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Oskarshamn site investigation

Difference flow measurements in borehole KSH01A at Simpevarp

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PRG-Tec Oy

June 2003

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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 KSH01A at Simpevarp in February and March 2003.

The main aim of the measurements presented in this report was to determine the depth and flow rate of flowing fractures in borehole KSH01A.

The measurements in borehole KSH01A were carried out between the depths of 100 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.

The flow guide encloses also an electrode for measuring electric conductivity (EC) of water. 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.

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

Sammanfattning

Posivas flödeslogg/Differens flöde kan relativt snabbt bestämma hydraulisk konduktivitet och hydraulisk trycknivå i sprickor eller sprickzoner i kärnborrade borrhål. Föreliggande rapport presenterar metodens principer och resultat från mätningar i borrhål KSH01A vid Simpevarp vilka utfördes under februari och mars 2003.

Huvudsyftet med mätningar presenterade i denna rapport är att bestämma sprickors djup och flöde i borrhål KSH01A. Resultatet utgör även underlag för grundvatten-provtagning.

Mätningarna utfördes i intervallet 100–1000 m, där flödeshastigheten till eller från en 5 m lång section mättes. Detta gjordes med och utan pumpning av borrhålet. Flödesloggningen uppepades over identifierade anomalier med 1 m sektioner som stegades 0,1 m.

Längdkalibrering gjordes baserat på frästa spår i borrhållsvägen. Spåren detekterades med ett kaliper instrument och med Singel Point Resitivty mätningar. Dessa två sensorer är kopplade till flödesmätarens elektornik

Flödesguiden innehåller ochså en elektrod för att mätta vattnets elektriska konduktivitet. Mätningen används för att studera salthaltsförändringar i borrhålet vid såväl naturliga (opumpade) förhållanden som vid pumpade förhållanden.

Borrhålsutrsutningen innehåller även en absoluttrycksensor. Den används för att bestämma det hydrostatiska trycket i öppet borrhål.

Contents

1 Introduction

The measurements were carried out in borehole KSH01A at the Simpevarp site near Oskarshamn in February 17 – March 3, 2003 according to activity plan AP PS 400-02-30 (SKB internal controlling document). KSH01A is the first cored borehole in the site investigation in the Simpevarp area. The borehole is sub-vertical, c 1000 m deep and cased to c 100 m depth. The borehole diameter is 76 mm in the interval 100–1000 m. The location of borehole KSH01A within the Simpevarp area is shown in Figure 1-1.

The work carried out in borehole KSH01A is defined in Table 5-1. The purpose of the difference flow logging is

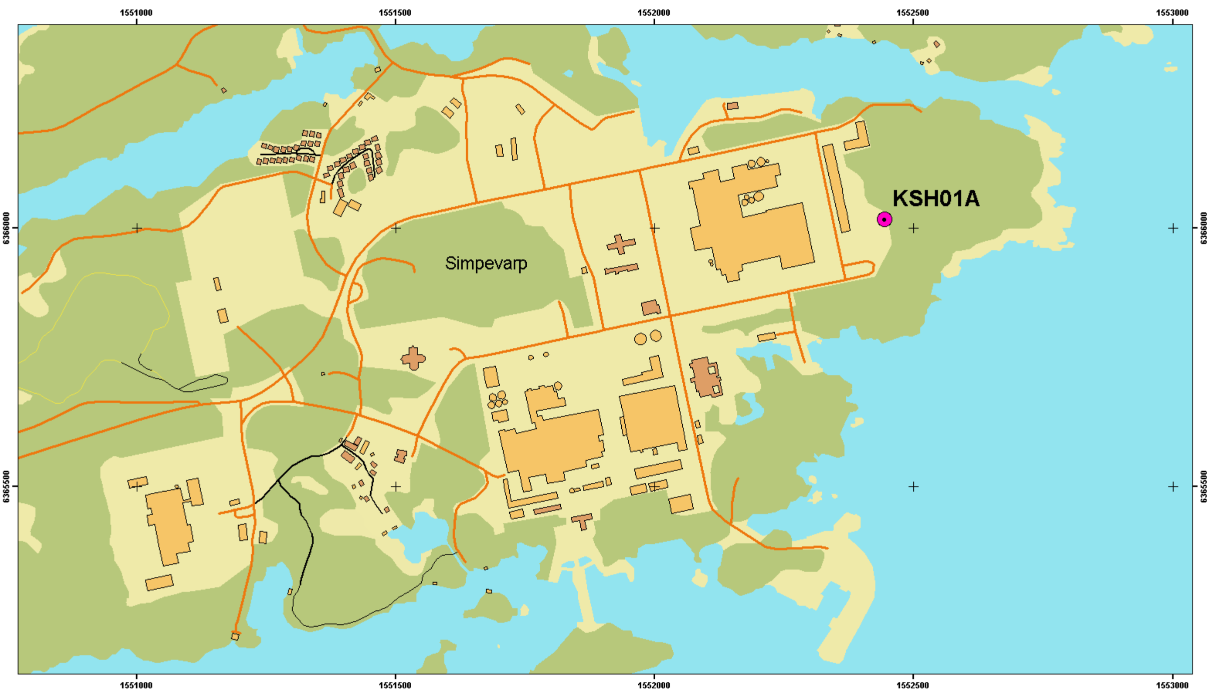
- to identify water-conductive sections/fractures along the hole, which are suitable for subsequent hydro-geochemical characterisation,

- a hydrogeological characterisation of the borehole, including the actual water flow balance in the hole and the hydraulic properties (hydraulic conductivity and undisturbed hydraulic head) of the tested sections. Based on the results of these investigations, a more detailed characterisation of flow anomalies along the hole, e.g. the conductive fracture frequency (CFF), may be carried out.

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, drawdown of groundwater level and its recovery was continuously measured.

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.



Borrhål:	X-koordinat:	Y-koordinat:
KSH01A	1552442,971	6366013,519

Figure 1-1. *Site map with showing the location of borehole KSH01A on the Simpevarp peninsula. (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 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.

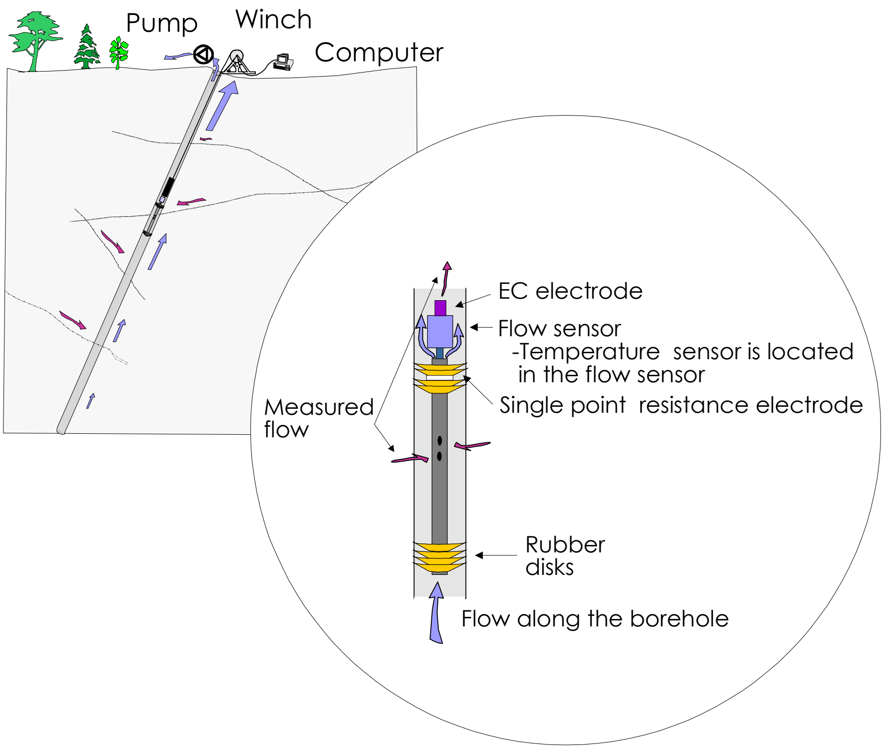


Figure 2-1. *Schematic of the downhole equipment used in the Difference flowmeter.*

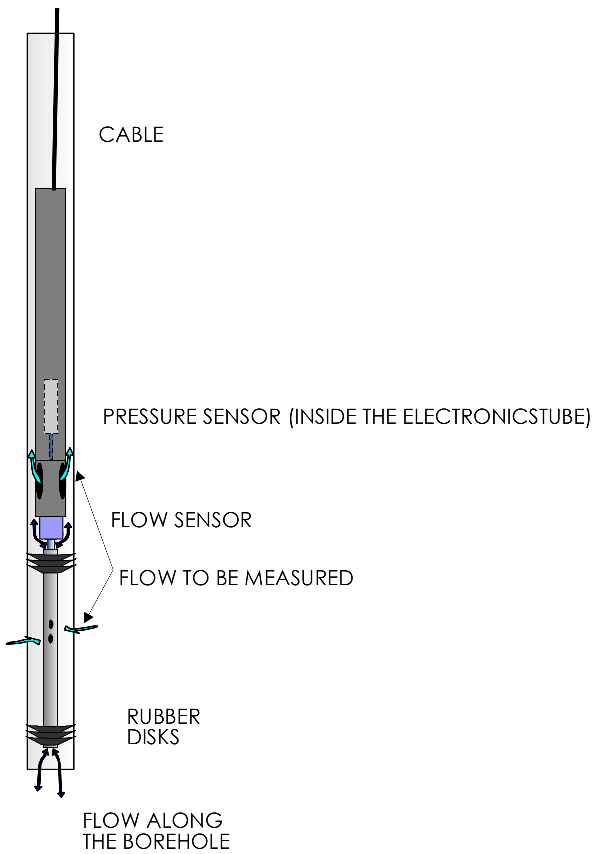


Figure 2-2. *The absolute pressure sensor is located inside the electronics tube and connected through a tube to the borehole water.*

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 2-3 b) 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 long 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

