.31	-	-	1.78E-10	-	0.15	3.31	10.55	10.97	
KSH02	226.51	231.51	5	5A	0	0	-	-0.03	-9.25	-	-	1.79E-10	-	0.15	3.20	10.61	11.04	
KSH02	231.51	236.51	5	5A	0	0	-	-0.01	-9.20	-	-	1.8E-10	-	0.16	3.07	10.69	11.12	

5A. PFL - DIFFERENCE FLOW LOGGING -Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	L_w (m)	Test type (1-6)	Q_0 (m3/s)	Q_1 (m3/s)	Q_2 (m3/s)	dh_0 (m)	dh_1 (m)	dh_2 (m)	T_D (m2/s)	T_D-measl (m2/s)	h_i (m)	EC_{w1} (S/m)	EC_{w2} (S/m)	Te_{w1} (C)	Te_{w2} (C)	Comments
KSH02	236.51	241.51	5	5A	-8.44E-09	1.71E-07	-	0.01	-9.16	-	1.94E-08	-	-0.4	0.16	3.07	10.75	11.18	
KSH02	241.52	246.52	5	5A	0	0	-	0.02	-9.10	-	-	1.81E-10	-	0.17	3.03	10.81	11.25	
KSH02	246.52	251.52	5	5A	0	0	-	0.03	-9.05	-	-	1.82E-10	-	0.19	2.85	10.88	11.31	
KSH02	251.52	256.52	5	5A	0	0	-	0.05	-9.00	-	-	1.82E-10	-	0.22	2.69	10.95	11.37	
KSH02	256.52	261.52	5	5A	0	0	-	0.06	-8.95	-	-	1.83E-10	-	0.25	2.62	11.02	11.45	
KSH02	261.52	266.52	5	5A	0	0	-	0.08	-8.88	-	-	1.84E-10	-	0.28	2.64	11.09	11.50	
KSH02	266.52	271.52	5	5A	0	0	-	0.09	-8.81	-	-	1.85E-10	-	0.32	2.71	11.15	11.57	
KSH02	271.52	276.52	5	5A	0	0	-	0.11	-8.75	-	-	1.86E-10	-	0.37	3.13	11.22	11.64	
KSH02	276.53	281.53	5	5A	0	0	-	0.12	-8.69	-	-	1.87E-10	-	0.44	3.10	11.31	11.73	
KSH02	281.53	286.53	5	5A	0	0	-	0.15	-8.64	-	-	1.88E-10	-	0.55	2.99	11.38	11.80	
KSH02	286.53	291.53	5	5A	-2.06E-08	1.92E-07	-	0.17	-8.60	-	2.4E-08	-	-0.7	0.64	2.82	11.44	11.85	
KSH02	291.54	296.54	5	5A	0	3.00E-07	-	0.18	-8.56	-	3.4E-08	-	-	0.76	2.99	11.52	11.95	
KSH02	296.54	301.54	5	5A	0	1.38E-07	-	0.20	-8.52	-	1.57E-08	-	-	0.88	2.87	11.60	11.99	
KSH02	301.54	306.54	5	5A	0	0	-	0.24	-8.45	-	-	1.9E-10	-	1.00	2.64	11.67	12.06	
KSH02	306.54	311.54	5	5A	0	0	-	0.28	-8.36	-	-	1.91E-10	-	1.08	2.55	11.73	12.12	
KSH02	311.54	316.54	5	5A	0	0	-	0.32	-8.30	-	-	1.91E-10	-	1.02	2.56	11.81	12.20	
KSH02	316.54	321.54	5	5A	0	0	-	0.37	-8.23	-	-	1.92E-10	-	1.29	2.73	11.87	12.26	
KSH02	321.54	326.54	5	5A	0	1.18E-07	-	0.39	-8.17	-	1.37E-08	-	-	1.39	2.98	11.94	12.31	
KSH02	326.54	331.54	5	5A	0	0	-	0.42	-8.11	-	-	1.94E-10	-	1.51	3.10	12.01	12.38	
KSH02	331.54	336.54	5	5A	0	0	-	0.46	-8.06	-	-	1.94E-10	-	1.64	3.17	12.08	12.43	
KSH02	336.53	341.53	5	5A	0	0	-	0.50	-8.01	-	-	1.94E-10	-	1.76	3.18	12.14	12.51	
KSH02	341.53	346.53	5	5A	0	0	-	0.55	-7.94	-	-	1.94E-10	-	1.86	3.17	12.21	12.58	
KSH02	346.53	351.53	5	5A	0	0	-	0.62	-7.87	-	-	1.94E-10	-	1.96	3.18	12.28	12.64	
KSH02	351.53	356.53	5	5A	0	0	-	0.68	-7.81	-	-	1.94E-10	-	2.01	3.18	12.35	12.70	
KSH02	356.53	361.53	5	5A	0	0	-	0.71	-7.78	-	-	1.95E-10	-	2.02	3.17	12.42	12.77	
KSH02	361.53	366.53	5	5A	0	0	-	0.74	-7.72	-	-	1.95E-10	-	2.04	3.09	12.49	12.85	
KSH02	366.53	371.53	5	5A	0	5.78E-08	-	0.80	-7.66	-	6.75E-09	-	-	2.05	2.50	12.57	12.89	
KSH02	371.54	376.54	5	5A	0	4.30E-07	-	0.85	-7.60	-	5.05E-08	-	-	2.05	2.07	12.63	12.91	
KSH02	376.54	381.54	5	5A	0	1.01E-06	-	0.89	-7.54	-	1.19E-07	-	-	2.18	3.05	12.70	13.05	
KSH02	381.55	386.55	5	5A	0	0	-	0.95	-7.49	-	-	1.96E-10	-	2.22	3.06	12.77	13.11	
KSH02	386.55	391.55	5	5A	0	7.39E-08	-	1.01	-7.44	-	8.65E-09	-	-	2.21	3.05	12.84	13.17	

5A. PFL - DIFFERENCE FLOW LOGGING -Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	L_w (m)	Test type (1-6)	Q_0 (m3/s)	Q_1 (m3/s)	Q_2 (m3/s)	dh_0 (m)	dh_1 (m)	dh_2 (m)	T_D (m2/s)	T_D-measl (m2/s)	h_i (m)	EC_{w1} (S/m)	EC_{w2} (S/m)	Te_{w1} (C)	Te_{w2} (C)	Comments
KSH02	391.56	396.56	5	5A	0	7.53E-08	-	1.07	-7.39	-	8.8E-09	-	-	2.36	2.94	12.91	13.22	
KSH02	396.56	401.56	5	5A	0	0	-	1.12	-7.34	-	-	1.95E-10	-	2.38	2.84	12.99	13.27	
KSH02	401.56	406.56	5	5A	0	0	-	1.17	-7.28	-	-	1.95E-10	-	2.51	2.76	13.06	13.32	
KSH02	406.56	411.56	5	5A	0	0	-	1.23	-7.18	-	-	1.96E-10	-	2.57	2.64	13.12	13.38	
KSH02	411.56	416.56	5	5A	0	4.83E-08	-	1.29	-7.11	-	5.7E-09	-	-	2.60	2.16	13.20	13.39	
KSH02	416.56	421.56	5	5A	0	6.45E-07	-	1.38	-7.04	-	7.6E-08	-	-	2.34	1.84	13.28	13.43	
KSH02	421.56	426.56	5	5A	-3.99E-07	8.98E-06	-	1.44	-6.98	-	1.1E-06	-	1.08	2.64	2.95	13.35	13.60	
KSH02	426.56	431.56	5	5A	0	0	-	1.51	-6.91	-	-	1.96E-10	-	2.78	3.06	13.42	13.68	
KSH02	431.55	436.55	5	5A	0	1.29E-07	-	1.57	-6.82	-	1.52E-08	-	-	2.81	3.19	13.49	13.73	
KSH02	436.55	441.55	5	5A	0	0	-	1.63	-6.75	-	-	1.97E-10	-	2.81	3.24	13.55	13.80	
KSH02	441.55	446.55	5	5A	0	0	-	1.68	-6.69	-	-	1.97E-10	-	2.74	3.23	13.63	13.87	
KSH02	446.55	451.55	5	5A	0	0	-	1.75	-6.62	-	-	1.97E-10	-	2.74	3.20	13.70	13.94	
KSH02	451.54	456.54	5	5A	0	0	-	1.81	-6.55	-	-	1.98E-10	-	2.75	3.21	13.77	14.01	
KSH02	456.54	461.54	5	5A	0	0	-	1.87	-6.46	-	-	1.98E-10	-	2.72	3.06	13.84	14.07	
KSH02	461.54	466.54	5	5A	0	2.03E-07	-	1.93	-6.39	-	2.41E-08	-	-	2.74	3.23	13.91	14.15	
KSH02	466.53	471.53	5	5A	0	1.21E-07	-	2.02	-6.31	-	1.43E-08	-	-	2.75	3.34	13.98	14.21	
KSH02	471.53	476.53	5	5A	0	0	-	2.10	-6.26	-	-	1.97E-10	-	2.68	3.36	14.06	14.28	
KSH02	476.53	481.53	5	5A	0	0	-	2.17	-6.22	-	-	1.97E-10	-	2.69	3.35	14.13	14.35	
KSH02	481.53	486.53	5	5A	0	5.81E-08	-	2.21	-6.16	-	6.85E-09	-	-	2.71	3.35	14.20	14.41	
KSH02	486.53	491.53	5	5A	0	0	-	2.26	-6.08	-	-	1.98E-10	-	2.66	3.34	14.27	14.49	
KSH02	491.52	496.52	5	5A	0	0	-	2.34	-6.02	-	-	1.98E-10	-	2.70	2.62	14.34	14.49	
KSH02	496.52	501.52	5	5A	0	1.54E-06	-	2.41	-5.94	-	1.82E-07	-	-	2.69	3.32	14.42	14.64	
KSH02	501.52	506.52	5	5A	0	0	-	2.47	-5.86	-	-	1.98E-10	-	2.70	3.24	14.48	14.70	
KSH02	506.52	511.52	5	5A	0	0	-	2.53	-5.77	-	-	1.99E-10	-	2.72	3.36	14.56	14.78	
KSH02	511.52	516.52	5	5A	0	8.39E-08	-	2.58	-5.69	-	1.01E-08	-	-	2.69	3.38	14.63	14.85	
KSH02	516.52	521.52	5	5A	0	0	-	2.63	-5.60	-	-	2.01E-10	-	2.76	3.01	14.70	14.89	
KSH02	521.52	526.52	5	5A	0	5.06E-07	-	2.69	-5.51	-	6.1E-08	-	-	2.77	3.82	14.78	14.99	
KSH02	526.52	531.52	5	5A	0	0	-	2.77	-5.42	-	-	2.02E-10	-	2.77	3.87	14.85	15.06	
KSH02	531.53	536.53	5	5A	0	0	-	2.83	-5.35	-	-	2.02E-10	-	2.73	3.88	14.93	15.13	
KSH02	536.53	541.53	5	5A	0	0	-	2.90	-5.25	-	-	2.03E-10	-	2.73	3.83	15.00	15.21	
KSH02	541.54	546.54	5	5A	0	0	-	2.97	-5.17	-	-	2.03E-10	-	2.71	3.81	15.08	15.28	

5A. PFL - DIFFERENCE FLOW LOGGING -Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	L_w (m)	Test type (1-6)	Q_0 (m3/s)	Q_1 (m3/s)	Q_2 (m3/s)	dh_0 (m)	dh_1 (m)	dh_2 (m)	T_D (m2/s)	T_D-measl (m2/s)	h_i (m)	EC_{w1} (S/m)	EC_{w2} (S/m)	Te_{w1} (C)	Te_{w2} (C)	Comments
KSH02	546.54	551.54	5	5A	0	0	-	3.01	-5.11	-	-	2.03E-10	-	2.72	3.75	15.16	15.36	
KSH02	551.55	556.55	5	5A	0	1.18E-07	-	3.07	-5.02	-	1.44E-08	-	-	2.72	3.74	15.23	15.42	
KSH02	556.56	561.56	5	5A	0	0	-	3.16	-4.91	-	-	2.05E-10	-	2.68	3.40	15.31	15.49	
KSH02	561.57	566.57	5	5A	0	1.93E-07	-	3.25	-4.81	-	2.37E-08	-	-	2.65	3.62	15.38	15.54	
KSH02	566.57	571.57	5	5A	0	0	-	3.32	-4.71	-	-	2.06E-10	-	2.61	3.62	15.45	15.60	
KSH02	571.58	576.58	5	5A	0	3.00E-07	-	3.38	-4.61	-	3.72E-08	-	-	2.53	3.09	15.51	15.61	
KSH02	576.59	581.59	5	5A	1.96E-07	3.89E-06	-	3.44	-4.52	-	4.59E-07	-	3.86	2.65	3.63	15.60	15.75	
KSH02	581.59	586.59	5	5A	0	3.00E-07	-	3.50	-4.44	-	3.75E-08	-	-	2.64	4.16	15.67	15.82	
KSH02	586.60	591.60	5	5A	0	0	-	3.56	-4.34	-	-	2.09E-10	-	2.64	3.27	15.75	15.84	
KSH02	591.60	596.60	5	5A	0	1.29E-06	-	3.64	-4.23	-	1.63E-07	-	-	2.59	3.99	15.82	15.97	
KSH02	596.60	601.60	5	5A	0	3.20E-07	-	3.71	-4.13	-	4.04E-08	-	-	2.64	3.73	15.90	16.03	
KSH02	601.60	606.60	5	5A	0	4.91E-07	-	3.77	-4.05	-	6.2E-08	-	-	2.69	4.33	15.98	16.14	
KSH02	606.60	611.60	5	5A	0	0	-	3.85	-3.96	-	-	2.11E-10	-	2.70	4.32	16.06	16.20	
KSH02	611.61	616.61	5	5A	0	0	-	3.92	-3.88	-	-	2.12E-10	-	2.74	4.26	16.13	16.28	
KSH02	616.61	621.61	5	5A	0	0	-	3.98	-3.76	-	-	2.13E-10	-	2.74	4.23	16.21	16.35	
KSH02	621.61	626.61	5	5A	0	0	-	4.04	-3.65	-	-	2.15E-10	-	2.75	4.19	16.28	16.42	
KSH02	626.61	631.61	5	5A	0	0	-	4.11	-3.55	-	-	2.16E-10	-	2.79	4.11	16.35	16.50	
KSH02	631.61	636.61	5	5A	0	0	-	4.16	-3.45	-	-	2.17E-10	-	2.81	3.97	16.43	16.58	
KSH02	636.61	641.61	5	5A	0	0	-	4.24	-3.35	-	-	2.17E-10	-	2.82	4.22	16.51	16.64	
KSH02	641.61	646.61	5	5A	0	0	-	4.33	-3.24	-	-	2.18E-10	-	2.82	4.18	16.58	16.71	
KSH02	646.61	651.61	5	5A	0	0	-	4.40	-3.13	-	-	2.19E-10	-	2.83	4.17	16.65	16.79	
KSH02	651.61	656.61	5	5A	0	0	-	4.47	-3.02	-	-	2.2E-10	-	2.82	4.38	16.73	16.85	
KSH02	656.62	661.62	5	5A	0	2.91E-07	-	4.53	-2.89	-	3.87E-08	-	-	2.81	4.65	16.80	16.94	
KSH02	661.63	666.63	5	5A	0	0	-	4.60	-2.77	-	-	2.24E-10	-	2.77	4.21	16.88	16.99	
KSH02	666.64	671.64	5	5A	0	4.44E-07	-	4.68	-2.67	-	6E-08	-	-	2.73	4.78	16.94	17.10	
KSH02	671.64	676.64	5	5A	0	0	-	4.74	-2.58	-	-	2.25E-10	-	2.75	4.87	17.04	17.17	
KSH02	676.65	681.65	5	5A	0	0	-	4.81	-2.49	-	-	2.26E-10	-	2.74	4.79	17.11	17.24	
KSH02	681.66	686.66	5	5A	0	0	-	4.87	-2.39	-	-	2.27E-10	-	2.54	4.64	17.17	17.29	
KSH02	686.67	691.67	5	5A	0	0	-	4.94	-2.29	-	-	2.28E-10	-	2.67	4.65	17.27	17.36	
KSH02	691.67	696.67	5	5A	0	3.60E-07	-	5.01	-2.19	-	7.35E-08	-	-	2.71	4.77	17.34	17.44	
KSH02	696.68	701.68	5	5A	0	2.91E-07	-	5.08	-2.06	-	4.04E-08	-	-	2.74	4.81	17.41	17.51	

5A. PFL - DIFFERENCE FLOW LOGGING -Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	L_w (m)	Test type (1-6)	Q_0 (m3/s)	Q_1 (m3/s)	Q_2 (m3/s)	dh_0 (m)	dh_1 (m)	dh_2 (m)	T_D (m2/s)	T_D-measl (m2/s)	h_i (m)	EC_{w1} (S/m)	EC_{w2} (S/m)	Te_{w1} (C)	Te_{w2} (C)	Comments
KSH02	701.69	706.69	5	5A	0	1.76E-07	-	5.14	-1.93	-	2.46E-08	-	-	2.71	3.90	17.49	17.53	
KSH02	706.70	711.70	5	5A	0	2.55E-06	-	5.24	-1.80	-	3.58E-07	-	-	2.70	4.98	17.57	17.67	
KSH02	711.70	716.70	5	5A	0	0	-	5.33	-1.68	-	-	2.35E-10	-	2.73	4.96	17.64	17.75	
KSH02	716.70	721.70	5	5A	0	0	-	5.40	-1.55	-	-	2.38E-10	-	2.71	4.93	17.72	17.82	
KSH02	721.71	726.71	5	5A	0	0	-	5.47	-1.42	-	-	2.39E-10	-	2.70	5.13	17.80	17.90	
KSH02	726.71	731.71	5	5A	0	2.42E-07	-	5.54	-1.30	-	3.51E-08	-	-	2.69	5.38	17.88	17.98	
KSH02	731.71	736.71	5	5A	0	0	-	5.61	-1.17	-	-	2.44E-10	-	2.67	5.26	17.96	18.03	
KSH02	736.72	741.72	5	5A	0	4.29E-07	-	5.68	-1.05	-	6.3E-08	-	-	2.67	5.82	18.04	18.13	
KSH02	741.72	746.72	5	5A	0	0	-	5.74	-0.93	-	-	2.47E-10	-	2.66	5.88	18.11	18.21	
KSH02	746.73	751.73	5	5A	0	0	-	5.83	-0.82	-	-	2.48E-10	-	2.64	5.82	18.20	18.28	
KSH02	751.74	756.74	5	5A	0	0	-	5.91	-0.71	-	-	2.49E-10	-	2.63	5.75	18.27	18.35	
KSH02	756.74	761.74	5	5A	0	0	-	5.98	-0.56	-	-	2.52E-10	-	2.63	5.73	18.35	18.44	
KSH02	761.75	766.75	5	5A	0	0	-	6.04	-0.43	-	-	2.55E-10	-	2.62	5.67	18.43	18.52	
KSH02	766.75	771.75	5	5A	0	0	-	6.11	-0.29	-	-	2.58E-10	-	2.61	5.60	18.50	18.60	
KSH02	771.76	776.76	5	5A	0	0	-	6.18	-0.17	-	-	2.6E-10	-	2.61	5.58	18.58	18.68	
KSH02	776.77	781.77	5	5A	0	0	-	6.27	-0.04	-	-	2.61E-10	-	2.61	5.57	18.66	18.76	
KSH02	781.77	786.77	5	5A	0	0	-	6.34	0.09	-	-	2.64E-10	-	2.61	5.55	18.74	18.84	
KSH02	786.78	791.78	5	5A	0	0	-	6.40	0.14	-	-	2.64E-10	-	2.61	5.51	18.82	18.92	
KSH02	791.78	796.78	5	5A	0	0	-	6.47	0.29	-	-	2.67E-10	-	2.62	5.51	18.90	18.99	
KSH02	796.79	801.79	5	5A	0	0	-	6.54	0.47	-	-	2.72E-10	-	2.62	5.38	18.98	19.07	
KSH02	801.80	806.80	5	5A	0	0	-	6.61	0.59	-	-	2.74E-10	-	2.61	5.38	19.06	19.15	
KSH02	806.80	811.80	5	5A	0	0	-	6.68	0.75	-	-	2.78E-10	-	2.62	5.36	19.13	19.23	
KSH02	811.80	816.80	5	5A	0	0	-	6.75	0.90	-	-	2.82E-10	-	2.63	5.32	19.22	19.31	
KSH02	816.80	821.80	5	5A	0	0	-	6.86	1.04	-	-	2.84E-10	-	2.70	5.39	19.30	19.39	
KSH02	821.80	826.80	5	5A	0	0	-	6.94	1.19	-	-	2.87E-10	-	2.78	5.62	19.38	19.48	
KSH02	826.80	831.80	5	5A	0	0	-	7.02	1.33	-	-	2.9E-10	-	2.93	5.71	19.46	19.56	
KSH02	831.80	836.80	5	5A	0	0	-	7.11	1.46	-	-	2.92E-10	-	3.10	5.80	19.54	19.65	
KSH02	836.80	841.80	5	5A	0	0	-	7.20	1.59	-	-	2.94E-10	-	3.29	5.82	19.62	19.72	
KSH02	841.80	846.80	5	5A	0	0	-	7.29	1.72	-	-	2.97E-10	-	3.46	5.88	19.70	19.80	
KSH02	846.80	851.80	5	5A	0	0	-	7.37	1.84	-	-	2.98E-10	-	3.62	5.91	19.78	19.88	
KSH02	851.81	856.81	5	5A	0	0	-	7.46	1.95	-	-	2.99E-10	-	3.76	5.78	19.87	19.97	