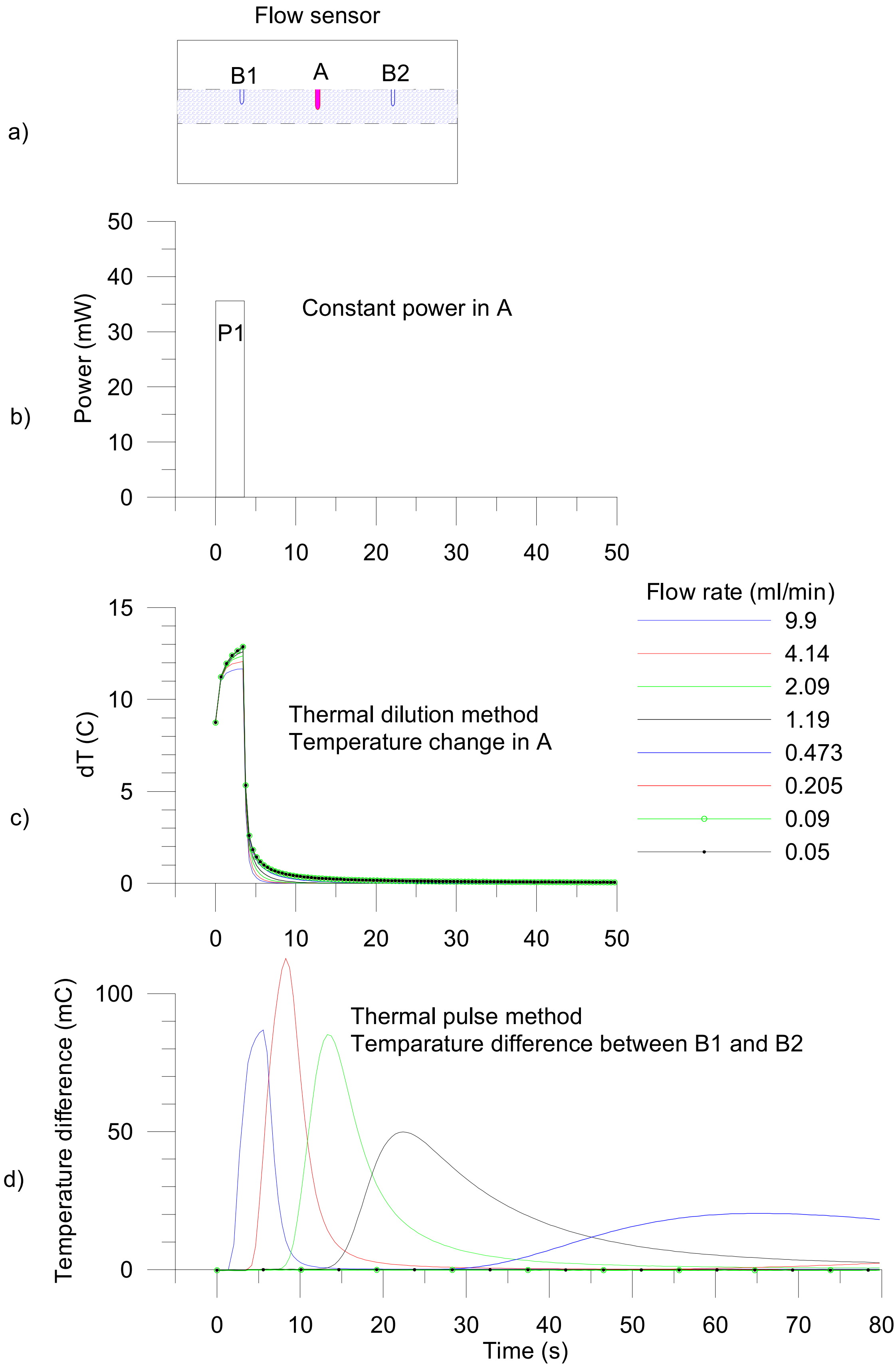


Figure 2-3. *Flow measurement, flow rate < 10 mL/min.*

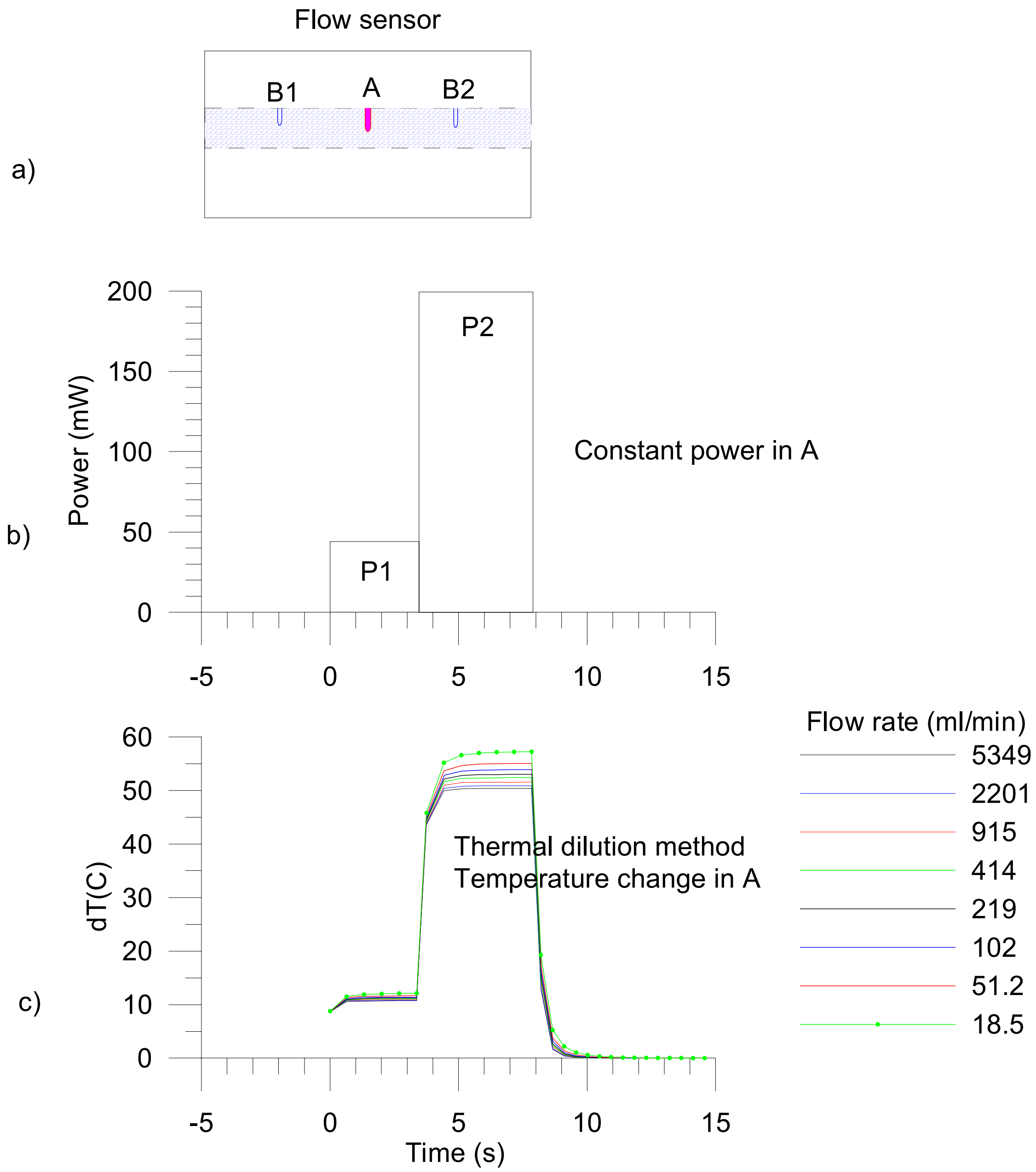


Figure 2-4. *Flow measurement, flow rate > 10 mL/min.*

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 pravail.

$Q_{n1} = K_n\ a\ (h_0 - h_1)$ 3-1

$Q_{n2} = K_n\ a\ (h_0 - h_2)$ 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 conductivityof the test section, and
h_0 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 h_0, and
r_0 is the nominal radius of the borehole.

The radial distance to the undisturbed hydraulic head h_0 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:

$h_0 = (h_1 - b\ h_2)/(1 - b)$ 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).

$h_0 = (h_1 - b\ h_2)/(1 - b)$ 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_0 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.

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 95.
Software:	Based on MS Visual Basic.
Total power consumption:	1.5–2.5 kW depending on the pumps.
Calibrated:	November 2002.
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% fullscale
Absolute pressure sensor	0 – 20 MPa	+/– 0.01% fullscale

5 Results

Data has been delivered to the SKB's database SICADA, Field note Simpevarp 18.

5.1 Field work

Before the actual measurements, the tools and the cable were cleaned and disinfected. Time was 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 7). 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 9) was carried out between the depths of 100–1000 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 February 22. After 24 hours waiting time, the combined sequential/overlapping flow logging (Item 10) was again carried out between the depths of 100–1000 m using the same section and step as before. 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 10th point).

The overlapping flow logging was then continued, i.e. the previously measured flow anomalies were measured again with 1 m section length and 0.1 m step (Item 11).

Thereafter EC of borehole water (Item 13) was measured, still at pumping. After this, the pump was stopped and groundwater recovery was monitored (Item 14).

Absolute pressure was also registered with the other measurements in Items 8–13.

Table 5-1. Flow logging and testing in KSH01A. Activity schedule.
(Item numbers from actual work are retained this table.)

Item	Activity	Explanation	Date
7	Length calibration of the down-hole tool	Dummy logging (SKB Caliper and SPR) Logging without the lower rubber discs, no pumping	2003-02-18 2003-02-19
8	EC- and temp-logging of the borehole fluid, absolute pressure	Logging without the lower rubber discs, no pumping	2003-02-19 2003-02-20
9	Sequential flow logging	Section length L_w=5 m, Step length dL=5 m, no pumping	2003-02-20 2003-02-22
10	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)	2003-02-22 2003-02-25
11	Overlapping flow logging	Section length L_w=1 m, Step length dL=0.1 m, at pumping (only in conductive borehole intervals)	2003-02-25 2003-03-01
13	EC- and temp- logging of the borehole fluid	Logging without the lower rubber discs, at pumping	2003-03-01
14	Recovery transient	Measurument of water level in the borehole after stopping of pumping	2003-03-01 2003-03-02

5.2 Depth corrections 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 7, 9, 10 and 11, see Table 5-1.

The zoomed results of Caliper and SPR are presented in Appendices 1.1–1.28. The depth marks were detected at 110 m, 150 m, 200 m, 300 m, 350 m, 400 m, 450 m, 500 m, 550 m, 600 m, and 650 m, 700 m, 750 m, 800 m, 850 m, 899 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.

At the depth of 250 m the borehole is widened and the depth marks are not visible on the Caliper curve. Weak traces of depth marks can be seen in the SPR result.

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

The aim of the plots in Appendices 1.1–1.28 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 1.29. If the error is negative, the cable is longer than expected.

The procedure of depth correction was the following:

- Caliper+SPR measurement (Item 7) was first depth corrected to the known depth marks, black curve in Appendix 1.29. Corrections between the borehole depth marks were obtained for each depth by linear interpolation.
- The SPR curve of Item 7 was then compared with the SPR curves of Items 9, 10, 11 to obtain relative depth errors of Items 9, 10, 11.
- All SPR curves could then be synchronized, as can be seen in Appendices 1.1–1.28.

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 six days pumping period), see Appendix 2.1 red curves. The results show inflow of saline water at the depths of about 560 m, 590 m and 685 m. The bottom of the borehole remains fresh water filled in spite of pumping.

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. Pumping changed very little the temperature profiles below the depth of 590 m; small flow rate is an apparent reason to this.

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 3.1–3.45. In this first flow measurement the borehole was at rest. The thermal dilution and thermal pulse methods were used for flow determination.

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 about 10 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 3.1–3.45. 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 their 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.

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 7) measurements. The depth corrections of Items 9–11 were carried out synchronizing the SPR curves of Items 9–11 with the depth corrected first SPR measurement (Item 7).

The depths of flowing fractures are marked with lines in the appendices of the detailed flow logs. Long line represents the depth of a leaky fracture; short line denotes that the existence of a leaky 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 pressure was registered with the other measurements in Items 8–13. The pressure sensor measures the sum of hydrostatic pressure in the borehole and air pressure. Air pressure was registered by SKB in a near environmental monitoring station, Figure 5-1. Hydraulic head along the borehole at natural and pumped conditions respectively 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. The hydraulic head (h) at a certain elevation z is then 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.

An offset of 13.kPa is subtracted from all absolute pressure results.

The calculated head results are presented in Appendix 4.1. 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. The depth correction of Caliper measurement was applied to borehole EC measurements, black curve in Appendix 1.29.

There are relatively large deviations of head during pumping. Head during the flow measurements show an increasing trend with time (February 23 – March 1). This may happen because the salt content in borehole water increases with pumping.

The last head measurement was carried out during the borehole EC logging with pumping. The deviation of head results downwards and upwards is 0.5–0.6 m, Appendix 4.1. The probably reason is the lengthening of the cable when the tool was lifted up. It was driven fast up in this measurement and the sensor was probably deeper than it was assumed in the depth correction. During the borehole EC logging without pumping the tool was lifted slowly during the night (see Figure 5-2) and the deviation of head downwards and upwards was smaller, Appendix 4.1.

A zoomed plot of head during the flow loggings at the bottom of the borehole is presented in Appendix 4.2. The level of head is shifted to show the both plots on the same scale. Point interval is denser in the measurement with pumping. Head increases below 990.5 m indicating ”heavy” (muddy?) water. The tool hits the bottom at 994.0 m, which can be seen in the SPR-curves. Below 994.0 m the measured pressure is constant (the tool does not move) but head goes lower because of the depth correction (assumed z coordinate correction).

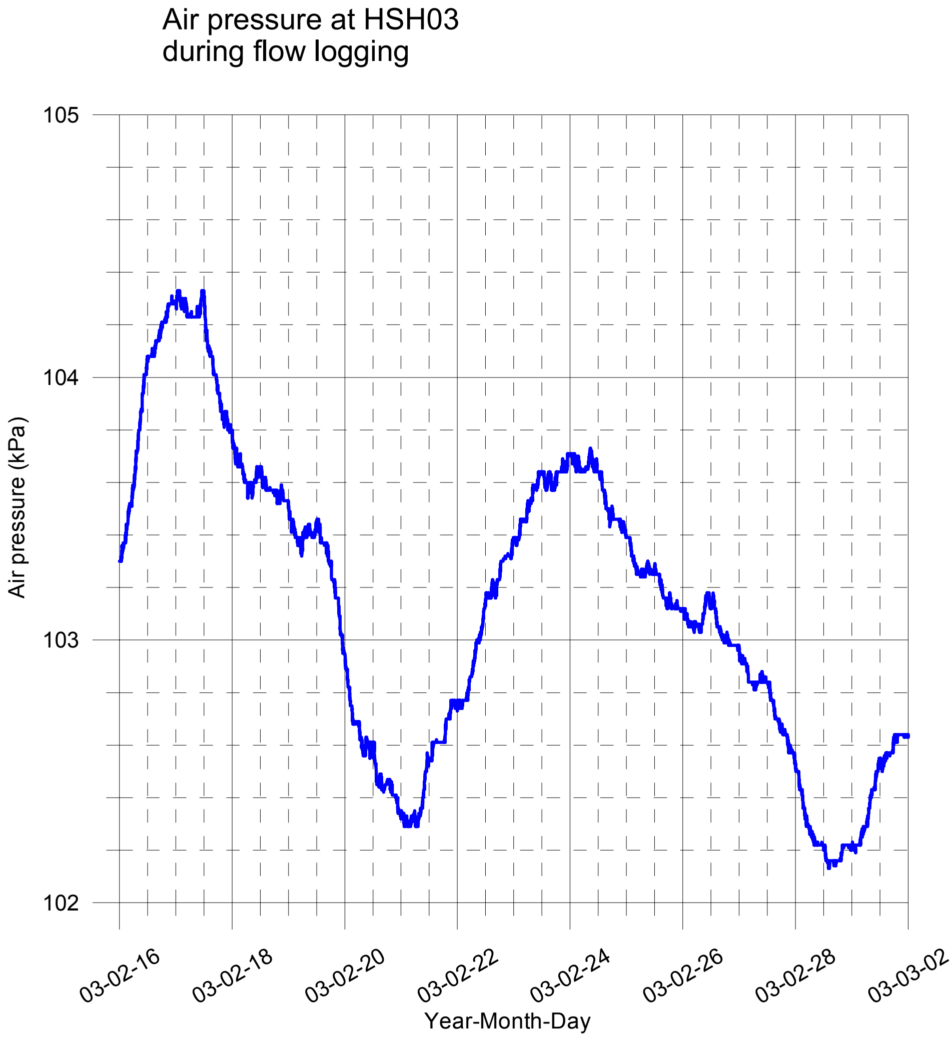


Figure 5-1. *Air pressure.*

5.6 Hydraulic head and conductivity of formations

The borehole was measured in sequential flow logging mode with 5 m depth increments. Section length was also 5 m. Both thermal dilution and thermal pulse methods were used.

Thermal pulse method is slow but it 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 to 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 5.1–6.2. The depths represent the distance from the reference depth (top of the casing tube) to the middle point of the test section. Depth1 and Depth2 represent depths without and with pumping the borehole, respectively. They are not equal although the aim is to measure at the same depths. The cable stretches out differently in different runs.

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 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 –383 ml/h. 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 6.1. 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 100 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 6.2.

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 February 19 and 23 when the first Caliper, EC and flow measurements were carried out.

The borehole was pumped with a drawdown of about ten meters. The pump stopped on February 25 at 22:45 for an unknown reason and it was restarted next morning at 7:25. The overlapping flow measurements were continued on February 26 at 13:00.

The groundwater recovery was measured as the last phase of the field work, March 1–2, 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.