5A. PFL - DIFFERENCE FLOW LOGGING -Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	L_w (m)	Test type (1-6)	Q_0 (m3/s)	Q_1 (m3/s)	Q_2 (m3/s)	dh_0 (m)	dh_1 (m)	dh_2 (m)	T_D (m2/s)	T_D-measl (m2/s)	h_i (m)	EC_{w1} (S/m)	EC_{w2} (S/m)	Te_{w1} (C)	Te_{w2} (C)	Comments
KSH02	856.82	861.82	5	5A	0	1.3E-07	-	7.55	2.09	-	2.36E-08	-	-	3.91	5.83	19.95	20.05	
KSH02	861.83	866.83	5	5A	0	0	-	7.64	2.22	-	-	3.05E-10	-	4.06	5.78	20.03	20.13	
KSH02	866.84	871.84	5	5A	0	0	-	7.77	2.36	-	-	3.05E-10	-	4.12	5.77	20.11	20.20	
KSH02	871.86	876.86	5	5A	0	0	-	7.89	2.48	-	-	3.05E-10	-	4.31	5.76	20.19	20.28	
KSH02	876.87	881.87	5	5A	0	0	-	8.00	2.60	-	-	3.05E-10	-	4.32	5.77	20.28	20.36	
KSH02	881.88	886.88	5	5A	0	0	-	8.10	2.71	-	-	3.06E-10	-	4.36	5.79	20.36	20.44	
KSH02	886.89	891.89	5	5A	0	0	-	8.20	2.84	-	-	3.08E-10	-	4.31	5.75	20.43	20.52	
KSH02	891.90	896.90	5	5A	0	0	-	8.30	2.96	-	-	3.09E-10	-	4.34	5.75	20.52	20.61	
KSH02	896.90	901.90	5	5A	0	0	-	8.43	3.08	-	-	3.09E-10	-	4.33	5.75	20.60	20.69	
KSH02	901.91	906.91	5	5A	0	0	-	8.55	3.21	-	-	3.09E-10	-	4.13	5.78	20.68	20.77	
KSH02	906.92	911.92	5	5A	0	0	-	8.66	3.36	-	-	3.12E-10	-	4.13	5.78	20.68	20.77	
KSH02	911.93	916.93	5	5A	0	0	-	8.76	3.51	-	-	3.14E-10	-	4.20	5.79	20.85	20.94	
KSH02	916.94	921.94	5	5A	0	0	-	8.88	3.63	-	-	3.14E-10	-	4.20	5.80	20.93	21.01	
KSH02	921.94	926.94	5	5A	0	0	-	8.99	3.76	-	-	3.15E-10	-	4.14	5.75	21.01	21.09	
KSH02	926.95	931.95	5	5A	0	0	-	9.09	3.89	-	-	3.17E-10	-	4.07	5.68	21.10	21.17	
KSH02	931.96	936.96	5	5A	0	3.23E-07	-	9.20	4.01	-	6.15E-08	-	-	3.98	5.81	21.18	21.26	
KSH02	936.97	941.97	5	5A	0	0	-	9.31	4.13	-	-	3.19E-10	-	4.04	5.78	21.26	21.34	
KSH02	941.98	946.98	5	5A	0	0	-	9.42	4.26	-	-	3.2E-10	-	4.23	5.76	21.35	21.42	
KSH02	946.98	951.98	5	5A	0	0	-	9.54	4.38	-	-	3.2E-10	-	4.22	5.88	21.44	21.48	
KSH02	951.99	956.99	5	5A	0	0	-	9.65	4.49	-	-	3.2E-10	-	4.46	4.71	21.52	21.52	
KSH02	956.99	961.99	5	5A	0	2.86E-06	-	9.76	4.63	-	5.5E-07	-	-	4.48	5.91	21.59	21.66	
KSH02	962.00	967.00	5	5A	0	0	-	9.89	4.76	-	-	3.22E-10	-	4.60	5.84	21.68	21.72	
KSH02	967.00	972.00	5	5A	0	0	-	10.01	4.89	-	-	3.23E-10	-	4.61	5.82	21.76	21.80	
KSH02	972.00	977.00	5	5A	0	0	-	10.12	5.02	-	-	3.23E-10	-	4.62	5.75	21.85	21.89	
KSH02	977.00	982.00	5	5A	0	0	-	10.27	5.15	-	-	3.22E-10	-	4.68	5.70	21.94	21.98	
KSH02	982.00	987.00	5	5A	0	0	-	10.40	5.27	-	-	3.22E-10	-	4.65	5.72	22.02	22.06	
KSH02	987.00	992.00	5	5A	0	0	-	10.49	5.35	-	-	3.21E-10	-	4.70	4.83	22.09	22.10	
KSH02	992.00	997.00	5	5A	0	2.09E-06	-	10.56	5.38	-	4E-07	-	-	4.70	4.83	22.09	22.10	

5B. PFL - DIFFERENCE FLOW LOGGING - Inferred flow anomalies from overlapping flow logging

Borehole ID	Length to flow anom. L (m)	L_w (m)	dL (m)	Test type (1-6)	Q_0 (m3/s)	Q_1 (m3/s)	Q_2 (m3/s)	dh_0 (m)	dh_1 (m)	dh_2 (m)	TD (m2/s)	TD-measl (m2/s)	h_i	EC_f	Te_f	Comments
KSH02	82.8	1.0	0.1	5B	-	6.36E-07	-	-0.43	-10.91	-	6.00E-08	7.86E-10	-	-	-	
KSH02	89	1.0	0.1	5B	-	1.94E-08	-	-0.42	-10.89	-	1.84E-09	7.87E-10	-	-	-	
KSH02	94.8	1.0	0.1	5B	-	6.22E-08	-	-0.40	-10.85	-	5.89E-09	7.88E-10	-	-	-	
KSH02	99.5	1.0	0.1	5B	-	5.91E-06	-	-0.37	-10.82	-	5.60E-07	7.89E-10	-	-	-	
KSH02	100.1	1.0	0.1	5B	-	8.75E-07	-	-0.37	-10.82	-	8.28E-08	7.89E-10	-	-	-	
KSH02	101.6	1.0	0.1	5B	-	1.84E-06	-	-0.37	-10.79	-	1.74E-07	7.90E-10	-	-	-	Uncertain
KSH02	102	1.0	0.1	5B	-	6.44E-06	-	-0.37	-10.79	-	6.12E-07	7.91E-10	-	-	-	
KSH02	103	1.0	0.1	5B	-	2.76E-06	-	-0.37	-10.77	-	2.62E-07	7.92E-10	-	-	-	Uncertain
KSH02	103.8	1.0	0.1	5B	-	6.47E-06	-	-0.37	-10.77	-	6.16E-07	7.93E-10	-	-	-	Uncertain
KSH02	104.2	1.0	0.1	5B	-	2.59E-06	-	-0.37	-10.76	-	2.47E-07	7.93E-10	-	-	-	
KSH02	107.2	1.0	0.1	5B	-	9.56E-07	-	-0.38	-10.72	-	9.14E-08	7.97E-10	-	-	-	
KSH02	107.6	1.0	0.1	5B	-	1.22E-06	-	-0.38	-10.72	-	1.16E-07	7.97E-10	-	-	-	
KSH02	176.6	1.0	0.1	5B	-	2.03E-06	-	-0.18	-9.86	-	2.07E-07	8.51E-10	-	-	-	
KSH02	216.8	1.0	0.1	5B	-	1.53E-07	-	-0.06	-9.33	-	1.63E-08	8.89E-10	-	-	-	Uncertain
KSH02	236.6	1.0	0.1	5B	-	1.44E-07	-	0.00	-9.03	-	1.58E-08	9.13E-10	-	-	-	
KSH02	290.5	1.0	0.1	5B	-	1.56E-07	-	0.18	-8.30	-	1.81E-08	9.72E-10	-	-	-	Uncertain
KSH02	294	1.0	0.1	5B	-	7.67E-08	-	0.18	-8.25	-	8.99E-09	9.78E-10	-	-	-	Uncertain
KSH02	296.8	1.0	0.1	5B	-	1.39E-07	-	0.19	-8.23	-	1.63E-08	9.79E-10	-	-	-	Uncertain
KSH02	325.7	1.0	0.1	5B	-	4.44E-08	-	0.39	-7.76	-	5.39E-09	1.01E-09	-	-	-	
KSH02	326.2	1.0	0.1	5B	-	7.50E-08	-	0.39	-7.78	-	9.08E-09	1.01E-09	-	-	-	
KSH02	352.2	1.0	0.1	5B	-	1.44E-08	-	0.66	-7.40	-	1.77E-09	1.02E-09	-	-	-	Uncertain
KSH02	367.3	1.0	0.1	5B	-	2.78E-08	-	0.77	-7.22	-	3.44E-09	1.03E-09	-	-	-	Uncertain
KSH02	368.6	1.0	0.1	5B	-	2.42E-08	-	0.79	-7.19	-	2.99E-09	1.03E-09	-	-	-	Uncertain
KSH02	371	1.0	0.1	5B	-	1.36E-08	-	0.83	-7.16	-	1.69E-09	1.03E-09	-	-	-	Uncertain
KSH02	373.6	1.0	0.1	5B	-	1.67E-07	-	0.85	-7.12	-	2.07E-08	1.03E-09	-	-	-	
KSH02	374.7	1.0	0.1	5B	-	2.17E-07	-	0.86	-7.09	-	2.70E-08	1.04E-09	-	-	-	
KSH02	376.8	1.0	0.1	5B	-	4.28E-08	-	0.87	-7.07	-	5.33E-09	1.04E-09	-	-	-	
KSH02	378.2	1.0	0.1	5B	-	5.78E-07	-	0.89	-7.06	-	7.19E-08	1.04E-09	-	-	-	

5B. PFL - DIFFERENCE FLOW LOGGING - Inferred flow anomalies from overlapping flow logging