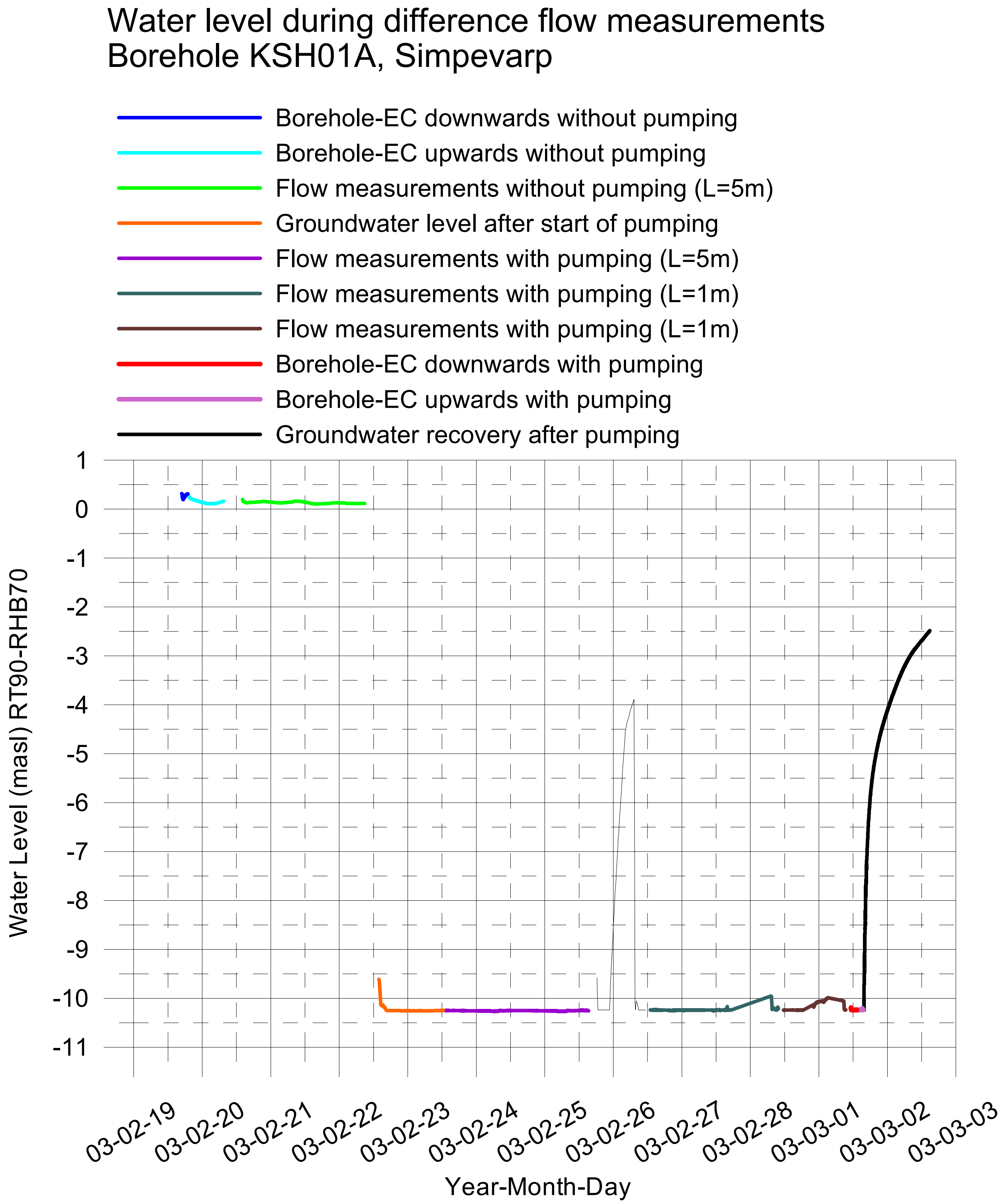


Figure 5-2. *Groundwater level in borehole KSH01A.*

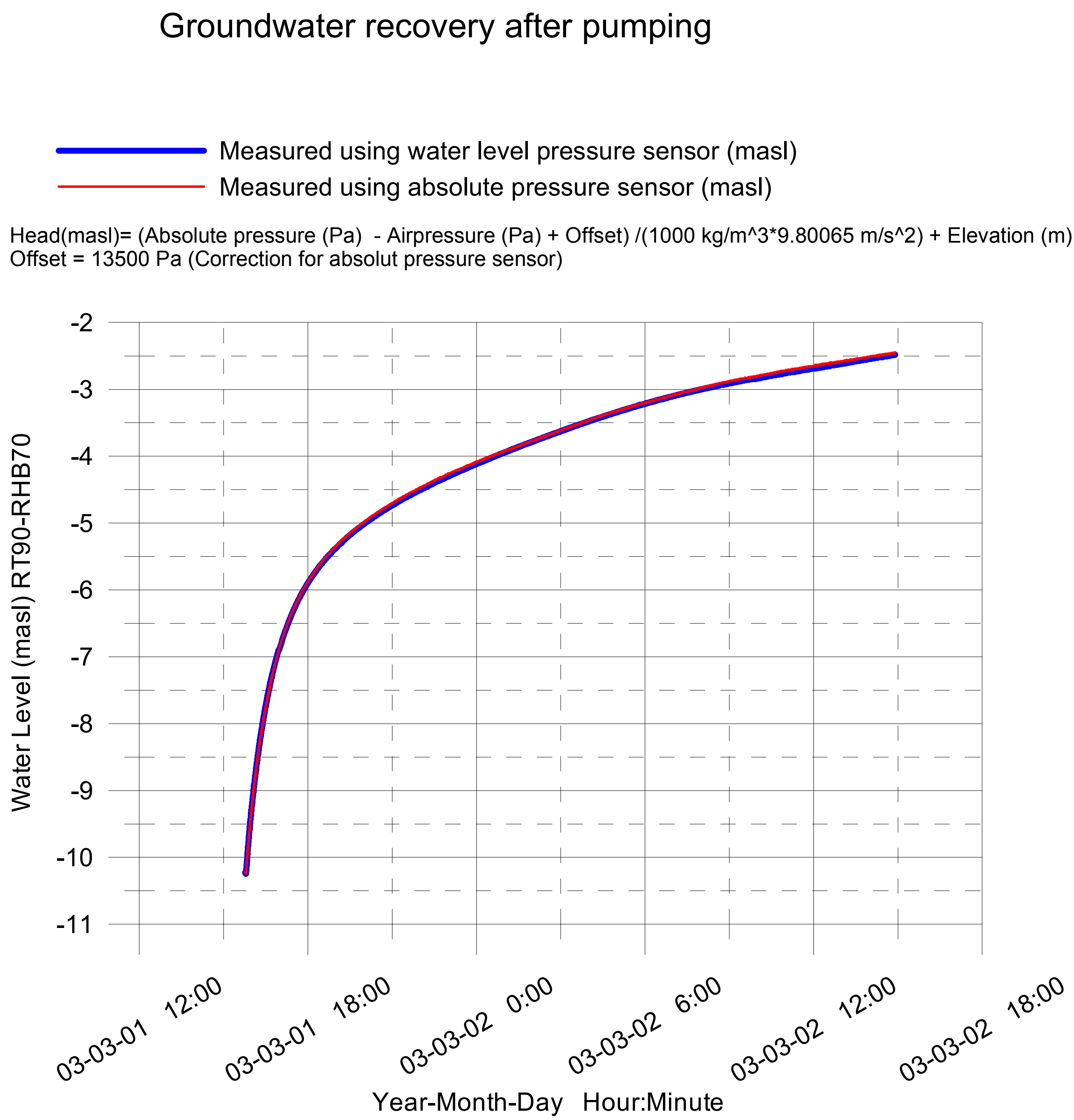


***Figure 5-3.** Groundwater level in borehole KSH01A.*

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 5.2 l/min to 3.2 l/min. This can be compared with the summed up flow result from of flow measurements from the entire borehole. The sum is about 3.6 l/min.

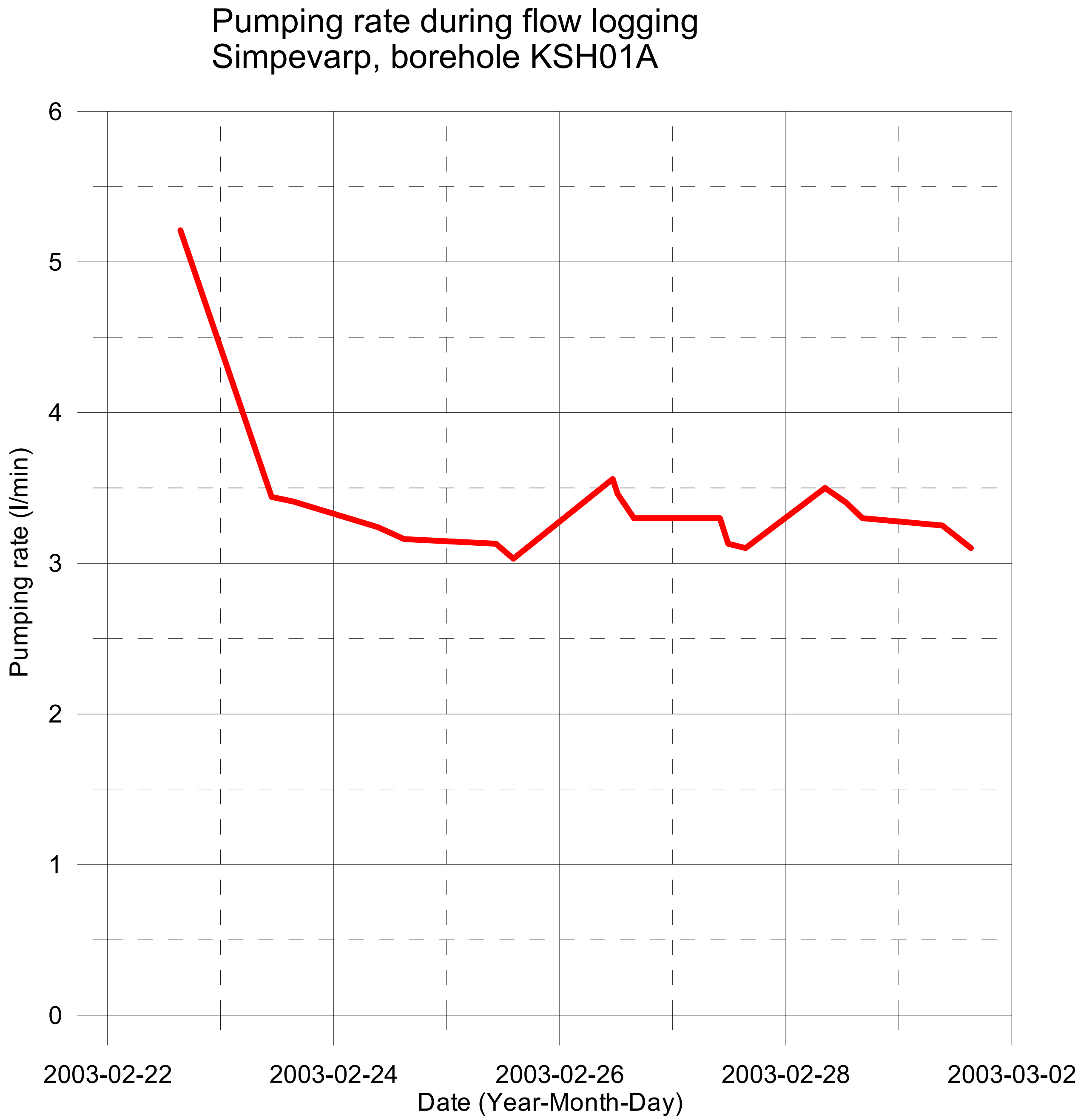


Figure 5-4. *Pumping rate during the flow logging.*

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.

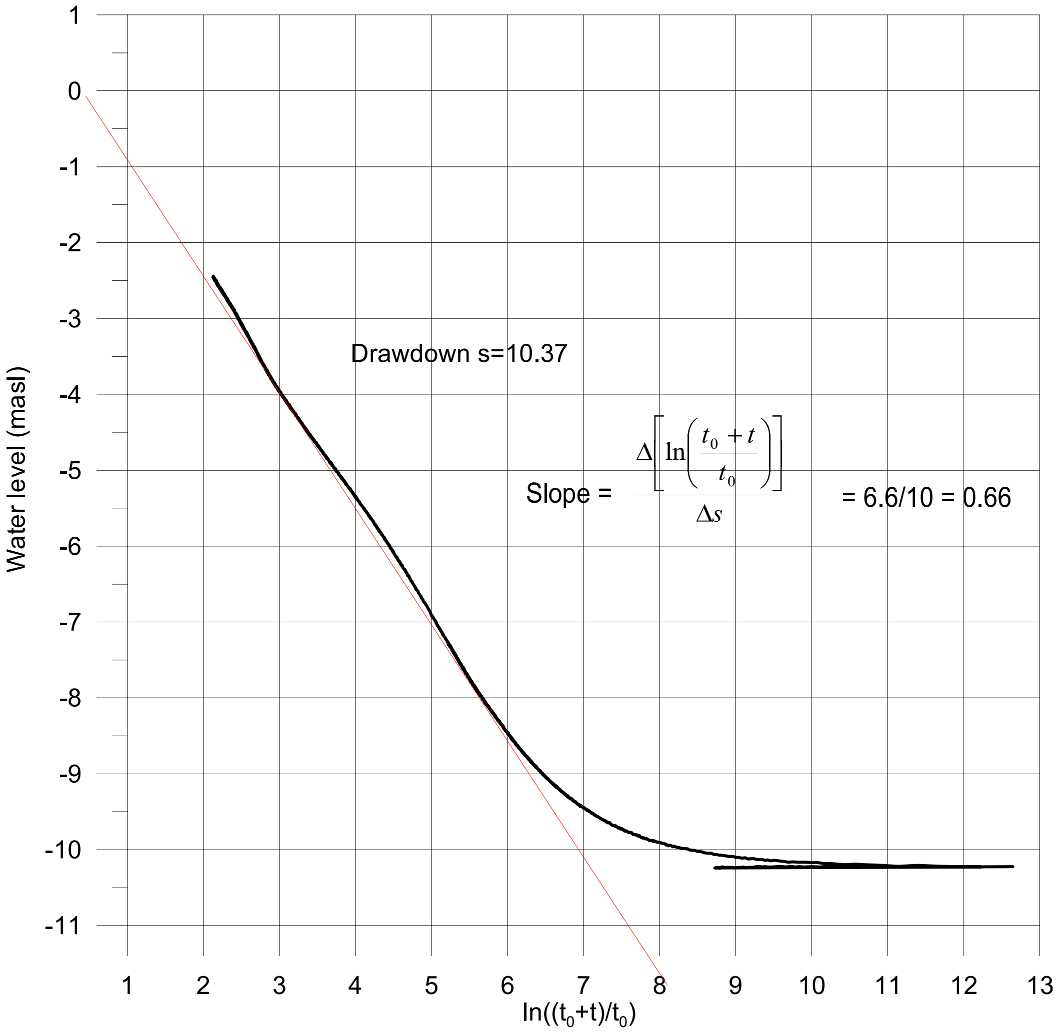


Figure 5-5. *Horner's diagram for the recovery phase.*

The results of the three methods are given in Table 5-2. Moye's approximation gives the highest and Jacob/Horner method the lowest transmissivity. Basic test data is gathered in Appendix 7.

Table 5-2. Flow logging and testing in KSH01A. Activity schedule.

Method	**Transmissivity (m^2/s)**
Dupuit	5.1 E-6
Moye	8.6 E-6
Jacob/Horner	2.8 E-6

5.9 Tables of sequential and overlapping logging

The results of sequential flow logging are presented in Appendices 8.1–8.6. Explanations of the columns are given Appendix 10. The lowest possible limit of transmissivity is presented in column Td-measl. It is calculated assuming the lowest measurable flow rate (0.1 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.

The results of overlapping flow logging are presented in Appendices 9.1–9.3. 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 0.5 mL/min). Many of the fracture specific results are marked as uncertain. In these cases the measured flow rate is below 0.5 mL/min 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 9 was used to calculate conductive fracture frequency (CFF), Appendices 11.1–11.4. The number of conductive fractures were counted on the same 5 m sections as in Appendices 8 and 9 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.

6 Discussion and conclusions

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 for groundwater sampling. 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.

Only a few flowing fractures were detected. Conductivity and head were calculated for formations. The highest conductivities 2.3 10^{-7} m/s and 2.9 10^{-7} m/s were detected in the fractures at the depths of 250.29 m and 290.28 m, respectively.

The field work went well from at least from the contactors point of view. An important reason to this is that the site was well organized. The measurements could be carried out in relatively short time. The measurements were going on during nearly all days and nights.

References

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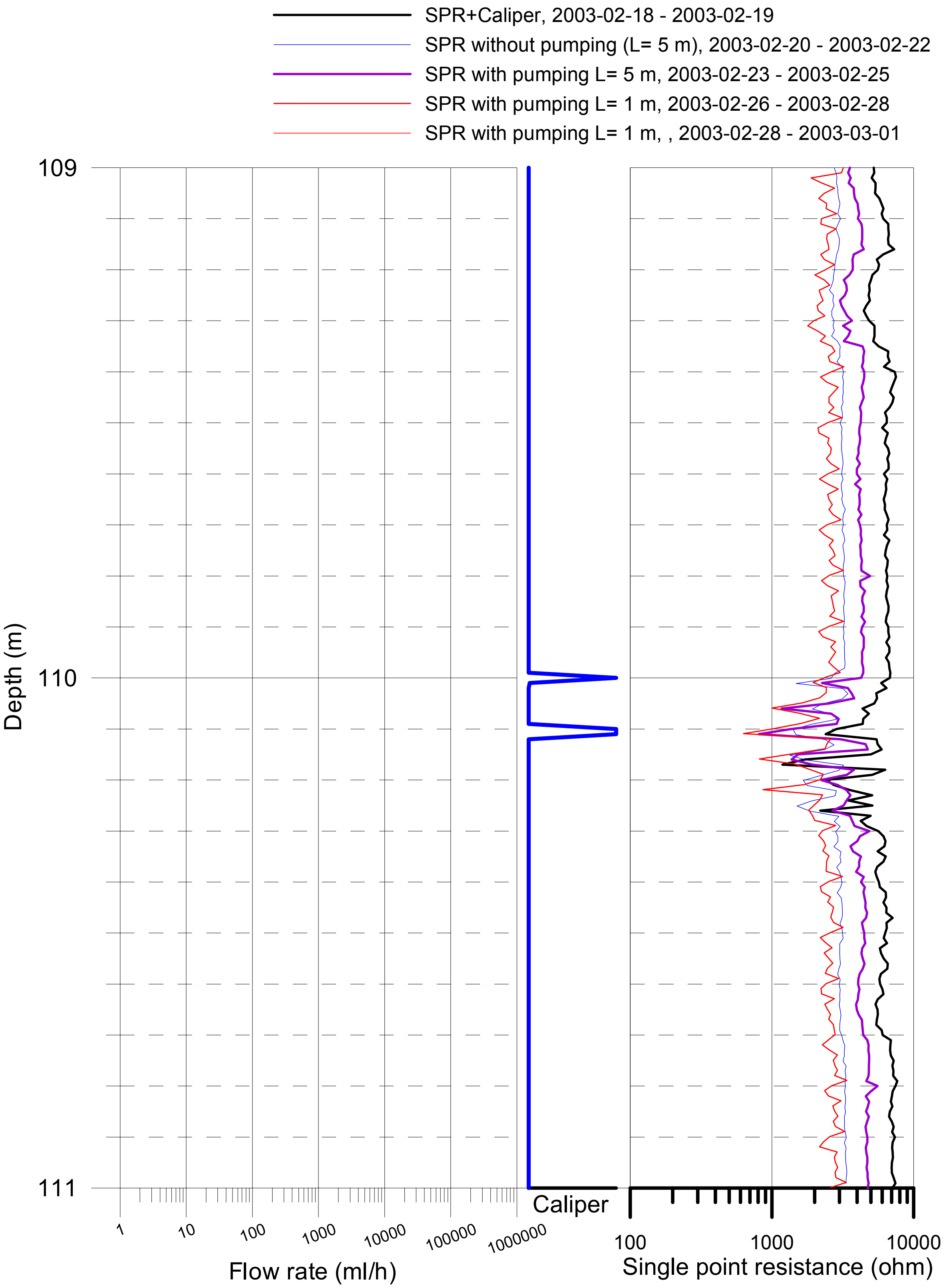
Öhberg A and Rouhiainen P, 2000. Posiva groundwater flow measuring techniques. Helsinki, Posiva Oy. Report POSIVA 2000-12.

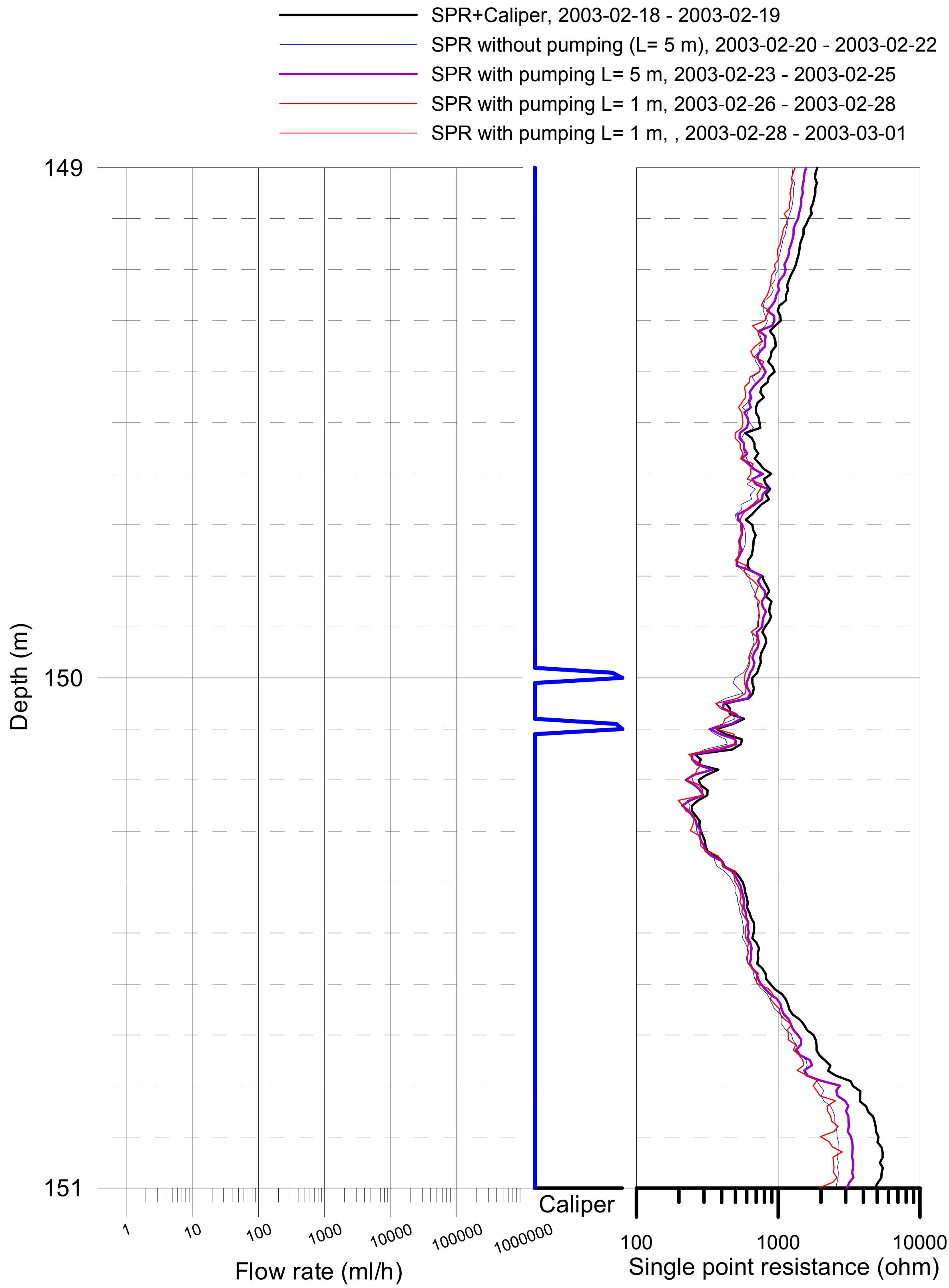
Appendices

Appendices	1.1–1.28	Depth calibration
Appendix	1.29	Depth corrections
Appendix	2.1	EC of borehole water
Appendix	2.2	Temperature of borehole water
Appendices	3.1–3.45	Measured flow rates, Caliper and Single point resistance
Appendices	4.1–4.2	Borehole head of 5 m
Appendices	5.1–5.7	Hydraulic conductance and head of 5 m sections
Appendix	6.1	Plotted flow rates of 5 m sections
Appendix	6.2	Plotted head and conductivity of formations
Appendix	7	Basic test data
Appendices	8.1–8.6	Results of sequential flow logging
Appendices	9.1–9.3	Inferred flow anomalies from overlapping flow logging
Appendix	10	Explanations for the tables in Appendices 7–9
Appendices	11.1–11.5	Conductive fracture frequency

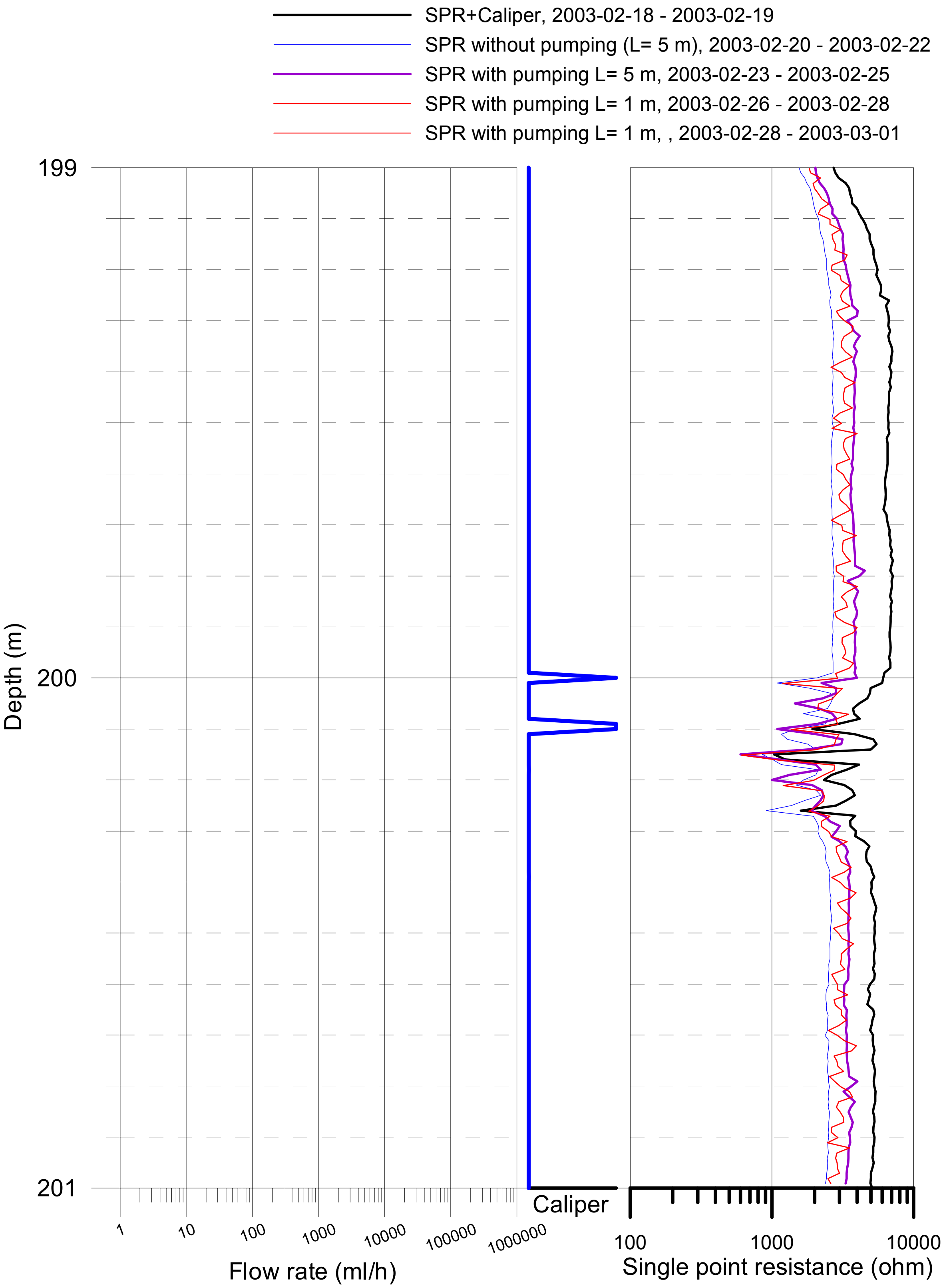
Simpevarp, KSH01A
SPR and Caliper results after depth correction