Borehole ID	Length to flow anom. L (m)	L_w (m)	dL (m)	Test type (1-6)	Q_0 (m3/s)	Q_1 (m3/s)	Q_2 (m3/s)	dh_0 (m)	dh_1 (m)	dh_2 (m)	TD (m2/s)	TD-measl (m2/s)	h_i	EC_f	Te_f	Comments
KSH02	378.8	1.0	0.1	5B	-	2.53E-07	-	0.89	-7.05	-	3.15E-08	1.04E-09	-	-	-	
KSH02	387.8	1.0	0.1	5B	-	1.67E-08	-	0.99	-6.89	-	2.09E-09	1.05E-09	-	-	-	
KSH02	389.2	1.0	0.1	5B	-	4.17E-08	-	1.01	-6.86	-	5.23E-09	1.05E-09	-	-	-	
KSH02	391.5	1.0	0.1	5B	-	1.25E-08	-	1.04	-6.84	-	1.57E-09	1.05E-09	-	-	-	Uncertain
KSH02	392.4	1.0	0.1	5B	-	3.06E-08	-	1.05	-6.84	-	3.84E-09	1.05E-09	-	-	-	
KSH02	392.9	1.0	0.1	5B	-	1.25E-08	-	1.05	-6.81	-	1.57E-09	1.05E-09	-	-	-	Uncertain
KSH02	413.4	1.0	0.1	5B	-	3.33E-08	-	1.28	-6.51	-	4.23E-09	1.06E-09	-	-	-	
KSH02	419.6	1.0	0.1	5B	-	5.44E-07	-	1.39	-6.40	-	6.91E-08	1.06E-09	-	-	-	
KSH02	422.8	1.0	0.1	5B	-	8.08E-06	-	1.43	-6.36	-	1.03E-06	1.06E-09	-	-	-	
KSH02	432	1.0	0.1	5B	-	1.00E-07	-	1.55	-6.20	-	1.28E-08	1.06E-09	-	-	-	
KSH02	435	1.0	0.1	5B	-	4.56E-08	-	1.58	-6.14	-	5.84E-09	1.07E-09	-	-	-	Uncertain
KSH02	465.9	1.0	0.1	5B	-	1.56E-07	-	1.96	-5.61	-	2.03E-08	1.09E-09	-	-	-	
KSH02	468.1	1.0	0.1	5B	-	1.11E-07	-	2.00	-5.61	-	1.44E-08	1.08E-09	-	-	-	
KSH02	483.6	1.0	0.1	5B	-	4.03E-08	-	2.20	-5.34	-	5.28E-09	1.09E-09	-	-	-	
KSH02	497.3	1.0	0.1	5B	-	4.44E-08	-	2.39	-5.13	-	5.85E-09	1.10E-09	-	-	-	
KSH02	498.4	1.0	0.1	5B	-	9.03E-07	-	2.40	-5.11	-	1.19E-07	1.10E-09	-	-	-	
KSH02	499.1	1.0	0.1	5B	-	4.17E-07	-	2.41	-5.09	-	5.49E-08	1.10E-09	-	-	-	
KSH02	514.7	1.0	0.1	5B	-	4.58E-08	-	2.58	-4.81	-	6.13E-09	1.11E-09	-	-	-	Uncertain
KSH02	523.9	1.0	0.1	5B	-	3.00E-07	-	2.68	-4.66	-	4.04E-08	1.12E-09	-	-	-	
KSH02	526.4	1.0	0.1	5B	-	1.03E-07	-	2.71	-4.61	-	1.39E-08	1.13E-09	-	-	-	
KSH02	533.4	1.0	0.1	5B	-	6.94E-09	-	2.83	-4.48	-	9.40E-10	1.13E-09	-	-	-	Uncertain
KSH02	535	1.0	0.1	5B	-	1.25E-08	-	2.84	-4.44	-	1.70E-09	1.13E-09	-	-	-	Uncertain
KSH02	555.8	1.0	0.1	5B	-	6.67E-08	-	3.10	-4.11	-	9.14E-09	1.14E-09	-	-	-	
KSH02	562.4	1.0	0.1	5B	-	1.53E-07	-	3.22	-3.94	-	2.11E-08	1.15E-09	-	-	-	
KSH02	573.8	1.0	0.1	5B	-	2.00E-07	-	3.38	-3.78	-	2.76E-08	1.15E-09	-	-	-	
KSH02	575.2	1.0	0.1	5B	-	2.78E-08	-	3.40	-3.75	-	3.85E-09	1.15E-09	-	-	-	Uncertain
KSH02	577	1.0	0.1	5B	-	3.00E-07	-	3.42	-3.72	-	4.16E-08	1.15E-09	-	-	-	
KSH02	578.3	1.0	0.1	5B	-	2.61E-06	-	3.43	-3.69	-	3.62E-07	1.16E-09	-	-	-	
KSH02	579.6	1.0	0.1	5B	-	1.72E-07	-	3.44	-3.68	-	2.39E-08	1.16E-09	-	-	-	
KSH02	580.3	1.0	0.1	5B	-	6.39E-08	-	3.44	-3.66	-	8.89E-09	1.16E-09	-	-	-	Uncertain

5B. PFL - DIFFERENCE FLOW LOGGING - Inferred flow anomalies from overlapping flow logging

Borehole ID	Length to flow anom. L (m)	L_w (m)	dL (m)	Test type (1-6)	Q_0 (m3/s)	Q_1 (m3/s)	Q_2 (m3/s)	dh_0 (m)	dh_1 (m)	dh_2 (m)	TD (m2/s)	TD-measl (m2/s)	h_i	EC_f	Te_f	Comments
KSH02	582.1	1.0	0.1	5B	-	3.47E-08	-	3.47	-3.63	-	4.84E-09	1.16E-09	-	-	-	Uncertain
KSH02	583.5	1.0	0.1	5B	-	1.19E-07	-	3.49	-3.61	-	1.66E-08	1.16E-09	-	-	-	Uncertain
KSH02	594.8	1.0	0.1	5B	-	9.94E-07	-	3.65	-3.40	-	1.39E-07	1.17E-09	-	-	-	
KSH02	595.6	1.0	0.1	5B	-	9.17E-08	-	3.67	-3.37	-	1.29E-08	1.17E-09	-	-	-	
KSH02	597.3	1.0	0.1	5B	-	1.35E-07	-	3.69	-3.35	-	1.89E-08	1.17E-09	-	-	-	
KSH02	598.1	1.0	0.1	5B	-	6.94E-08	-	3.70	-3.34	-	9.77E-09	1.17E-09	-	-	-	Uncertain
KSH02	598.8	1.0	0.1	5B	-	3.33E-08	-	3.70	-3.32	-	4.70E-09	1.17E-09	-	-	-	Uncertain
KSH02	601.7	1.0	0.1	5B	-	8.89E-08	-	3.74	-3.25	-	1.26E-08	1.18E-09	-	-	-	
KSH02	602.7	1.0	0.1	5B	-	5.83E-08	-	3.75	-3.24	-	8.25E-09	1.18E-09	-	-	-	
KSH02	603.6	1.0	0.1	5B	-	2.56E-07	-	3.76	-3.21	-	3.62E-08	1.18E-09	-	-	-	
KSH02	656.8	1.0	0.1	5B	-	8.89E-08	-	4.50	-2.15	-	1.32E-08	1.24E-09	-	-	-	
KSH02	661.1	1.0	0.1	5B	-	1.42E-07	-	4.56	-2.07	-	2.12E-08	1.24E-09	-	-	-	
KSH02	669.6	1.0	0.1	5B	-	2.33E-07	-	4.69	-1.86	-	3.52E-08	1.26E-09	-	-	-	
KSH02	696.6	1.0	0.1	5B	-	3.06E-07	-	5.04	-1.31	-	4.76E-08	1.30E-09	-	-	-	
KSH02	697	1.0	0.1	5B	-	1.11E-07	-	5.05	-1.30	-	1.73E-08	1.30E-09	-	-	-	Uncertain
KSH02	705.8	1.0	0.1	5B	-	5.56E-08	-	5.16	-1.11	-	8.76E-09	1.31E-09	-	-	-	Uncertain
KSH02	707.7	1.0	0.1	5B	-	1.47E-06	-	5.21	-1.07	-	2.32E-07	1.31E-09	-	-	-	
KSH02	708.4	1.0	0.1	5B	-	3.61E-07	-	5.22	-1.07	-	5.68E-08	1.31E-09	-	-	-	
KSH02	727.2	1.0	0.1	5B	-	1.75E-07	-	5.51	-0.63	-	2.82E-08	1.34E-09	-	-	-	
KSH02	739.2	1.0	0.1	5B	-	3.44E-07	-	5.68	-0.37	-	5.63E-08	1.36E-09	-	-	-	
KSH02	859.1	1.0	0.1	5B	-	6.67E-08	-	7.54	2.60	-	1.33E-08	1.67E-09	-	-	-	
KSH02	932.1	1.0	0.1	5B	-	2.75E-07	-	9.15	4.42	-	5.76E-08	1.74E-09	-	-	-	
KSH02	957.8	1.0	0.1	5B	-	2.54E-06	-	9.73	5.06	-	5.38E-07	1.77E-09	-	-	-	
KSH02	995.2	1.0	0.1	5B	-	1.83E-06	-	10.56	6.08	-	4.04E-07	1.84E-09	-	-	-	

EXPLANATIONS		
Header	**Unit**	**Explanations**
Borehole		ID for borehole
Secup	m	Length along the borehole for the upper limit of the test section (based on corrected length L)
Seclow	m	Length along the borehole for the lower limit of the test section (based on corrected length L)
L	m	Corrected length along borehole based on SKB procedures for length correction.
Length to flow anom.	m	Length along the borehole to inferred flow anomaly during overlapping flow logging
Test type (1-6)	(-)	1A: Pumping test – wire-line eq., 1B:Pumping test-submersible pump, 1C: Pumping test-airlift pumping, 2: Interference test, 3: Injection test, 4: Slug test,
Date of test, start	YY-MM-DD	Date for start of pumping
Time of test, start	hh:mm	Time for start of pumping
Date of flowl., start .	YY-MM-DD	Date for start of the flow logging
Time of flowl., start	hh:mm	Time for start of the flow logging
Date of test, stop	YY-MM-DD	Date for stop of the test
Time of test, stop	hh:mm	Time for stop of the test
L_w	m	Section length used in the difference flow logging
dL	m	Step length (increment) used in the difference flow logging
Q_{p1}	m^3/s	Flow rate at surface by the end of the first pumping period of the flow logging
Q_{p2}	m^3/s	Flow rate at surface by the end of the second pumping period of the flow logging
t_{p1}	s	Duration of the first pumping period
t_{p2}	s	Duration of the second pumping period
t_{F1}	s	Duration of the first recovery period
t_{F2}	s	Duration of the second recovery period
h_0	m a.s l.	Initial hydraulic head before pumping. Elevation of water level in open borehole in the local co-ordinates system with z=0 m.
h_1	m a s l.	Stabilised hydraulic head during the first pumping period. Elevation of water level in open borehole in the local co-ordinates system with z=0 m.
h_2	m.a.s l.	Stabilised hydraulic head during the second pumping period. Elevation of water level in open borehole in the local co-ordinates system with z=0 m.
s_1	m	Drawdown of the water level in the borehole during first pumping period. Difference between the actual hydraulic head and the initial head (s_1= h_1-h_0)
s_2	m	Drawdown of the water level in the borehole during second pumping period. Difference between the actual hydraulic head and the initial head (s_2=h_2-h_0)
T	m^2/s	Transmissivity of the entire borehole
Q_0	m^3/s	Measured flow rate through the test section or flow anomaly under natural conditions (no pumping) with h=h_0 in the open borehole
Q_1	m^3/s	Measured flow rate through the test section or flow anomaly during the first pumping period
Q_2	m^3/s	Measured flow rate through the test section or flow anomaly during the second pumping period
dh_0	m	Corrected initial hydraulic head difference along the hole due to e.g. varying salinity conditions of the borehole fluid before pumping
dh_1	m	Corrected hydraulic head difference along the hole due to e.g. varying salinity conditions of the borehole fluid during the first pumping period
dh_2	m	Corrected hydraulic head difference along the hole due to e.g. varying salinity conditions of the borehole fluid during the second pumping period
EC_w	S/m	Measured electric conductivity of the borehole fluid in the test section during difference flow logging
Te_w	° C	Measured borehole fluid temperature in the test section during difference flow logging
EC_f	S/m	Measured fracture-specific electric conductivity of the fluid in flow anomaly during difference flow logging
Te_f	° C	Measured fracture-specific fluid temperature in flow anomaly during difference flow logging
T_D	m^2/s	Transmissivity of section or flow anomaly based on 2D model for evaluation of formation properties of the test section based on PFL-DIFF.
T-measl	m^2/s	Estimated measurement limit for evaluated T_D. If the estimated T_D equals T_D-measlim, the actual T_D is considered to be equal or less than T_D-measlim.
h_i	m	Calculated relative, natural freshwater head for test section or flow anomaly (undisturbed conditions)