Simpevarp, KSH01A
SPR and Caliper results after depth correction



Simpevarp, KSH01A
SPR and Caliper results after depth correction



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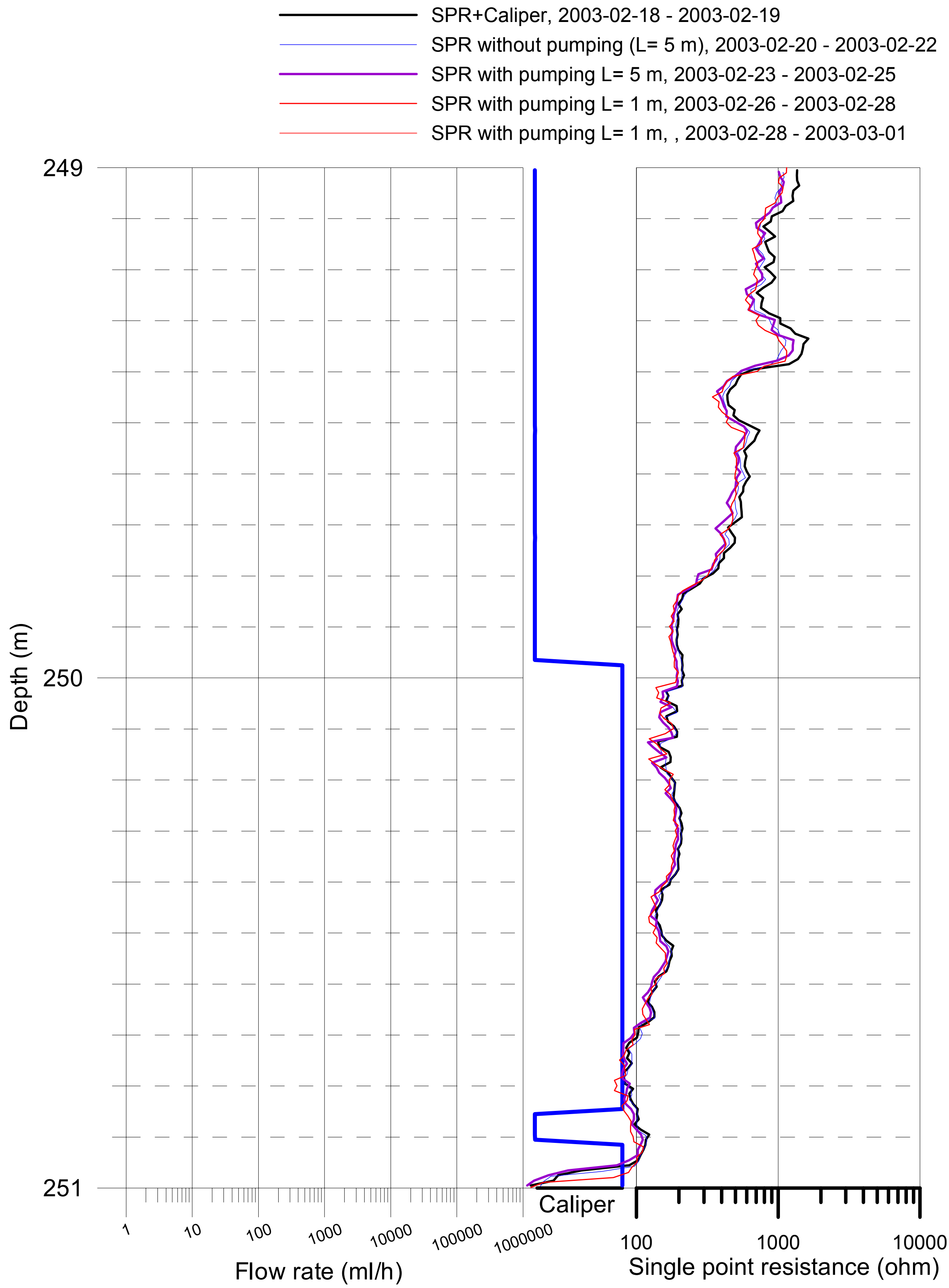
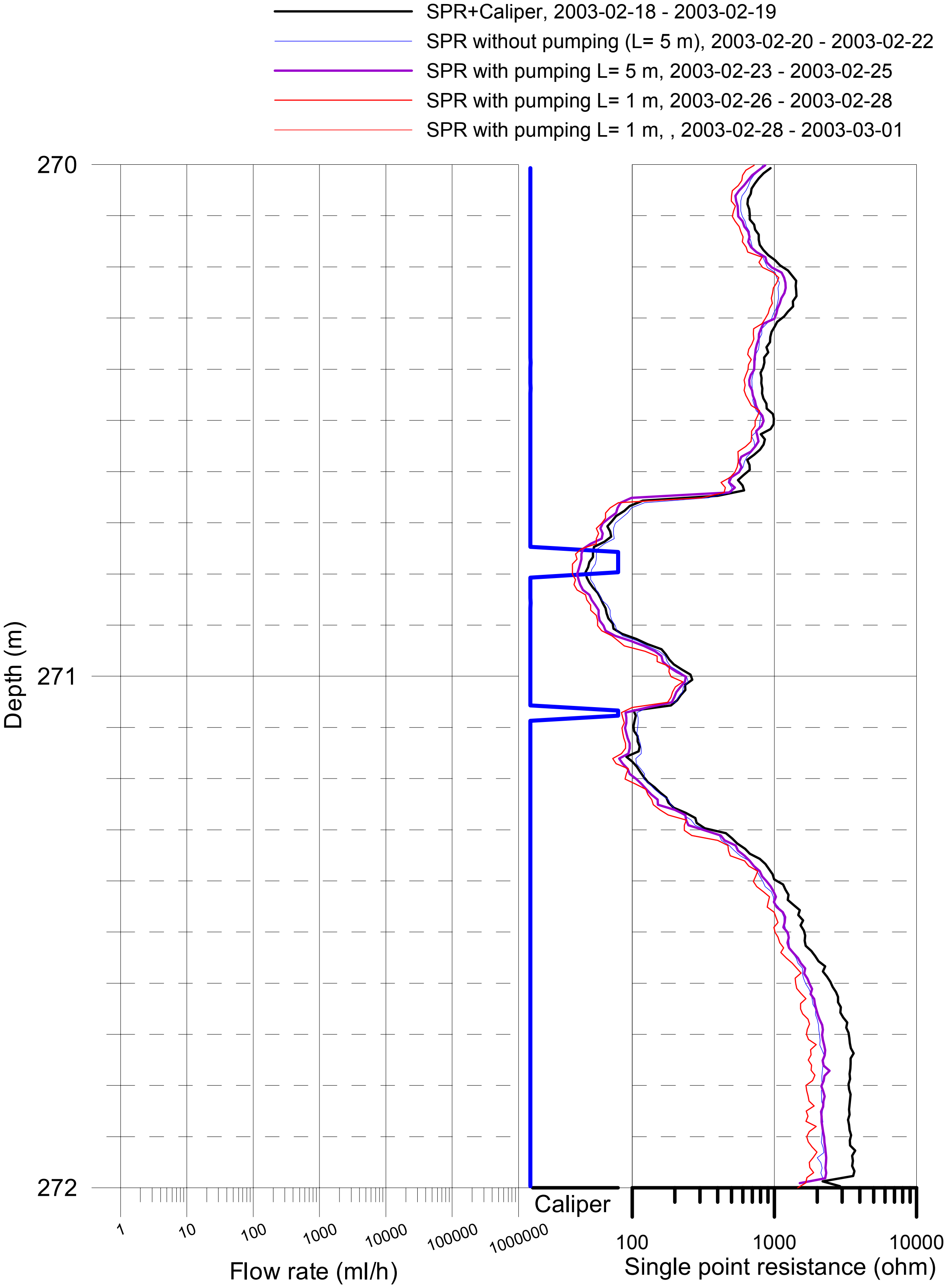
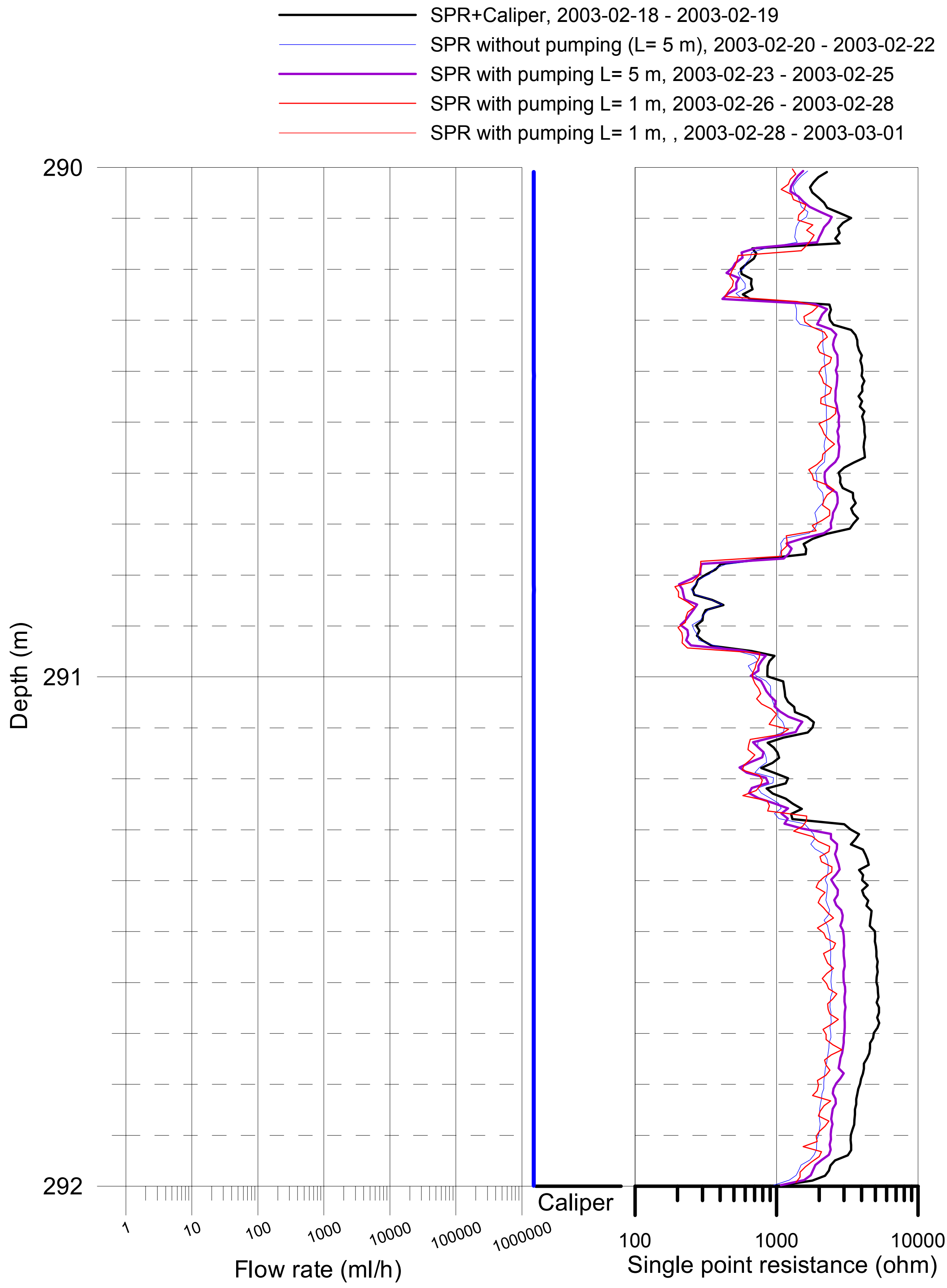


Simpevarp, KSH01A
SPR and Caliper results after depth correction



Simpevarp, KSH01A
SPR and Caliper results after depth correction



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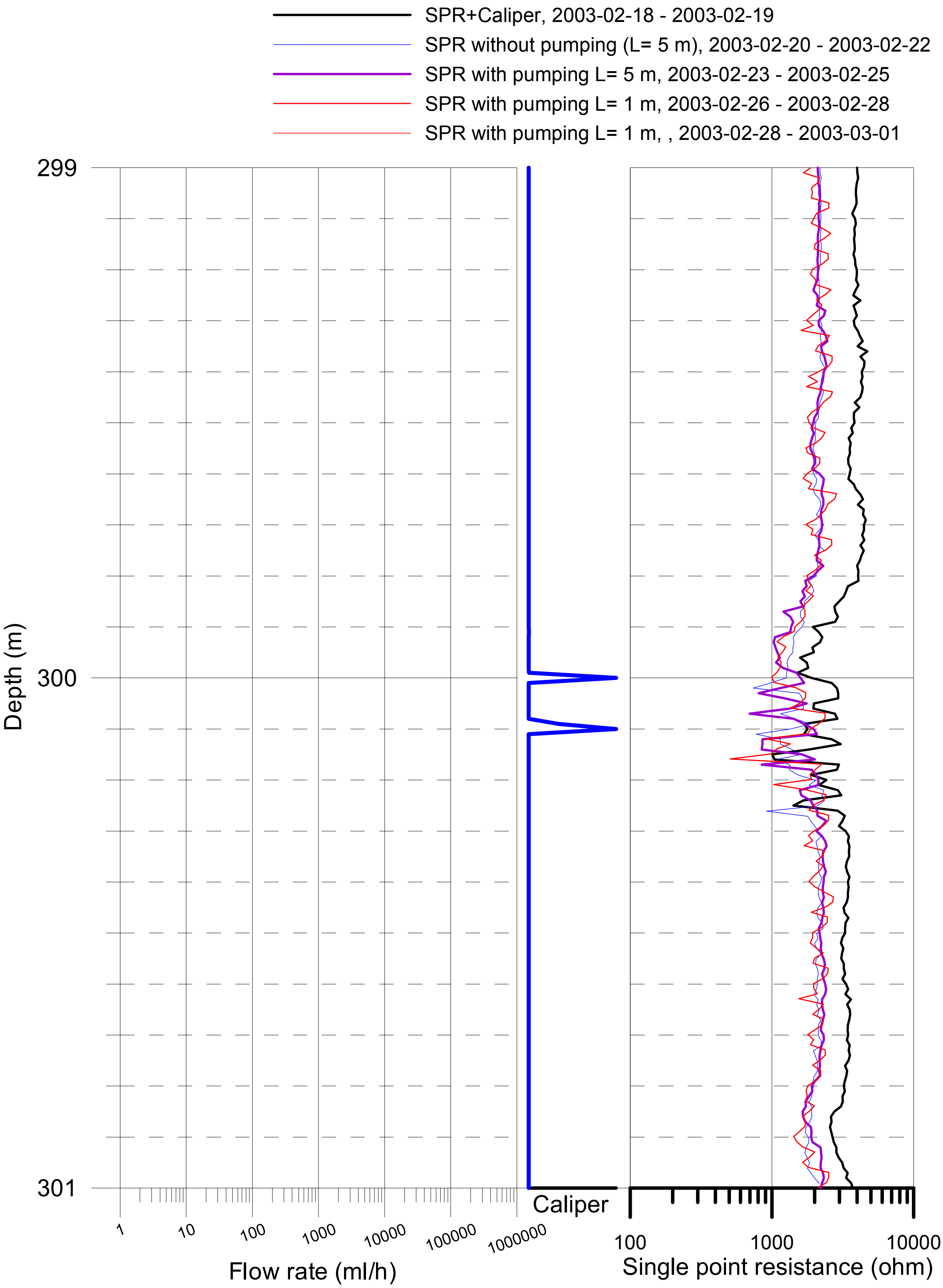
SPR and Caliper results after depth correction



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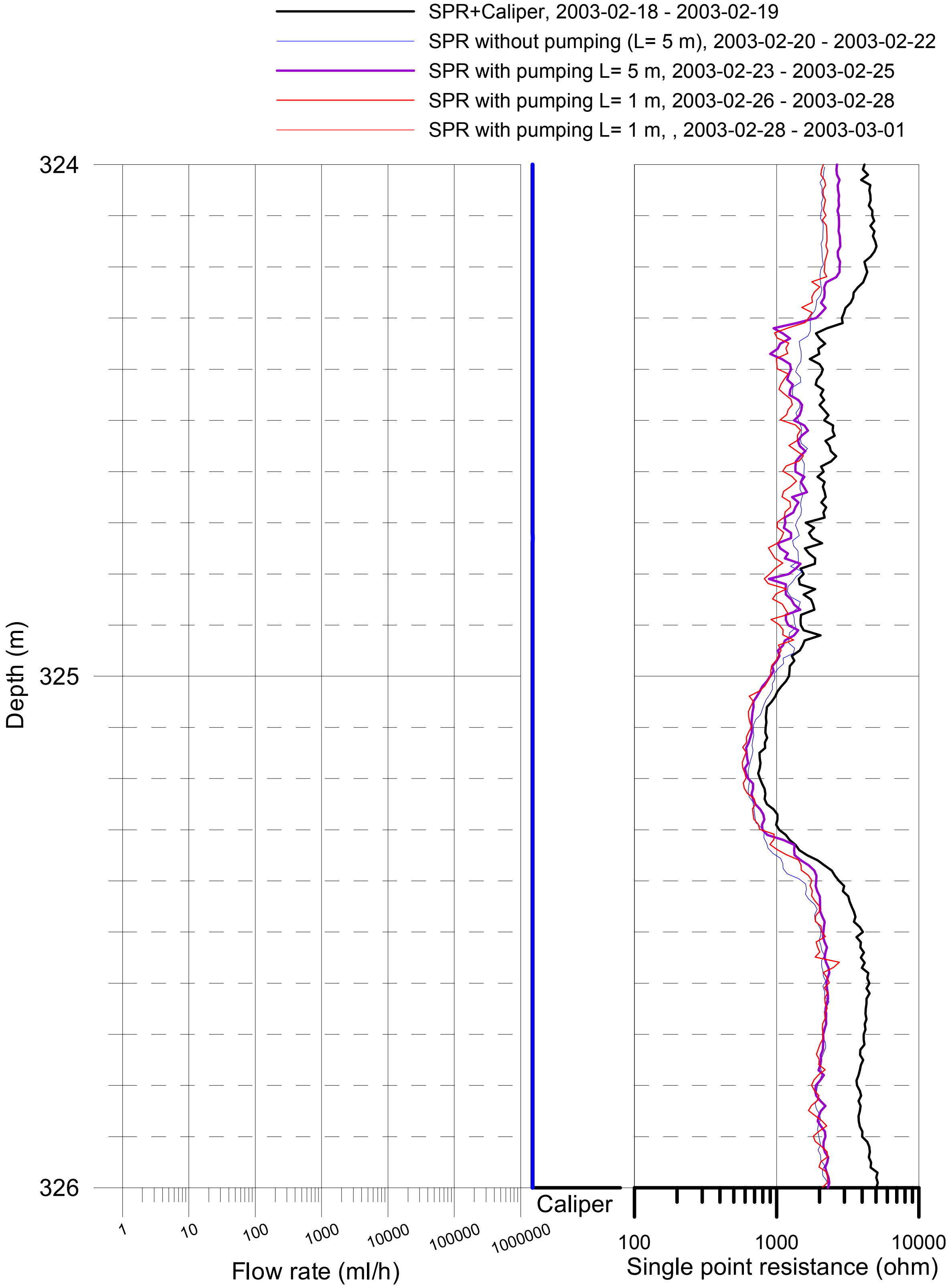
SPR and Caliper results after depth correction



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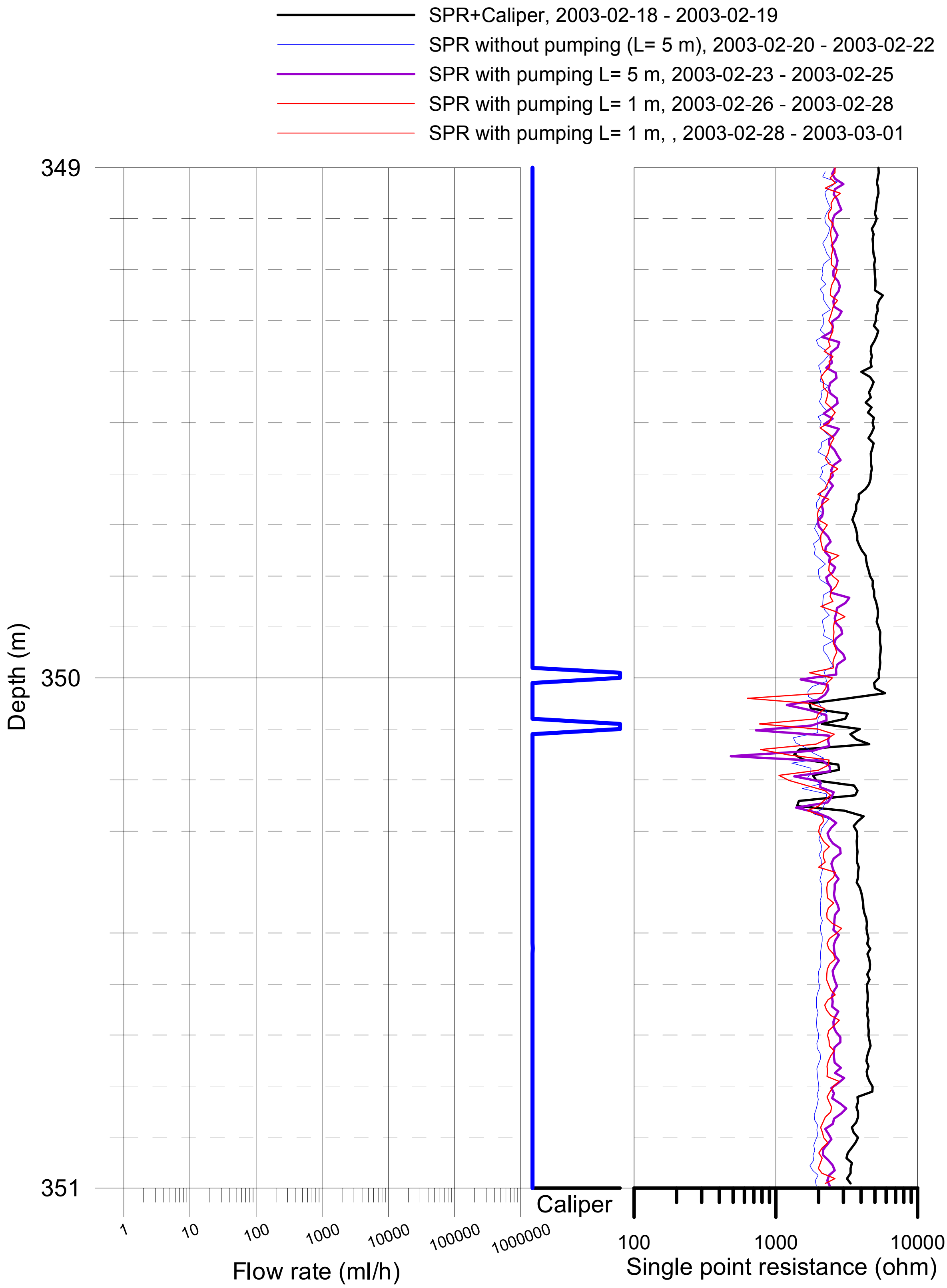
SPR and Caliper results after depth correction



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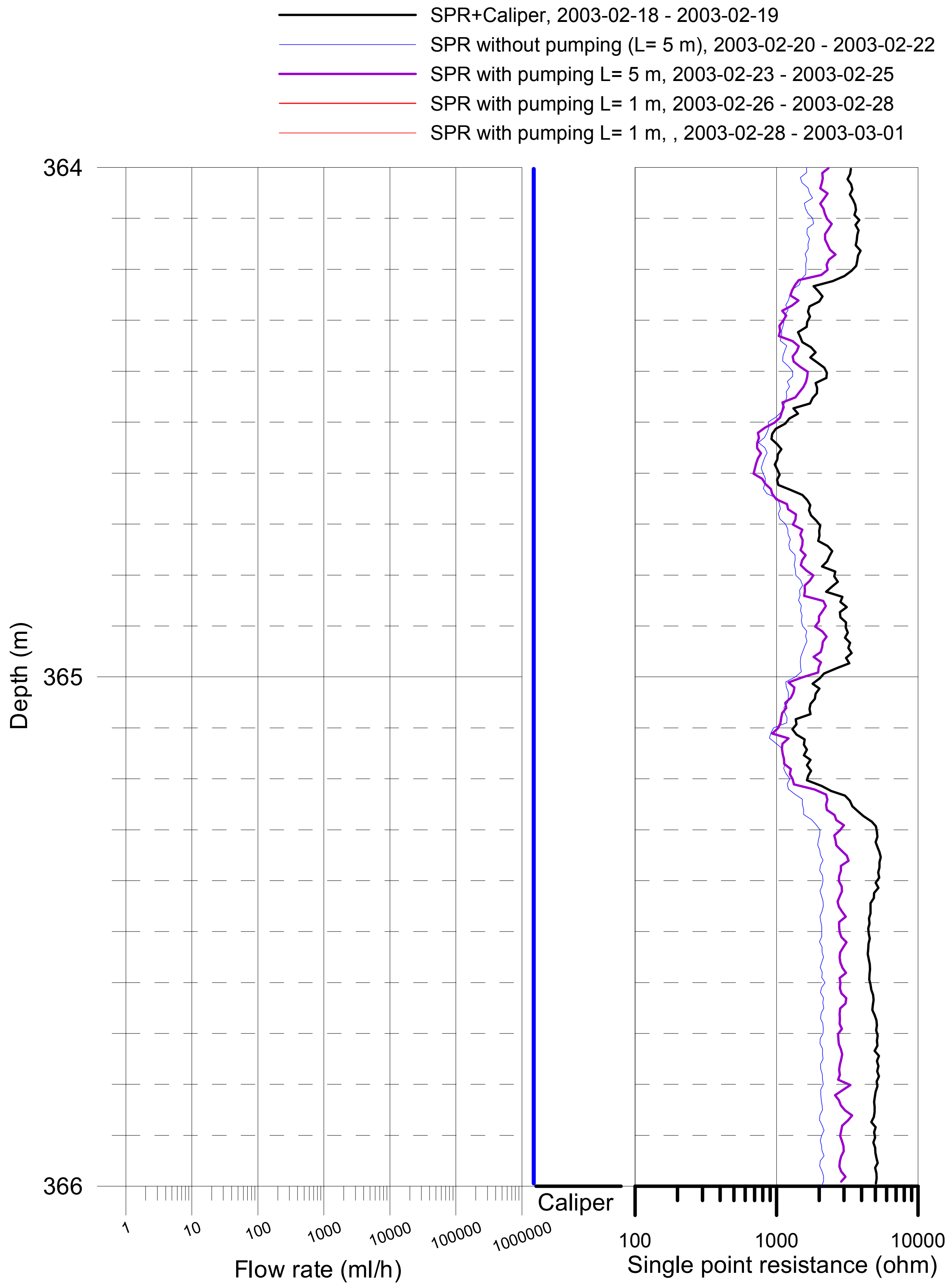
SPR and Caliper results after depth correction