Calculation of conductive fracture frequency

SecUp (m)	SecLow (m)	Number Of Fractures, Total	Number Of Fractures 10-100 (ml/h)	Number Of Fractures 100-1000 (ml/h)	Number Of Fractures 1000-10000 (ml/h)	Number Of Fractures 10000-100000 (ml/h)	Number Of Fractures 100000-1000000 (ml/h)
81.518	86.518	1	0	0	1	0	0
86.517	91.517	1	1	0	0	0	0
91.515	96.515	1	0	1	0	0	0
96.513	101.513	2	0	0	1	1	0
101.512	106.512	5	0	0	3	2	0
106.51	111.51	2	0	0	2	0	0
111.509	116.509	0	0	0	0	0	0
116.507	121.507	0	0	0	0	0	0
121.505	126.505	0	0	0	0	0	0
126.506	131.506	0	0	0	0	0	0
131.506	136.506	0	0	0	0	0	0
136.506	141.506	0	0	0	0	0	0
141.507	146.507	0	0	0	0	0	0
146.507	151.507	0	0	0	0	0	0
151.507	156.507	0	0	0	0	0	0
156.508	161.508	0	0	0	0	0	0
161.508	166.508	0	0	0	0	0	0
166.508	171.508	0	0	0	0	0	0
171.509	176.509	0	0	0	0	0	0
176.509	181.509	1	0	0	1	0	0
181.509	186.509	0	0	0	0	0	0
186.51	191.51	0	0	0	0	0	0
191.51	196.51	0	0	0	0	0	0
196.51	201.51	0	0	0	0	0	0
201.511	206.511	0	0	0	0	0	0
206.511	211.511	0	0	0	0	0	0
211.511	216.511	0	0	0	0	0	0
216.512	221.512	1	0	1	0	0	0
221.512	226.512	0	0	0	0	0	0
226.513	231.513	0	0	0	0	0	0
231.513	236.513	0	0	0	0	0	0
236.515	241.515	1	0	1	0	0	0
241.516	246.516	0	0	0	0	0	0
246.518	251.518	0	0	0	0	0	0
251.519	256.519	0	0	0	0	0	0
256.521	261.521	0	0	0	0	0	0
261.522	266.522	0	0	0	0	0	0
266.524	271.524	0	0	0	0	0	0
271.525	276.525	0	0	0	0	0	0
276.526	281.526	0	0	0	0	0	0
281.528	286.528	0	0	0	0	0	0
286.532	291.532	1	0	1	0	0	0
291.535	296.535	1	0	1	0	0	0
296.538	301.538	1	0	1	0	0	0
301.54	306.54	0	0	0	0	0	0

Calculation of conductive fracture frequency

SecUp (m)	SecLow (m)	Number Of Fractures, Total	Number Of Fractures 10-100 (ml/h)	Number Of Fractures 100-1000 (ml/h)	Number Of Fractures 1000-10000 (ml/h)	Number Of Fractures 10000-100000 (ml/h)	Number Of Fractures 100000-1000000 (ml/h)
306.542	311.542	0	0	0	0	0	0
311.543	316.543	0	0	0	0	0	0
316.542	321.542	0	0	0	0	0	0
321.54	326.54	2	0	2	0	0	0
326.538	331.538	0	0	0	0	0	0
331.535	336.535	0	0	0	0	0	0
336.534	341.534	0	0	0	0	0	0
341.534	346.534	0	0	0	0	0	0
346.533	351.533	0	0	0	0	0	0
351.532	356.532	1	1	0	0	0	0
356.531	361.531	0	0	0	0	0	0
361.53	366.53	0	0	0	0	0	0
366.535	371.535	3	2	0	0	0	0
371.54	376.54	2	0	2	0	0	0
376.544	381.544	3	0	2	1	0	0
381.548	386.548	0	0	0	0	0	0
386.553	391.553	3	2	1	0	0	0
391.558	396.558	2	1	1	0	0	0
396.56	401.56	0	0	0	0	0	0
401.56	406.56	0	0	0	0	0	0
406.56	411.56	0	0	0	0	0	0
411.56	416.56	1	0	1	0	0	0
416.56	421.56	1	0	0	1	0	0
421.559	426.559	1	0	0	0	1	0
426.556	431.556	0	0	0	0	0	0
431.554	436.554	2	0	2	0	0	0
436.551	441.551	0	0	0	0	0	0
441.548	446.548	0	0	0	0	0	0
446.545	451.545	0	0	0	0	0	0
451.542	456.542	0	0	0	0	0	0
456.54	461.54	0	0	0	0	0	0
461.537	466.537	1	0	1	0	0	0
466.534	471.534	1	0	1	0	0	0
471.532	476.532	0	0	0	0	0	0
476.529	481.529	0	0	0	0	0	0
481.528	486.528	1	0	1	0	0	0
486.526	491.526	0	0	0	0	0	0
491.524	496.524	0	0	0	0	0	0
496.522	501.522	3	0	1	2	0	0
501.52	506.52	0	0	0	0	0	0
506.517	511.517	0	0	0	0	0	0
511.516	516.516	1	0	1	0	0	0
516.518	521.518	0	0	0	0	0	0
521.521	526.521	2	0	1	1	0	0
526.524	531.524	0	0	0	0	0	0
531.527	536.527	2	2	0	0	0	0

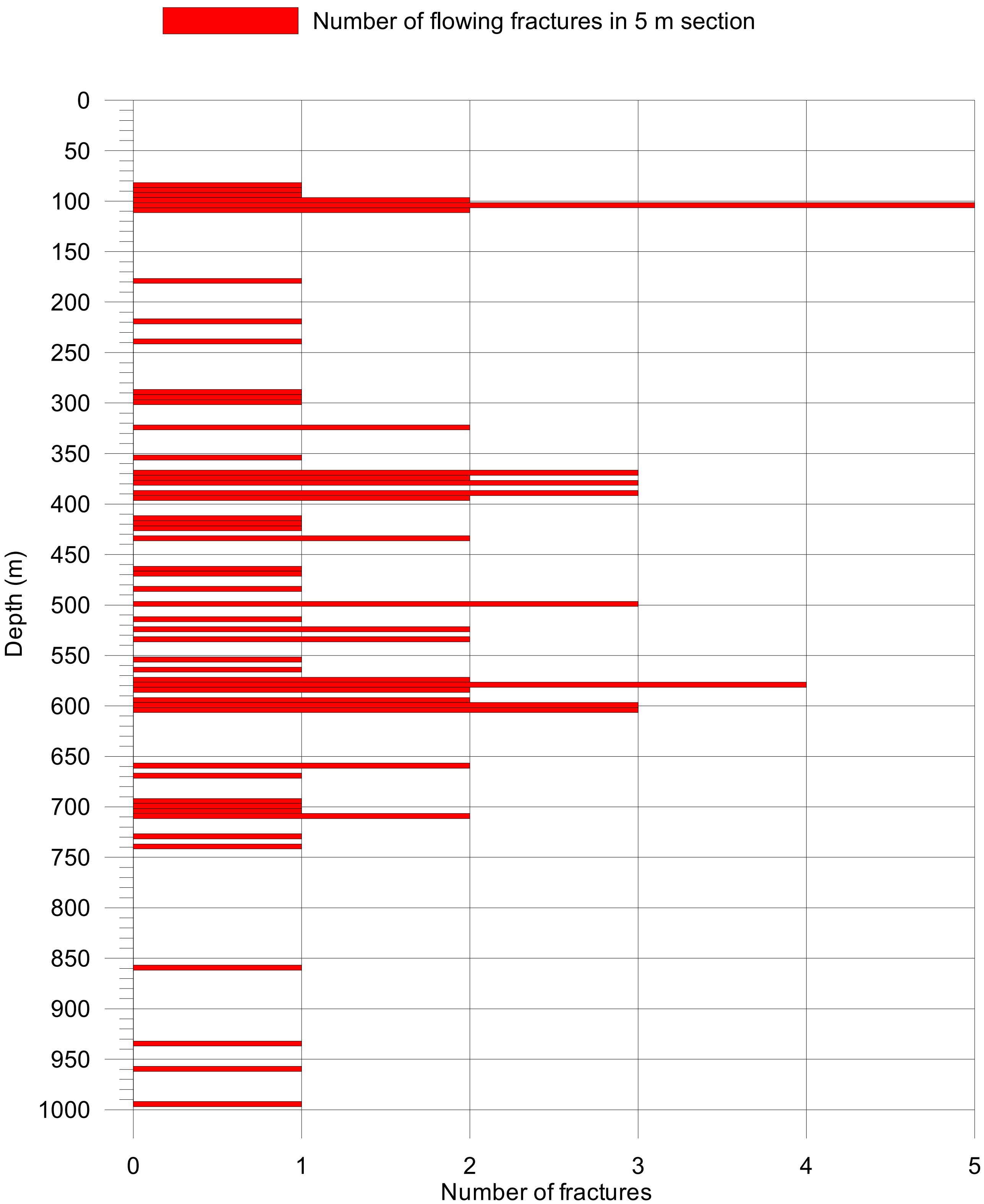
Calculation of conductive fracture frequency