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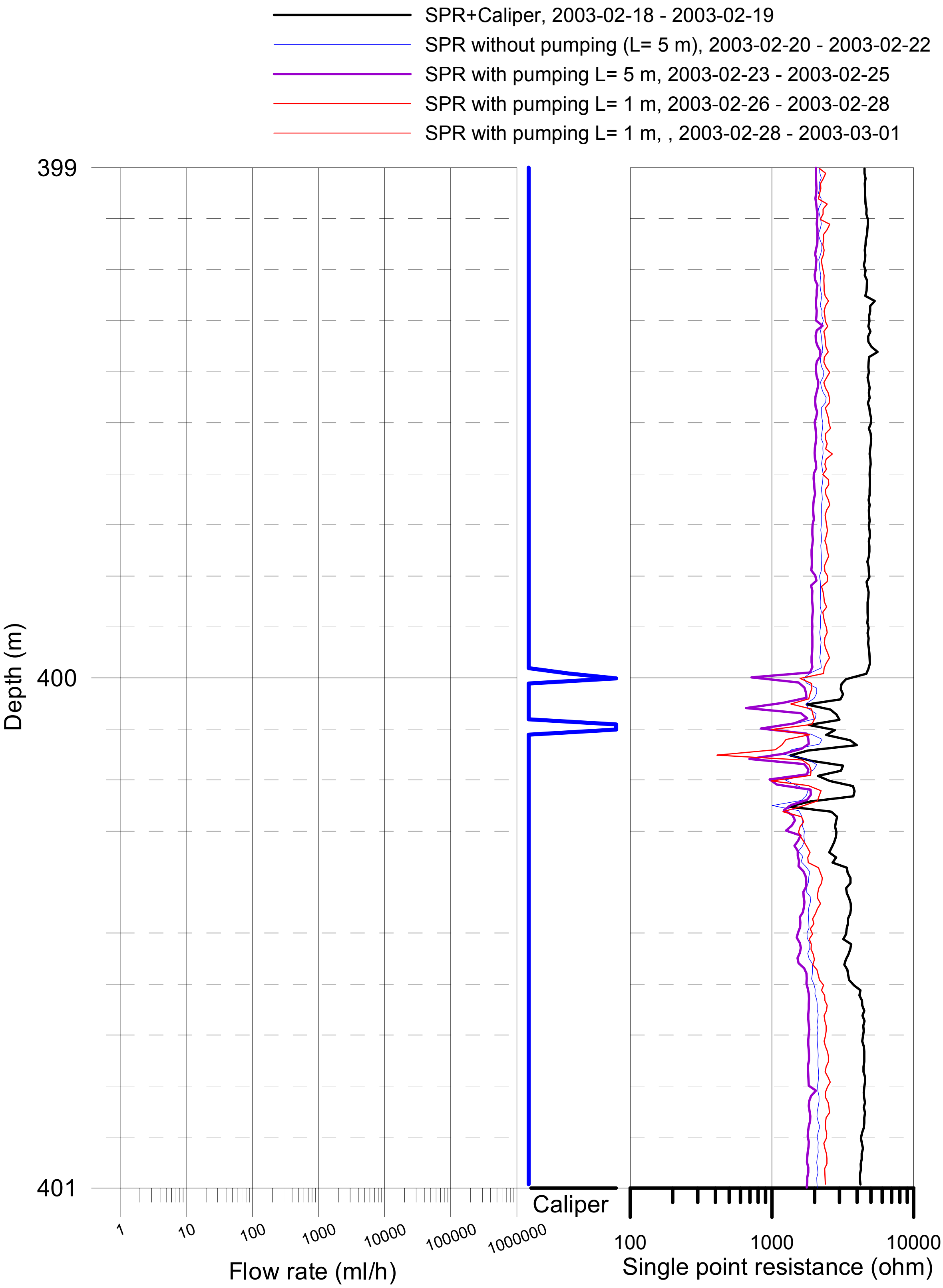
SPR and Caliper results after depth correction



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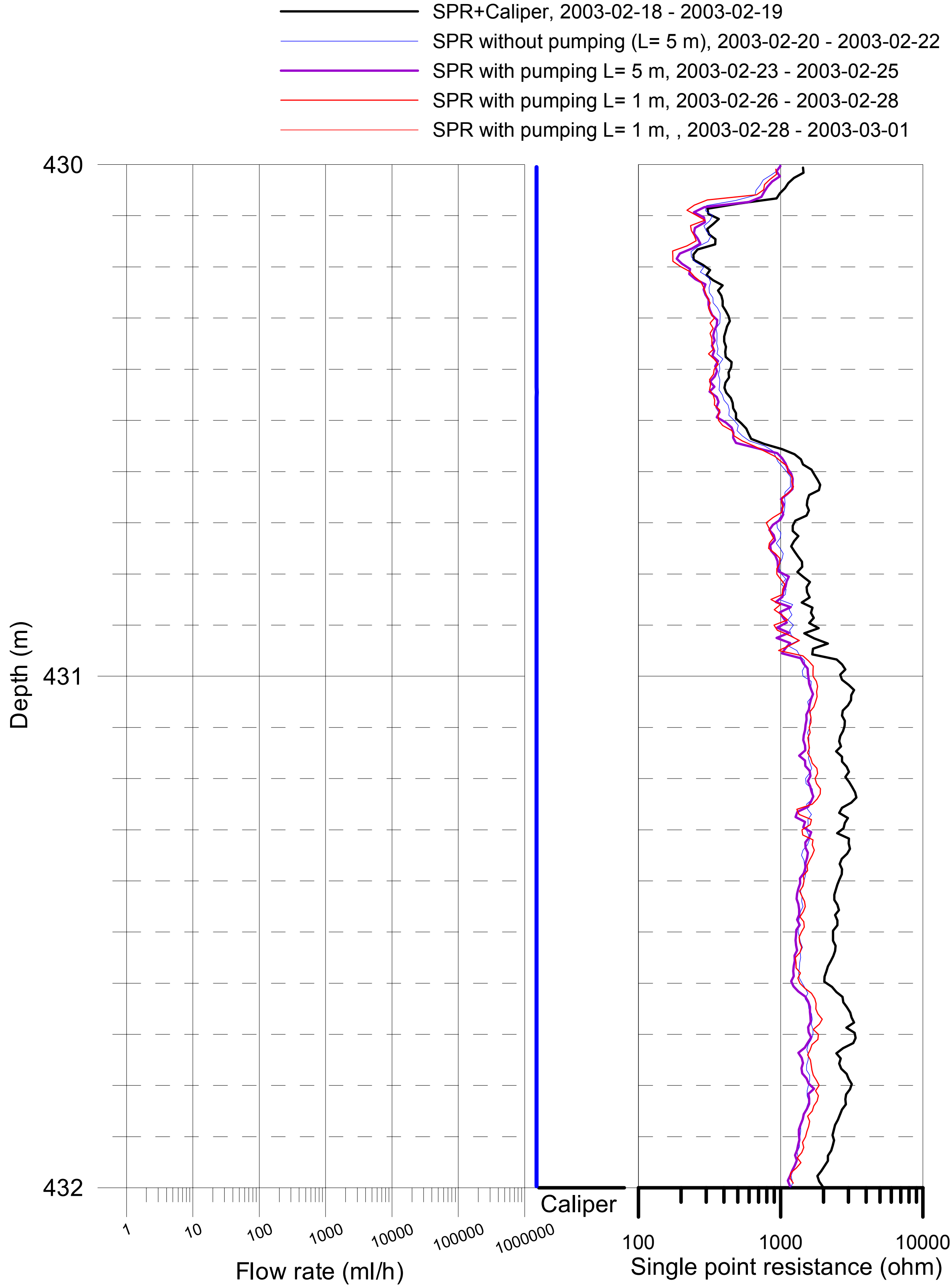

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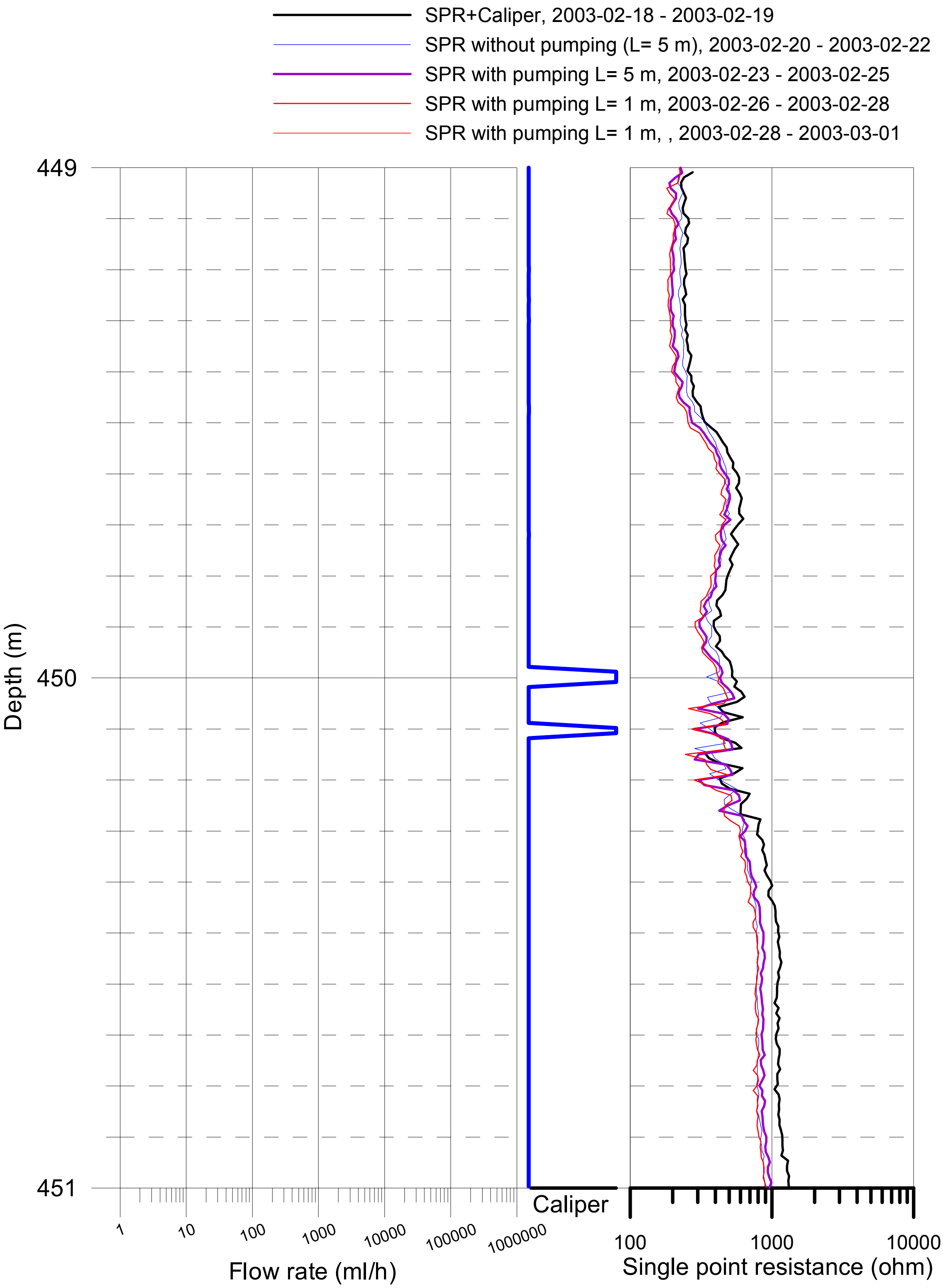
SPR and Caliper results after depth correction



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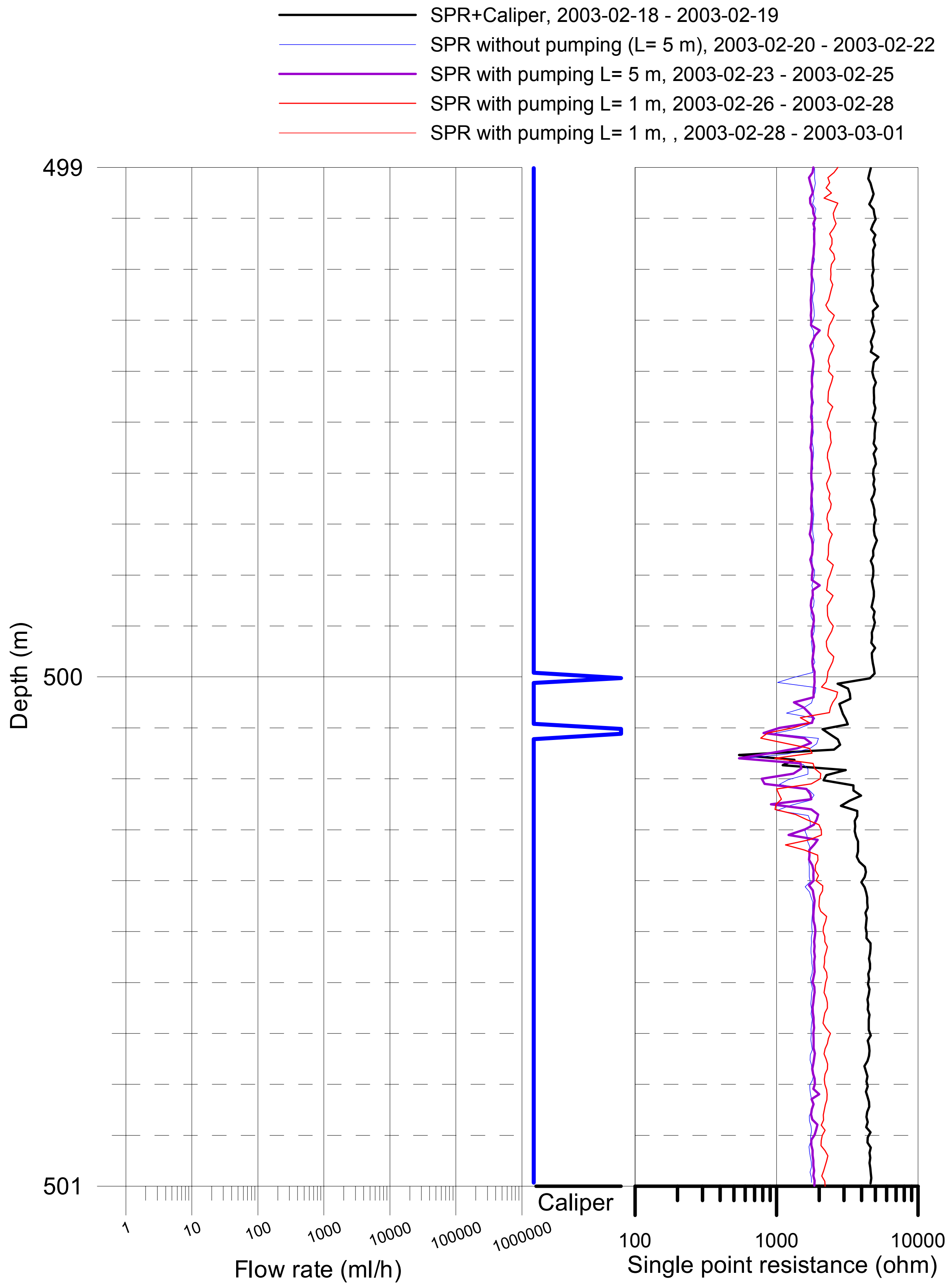