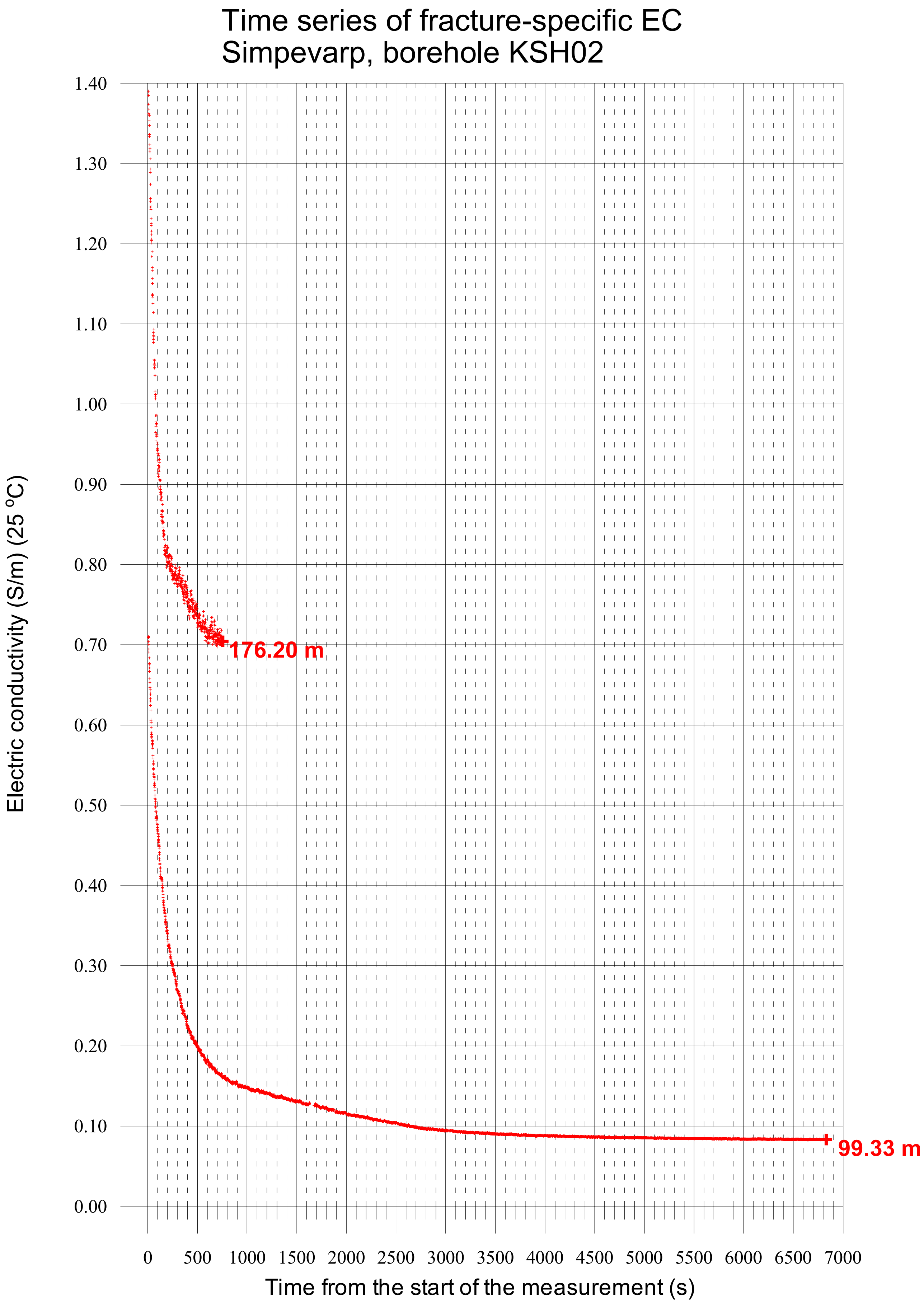
SecUp (m)	SecLow (m)	Number Of Fractures, Total	Number Of Fractures 10-100 (ml/h)	Number Of Fractures 100-1000 (ml/h)	Number Of Fractures 1000-10000 (ml/h)	Number Of Fractures 10000-100000 (ml/h)	Number Of Fractures 100000-1000000 (ml/h)
536.532	541.532	0	0	0	0	0	0
541.539	546.539	0	0	0	0	0	0
546.545	551.545	0	0	0	0	0	0
551.553	556.553	1	0	1	0	0	0
556.559	561.559	0	0	0	0	0	0
561.566	566.566	1	0	1	0	0	0
566.573	571.573	0	0	0	0	0	0
571.579	576.579	2	0	1	0	0	0
576.587	581.587	4	0	2	2	0	0
581.594	586.594	2	0	2	0	0	0
586.6	591.6	0	0	0	0	0	0
591.601	596.601	2	0	1	1	0	0
596.603	601.603	3	0	3	0	0	0
601.604	606.604	3	0	3	0	0	0
606.605	611.605	0	0	0	0	0	0
611.606	616.606	0	0	0	0	0	0
616.607	621.607	0	0	0	0	0	0
621.608	626.608	0	0	0	0	0	0
626.609	631.609	0	0	0	0	0	0
631.61	636.61	0	0	0	0	0	0
636.612	641.612	0	0	0	0	0	0
641.613	646.613	0	0	0	0	0	0
646.614	651.614	0	0	0	0	0	0
651.615	656.615	0	0	0	0	0	0
656.621	661.621	2	0	2	0	0	0
661.629	666.629	0	0	0	0	0	0
666.637	671.637	1	0	1	0	0	0
671.645	676.645	0	0	0	0	0	0
676.652	681.652	0	0	0	0	0	0
681.66	686.66	0	0	0	0	0	0
686.668	691.668	0	0	0	0	0	0
691.675	696.675	1	0	0	1	0	0
696.683	701.683	1	0	1	0	0	0
701.691	706.691	1	0	1	0	0	0
706.697	711.697	2	0	0	2	0	0
711.7	716.7	0	0	0	0	0	0
716.704	721.704	0	0	0	0	0	0
721.708	726.708	0	0	0	0	0	0
726.711	731.711	1	0	1	0	0	0
731.714	736.714	0	0	0	0	0	0
736.718	741.718	1	0	0	1	0	0
741.722	746.722	0	0	0	0	0	0
746.729	751.729	0	0	0	0	0	0
751.735	756.735	0	0	0	0	0	0
756.741	761.741	0	0	0	0	0	0
761.747	766.747	0	0	0	0	0	0

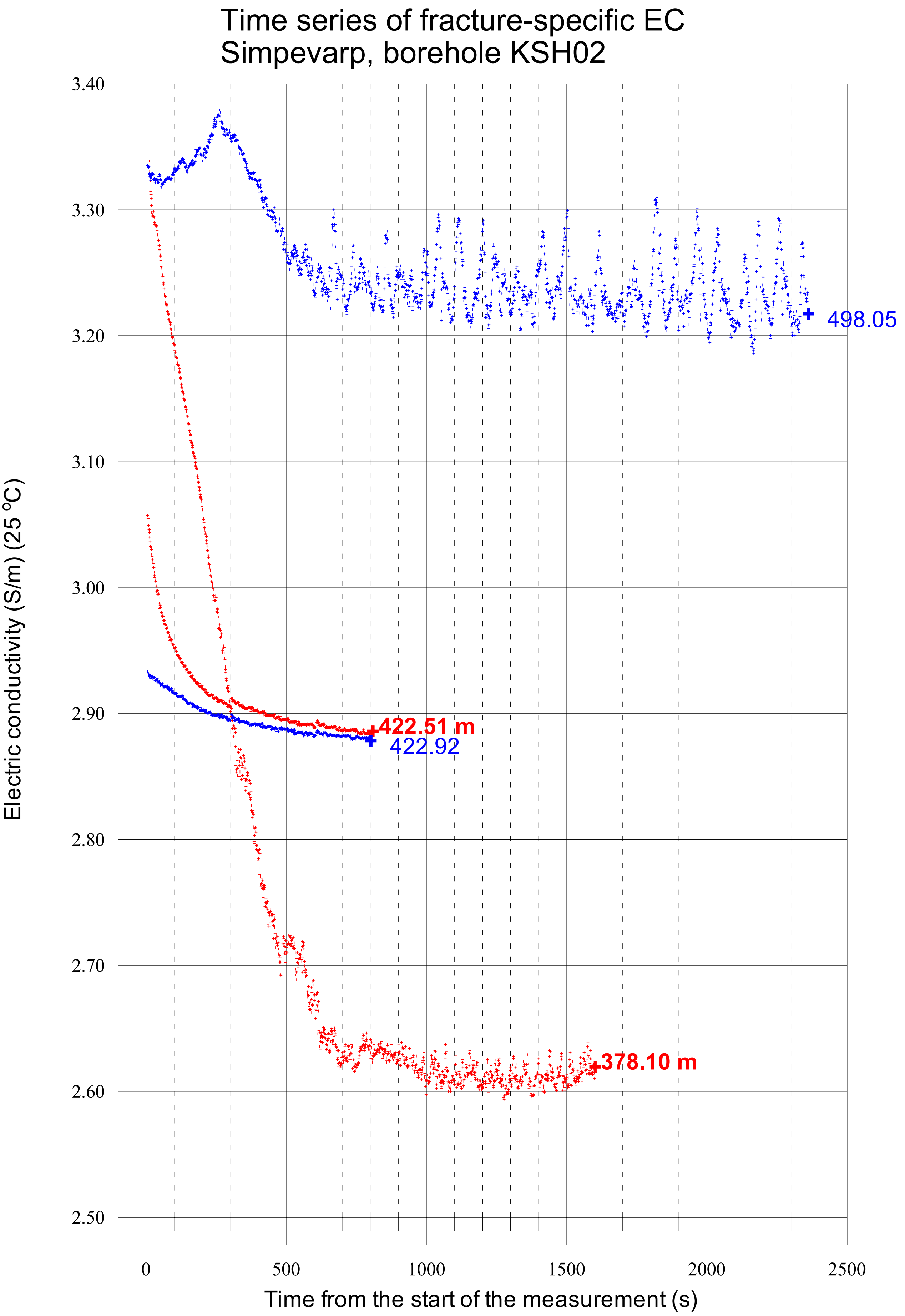
Calculation of conductive fracture frequency

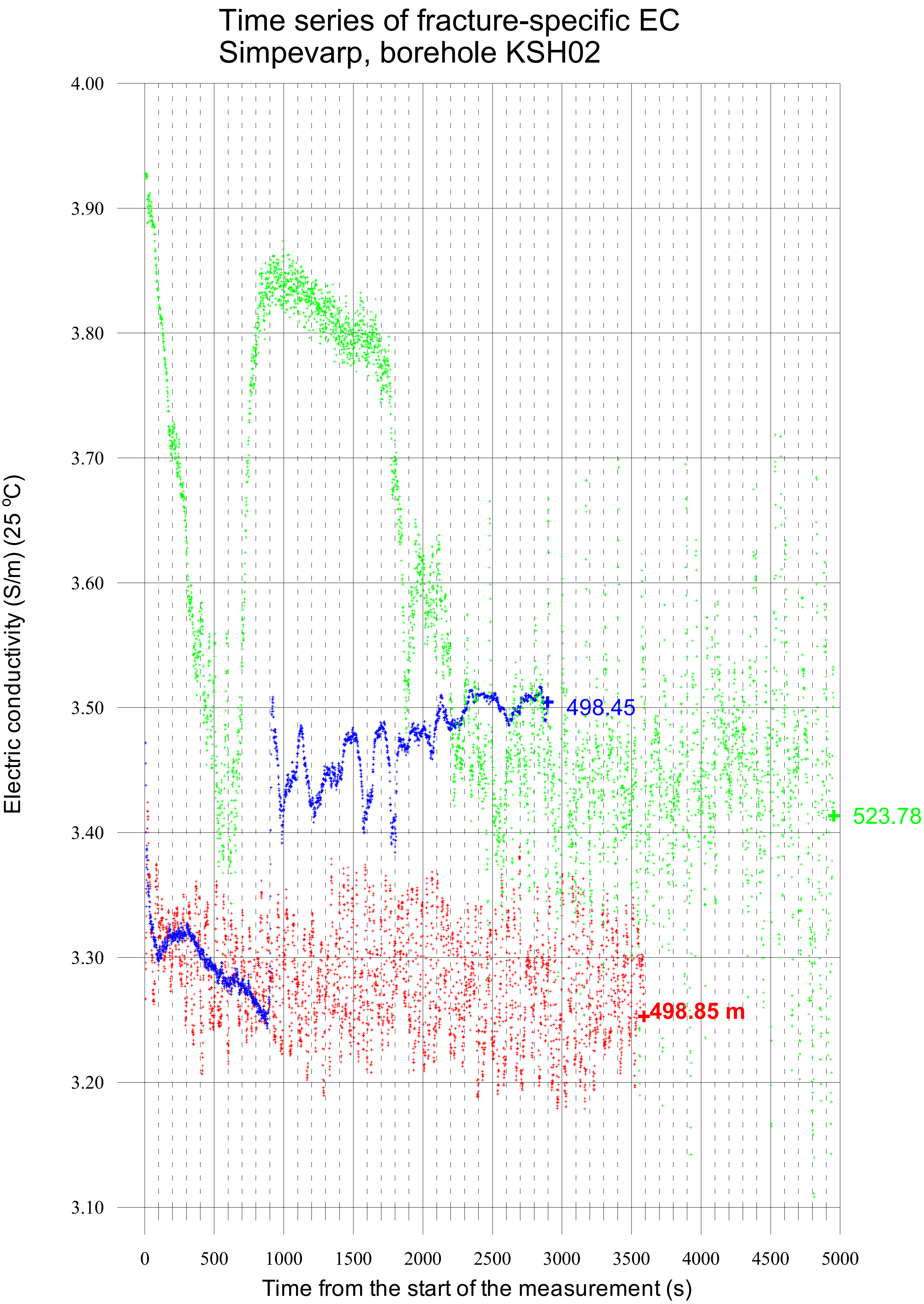
SecUp (m)	SecLow (m)	Number Of Fractures, Total	Number Of Fractures 10-100 (ml/h)	Number Of Fractures 100-1000 (ml/h)	Number Of Fractures 1000-10000 (ml/h)	Number Of Fractures 10000-100000 (ml/h)	Number Of Fractures 100000-1000000 (ml/h)
766.754	771.754	0	0	0	0	0	0
771.76	776.76	0	0	0	0	0	0
776.766	781.766	0	0	0	0	0	0
781.773	786.773	0	0	0	0	0	0
786.779	791.779	0	0	0	0	0	0
791.785	796.785	0	0	0	0	0	0
796.79	801.79	0	0	0	0	0	0
801.796	806.796	0	0	0	0	0	0
806.798	811.798	0	0	0	0	0	0
811.799	816.799	0	0	0	0	0	0
816.8	821.8	0	0	0	0	0	0
821.801	826.801	0	0	0	0	0	0
826.801	831.801	0	0	0	0	0	0
831.802	836.802	0	0	0	0	0	0
836.803	841.803	0	0	0	0	0	0
841.804	846.804	0	0	0	0	0	0
846.805	851.805	0	0	0	0	0	0
851.81	856.81	0	0	0	0	0	0
856.821	861.821	1	0	1	0	0	0
861.833	866.833	0	0	0	0	0	0
866.844	871.844	0	0	0	0	0	0
871.856	876.856	0	0	0	0	0	0
876.867	881.867	0	0	0	0	0	0
881.878	886.878	0	0	0	0	0	0
886.889	891.889	0	0	0	0	0	0
891.896	896.896	0	0	0	0	0	0
896.904	901.904	0	0	0	0	0	0
901.912	906.912	0	0	0	0	0	0
906.92	911.92	0	0	0	0	0	0
911.928	916.928	0	0	0	0	0	0
916.936	921.936	0	0	0	0	0	0
921.944	926.944	0	0	0	0	0	0
926.952	931.952	0	0	0	0	0	0
931.96	936.96	1	0	1	0	0	0
936.968	941.968	0	0	0	0	0	0
941.975	946.975	0	0	0	0	0	0
946.982	951.982	0	0	0	0	0	0
951.988	956.988	0	0	0	0	0	0
956.994	961.994	1	0	0	1	0	0
961.998	966.998	0	0	0	0	0	0
966.998	971.998	0	0	0	0	0	0
971.998	976.998	0	0	0	0	0	0
976.998	981.998	0	0	0	0	0	0
981.998	986.998	0	0	0	0	0	0
986.998	991.998	0	0	0	0	0	0
991.998	996.998	1	0	0	1	0	0

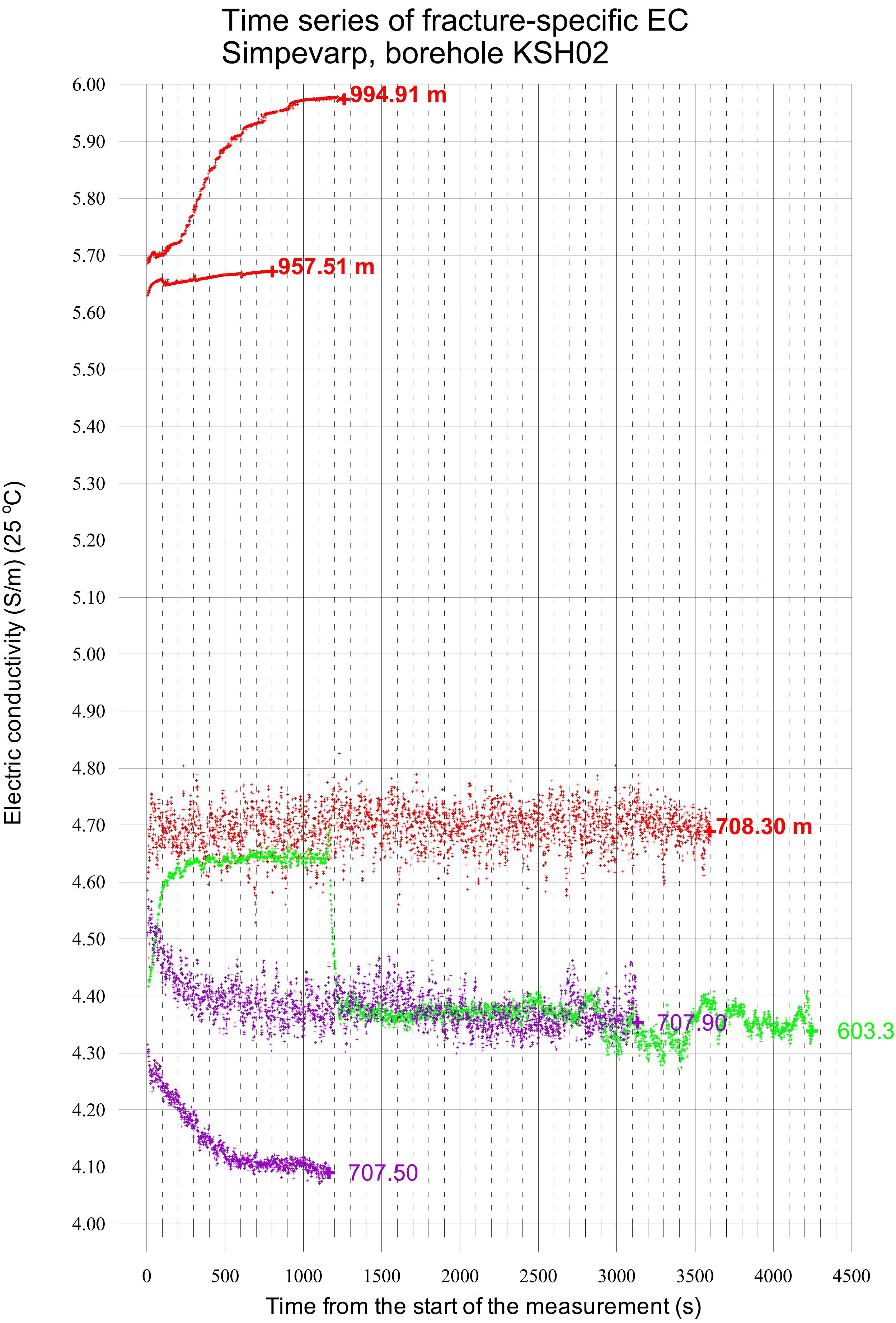
Simpevarp, Borehole KSH02
Calculation of conductive fracture frequency

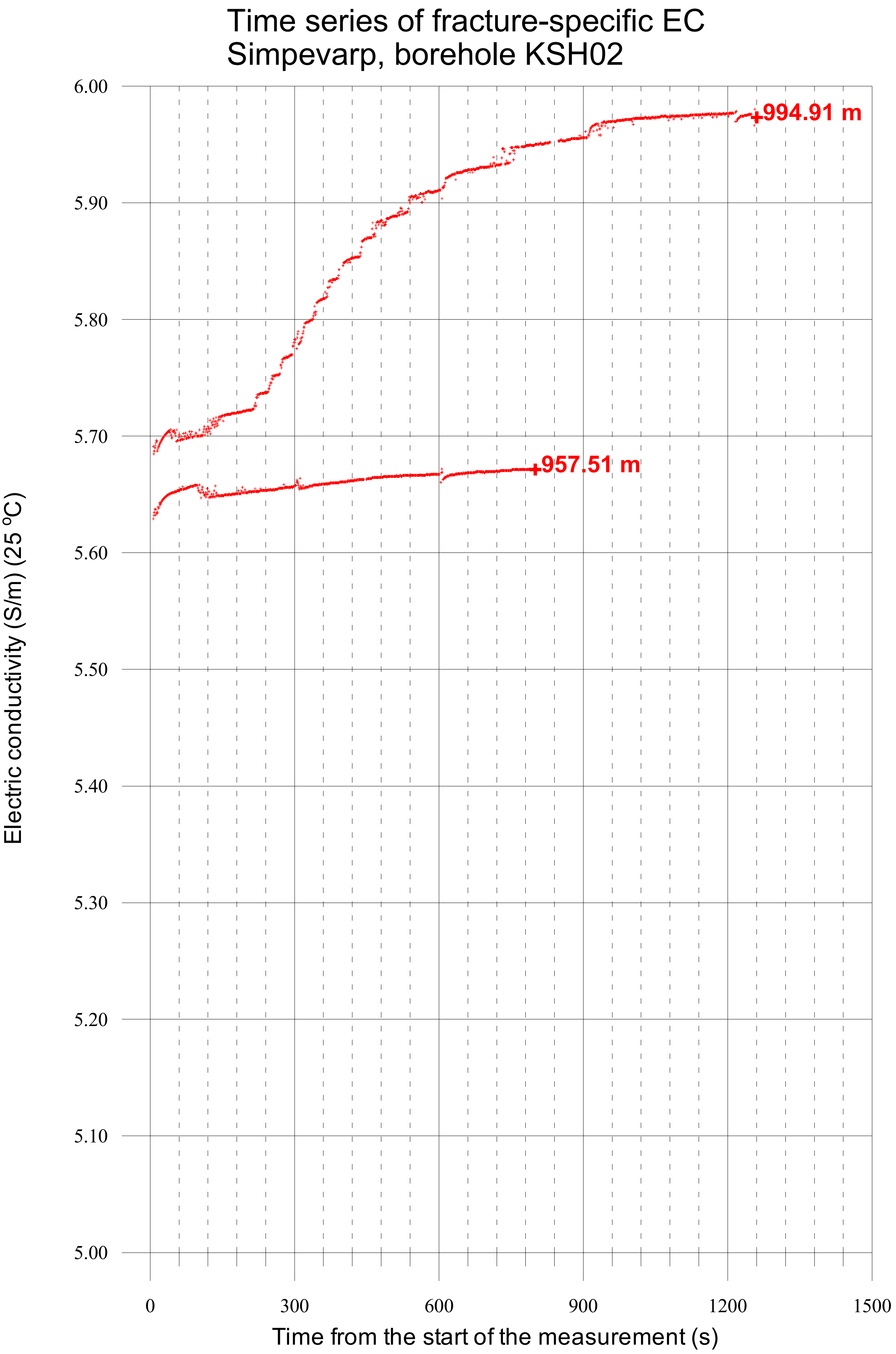


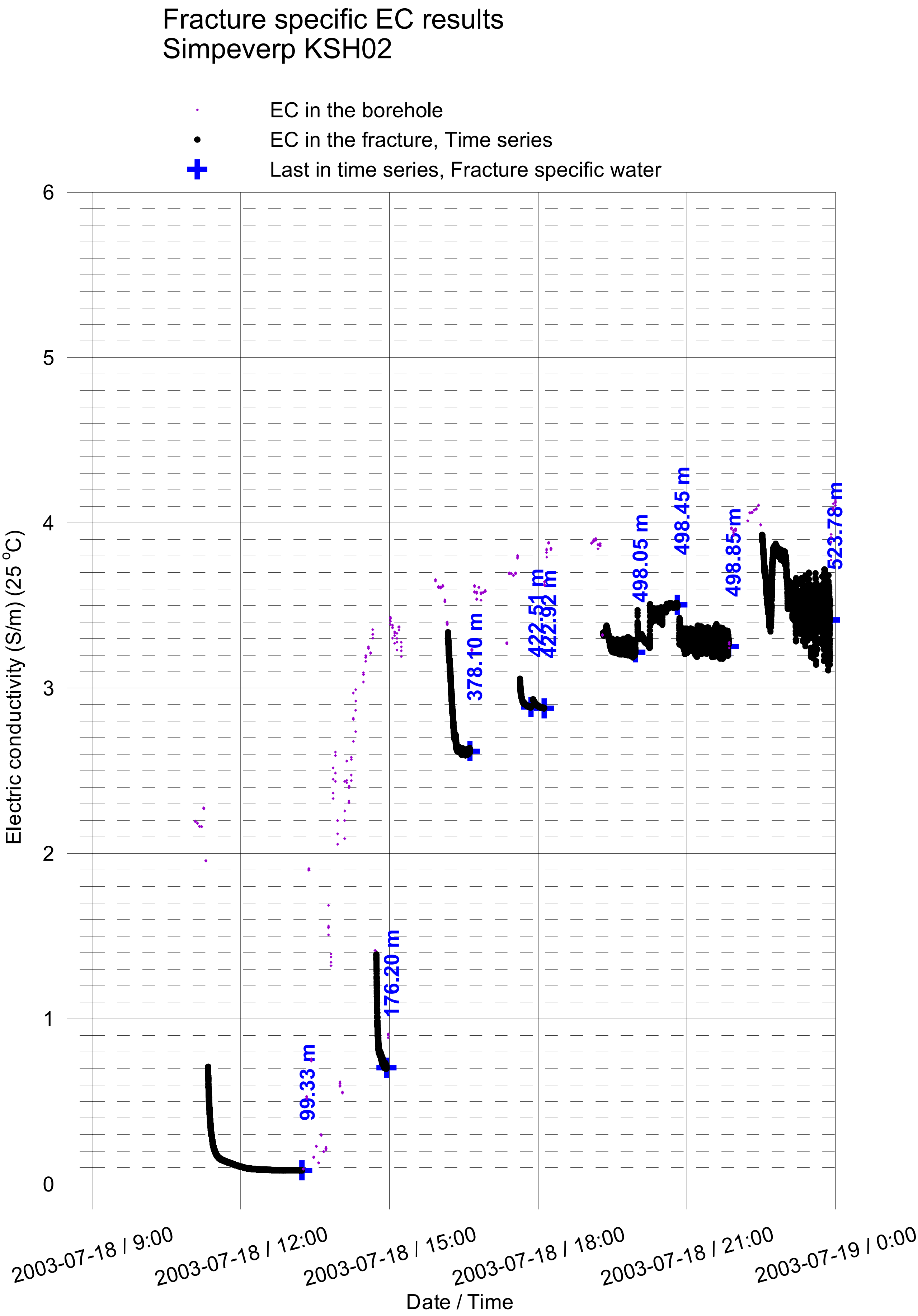

Time series of fracture-specific EC
Simpevarp, borehole KSH02
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Electric conductivity (S/m) (25 °C)
176.20 m
99.33 m
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
Time from the start of the measurement (s)

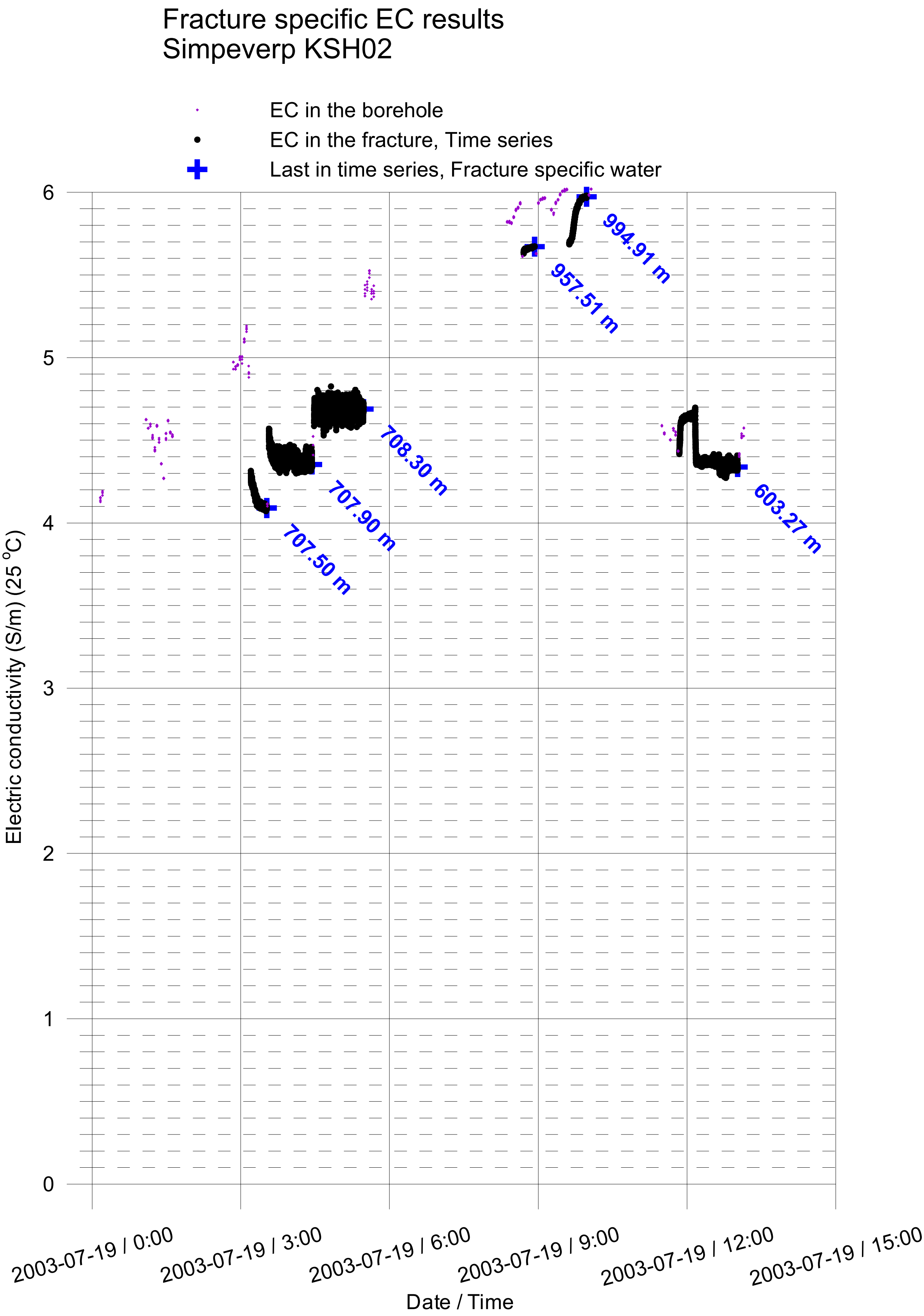

Time series of fracture-specific EC
Simpevarp, borehole KSH02
Electric conductivity (S/m) (25 ºC)
3.40
3.30
3.20
3.10
3.00
2.90
2.80
2.70
2.60
2.50
0
500
1000
1500
2000
2500
Time from the start of the measurement (s)
498.05
422.51 m
422.92
378.10 m


Time series of fracture-specific EC
Simpevarp, borehole KSH02
Electric conductivity (S/m) (25 °C)
4.00
3.90
3.80
3.70
3.60
3.50
3.40
3.30
3.20
3.10
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Time from the start of the measurement (s)
498.45
523.78
498.85 m


Time series of fracture-specific EC
Simpevarp, borehole KSH02
Electric conductivity (S/m) (25 ºC)
Time from the start of the measurement (s)
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00
4.90
4.80
4.70
4.60
4.50
4.40
4.30
4.20
4.10
4.00
0
500
1000
1500
2000
2500
3000
3500
4000
4500
994.91 m
957.51 m
708.30 m
707.90
603.3
707.50


Time series of fracture-specific EC
Simpevarp, borehole KSH02
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00
Electric conductivity (S/m) (25 ºC)
994.91 m
957.51 m
0
300
600
900
1200
1500
Time from the start of the measurement (s)


Fracture specific EC results
Simpeverp KSH02
EC in the borehole
EC in the fracture, Time series
Last in time series, Fracture specific water
Electric conductivity (S/m) (25 °C)
6
5
4
3
2
1
0
99.33 m
176.20 m
378.10 m
422.51 m
422.92 m
498.05 m
498.45 m
498.85 m
523.78 m
2003-07-18 / 9:00
2003-07-18 / 12:00
2003-07-18 / 15:00
2003-07-18 / 18:00
2003-07-18 / 21:00
2003-07-19 / 0:00
Date / Time


Fracture specific EC results
Simpeverp KSH02
EC in the borehole
EC in the fracture, Time series
Last in time series, Fracture specific water
Electric conductivity (S/m) (25 °C)
6
5
4
3
2
1
0
994.91 m
957.51 m
708.30 m
707.90 m
707.50 m
603.27 m
2003-07-19 / 0:00
2003-07-19 / 3:00
2003-07-19 / 6:00
2003-07-19 / 9:00
2003-07-19 / 12:00
2003-07-19 / 15:00
Date / Time