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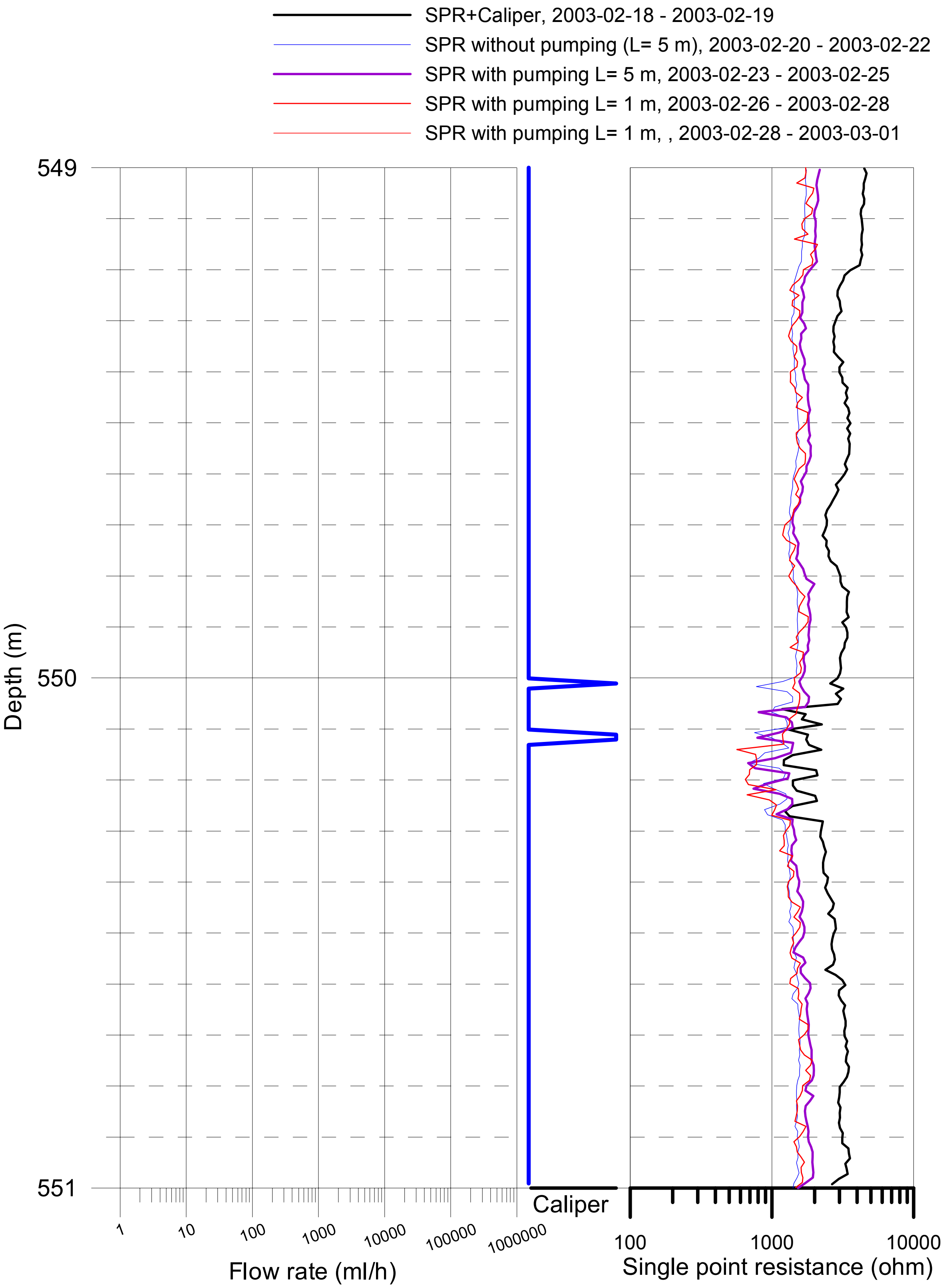

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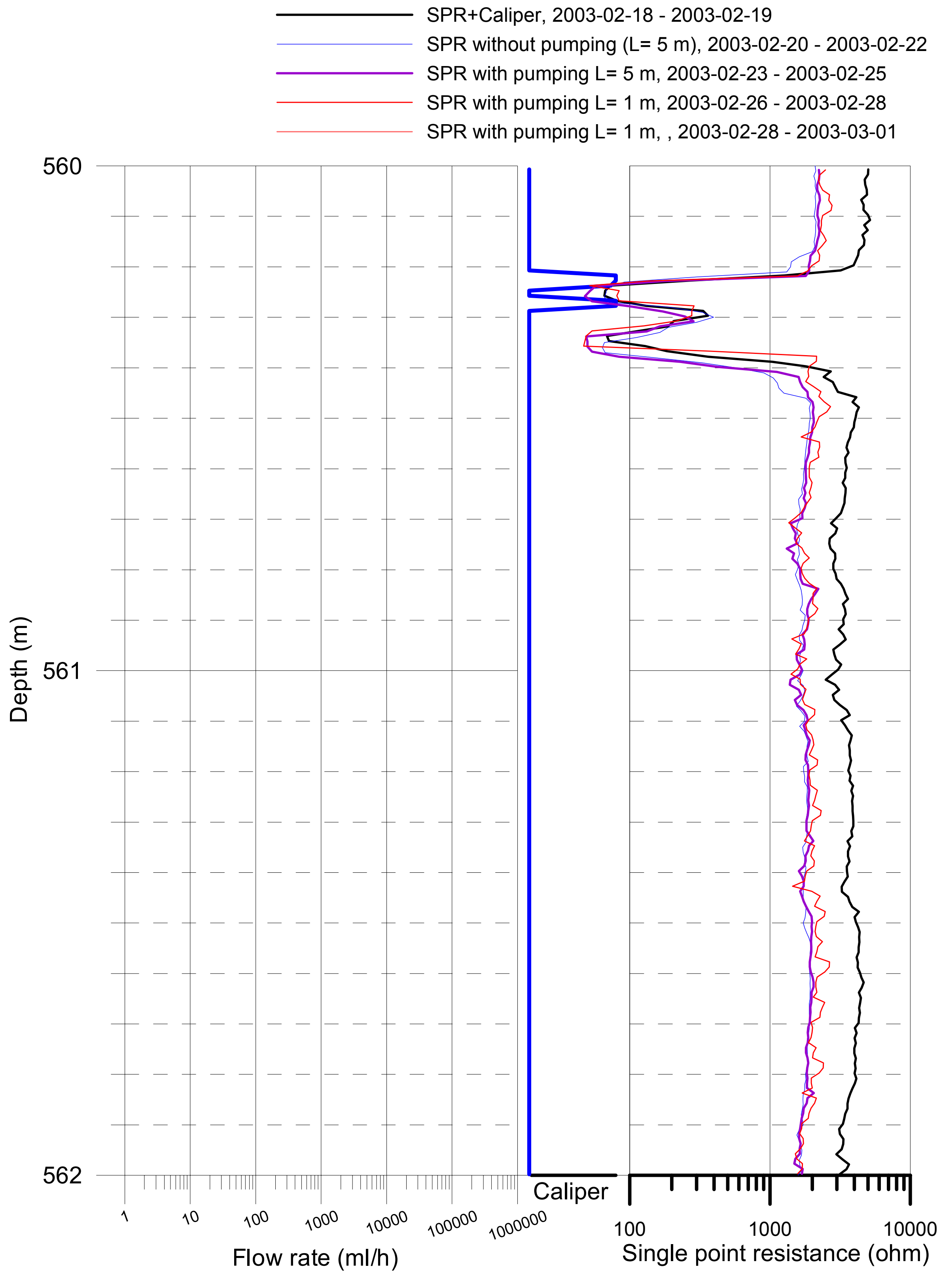

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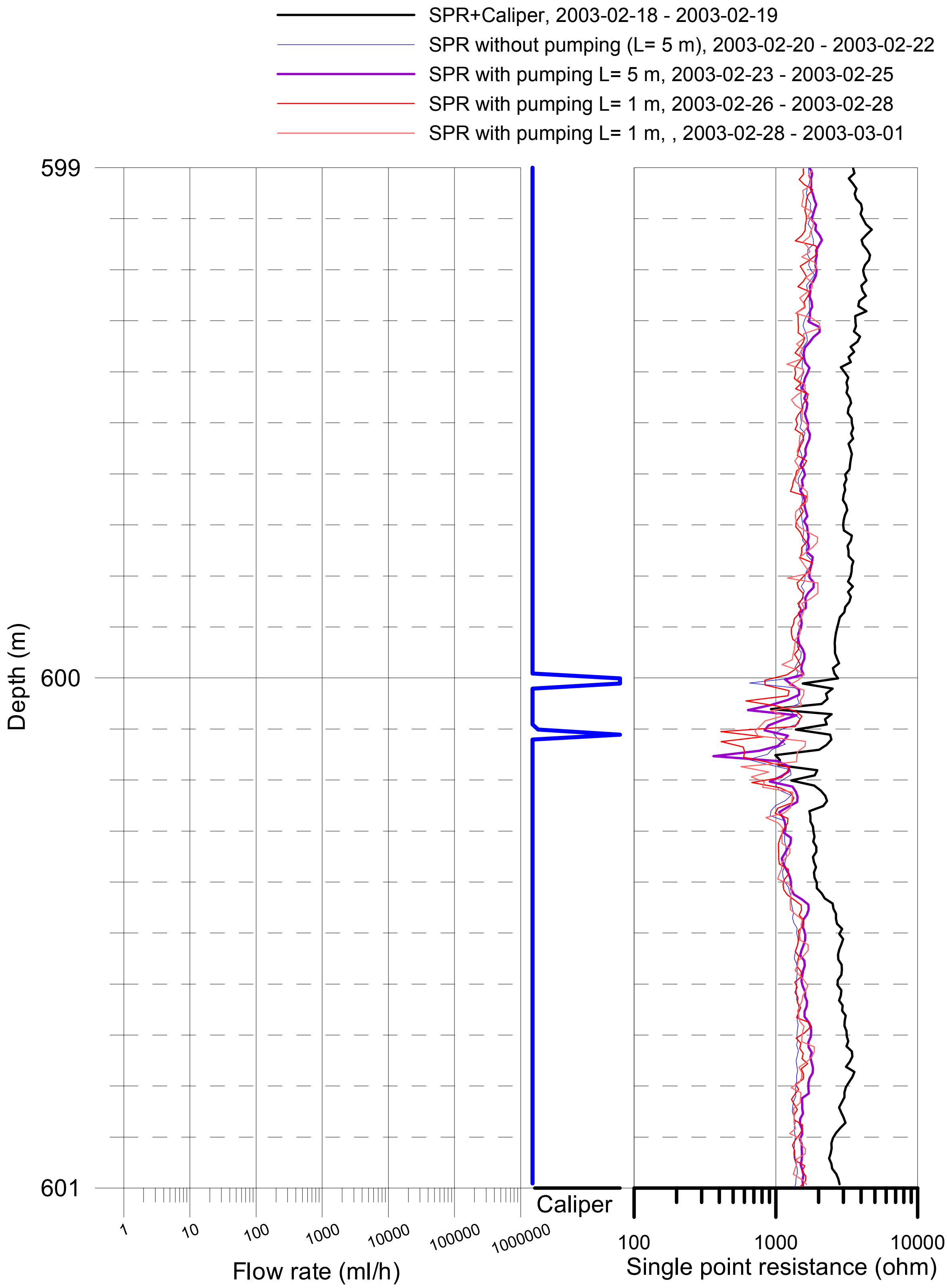

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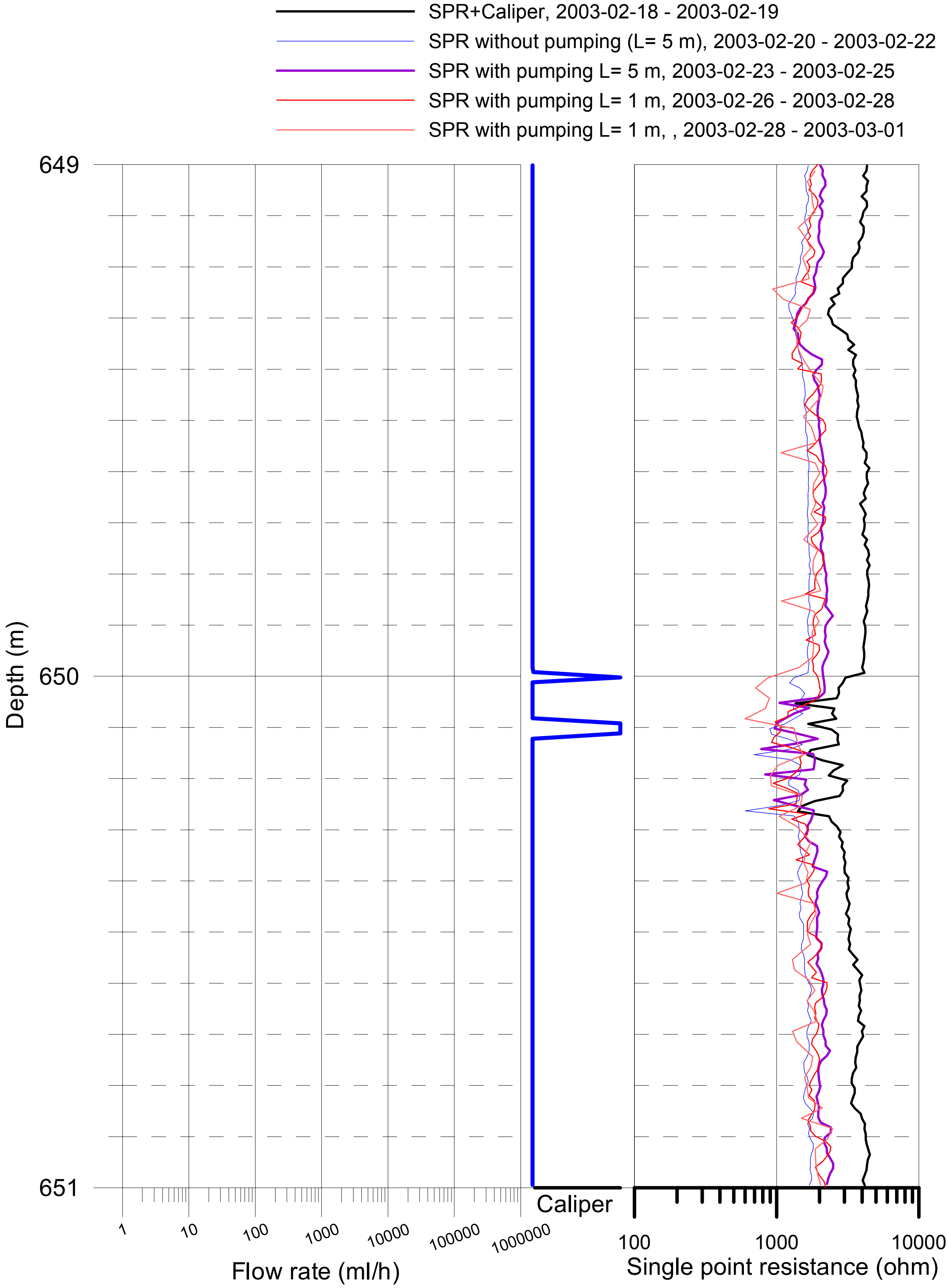

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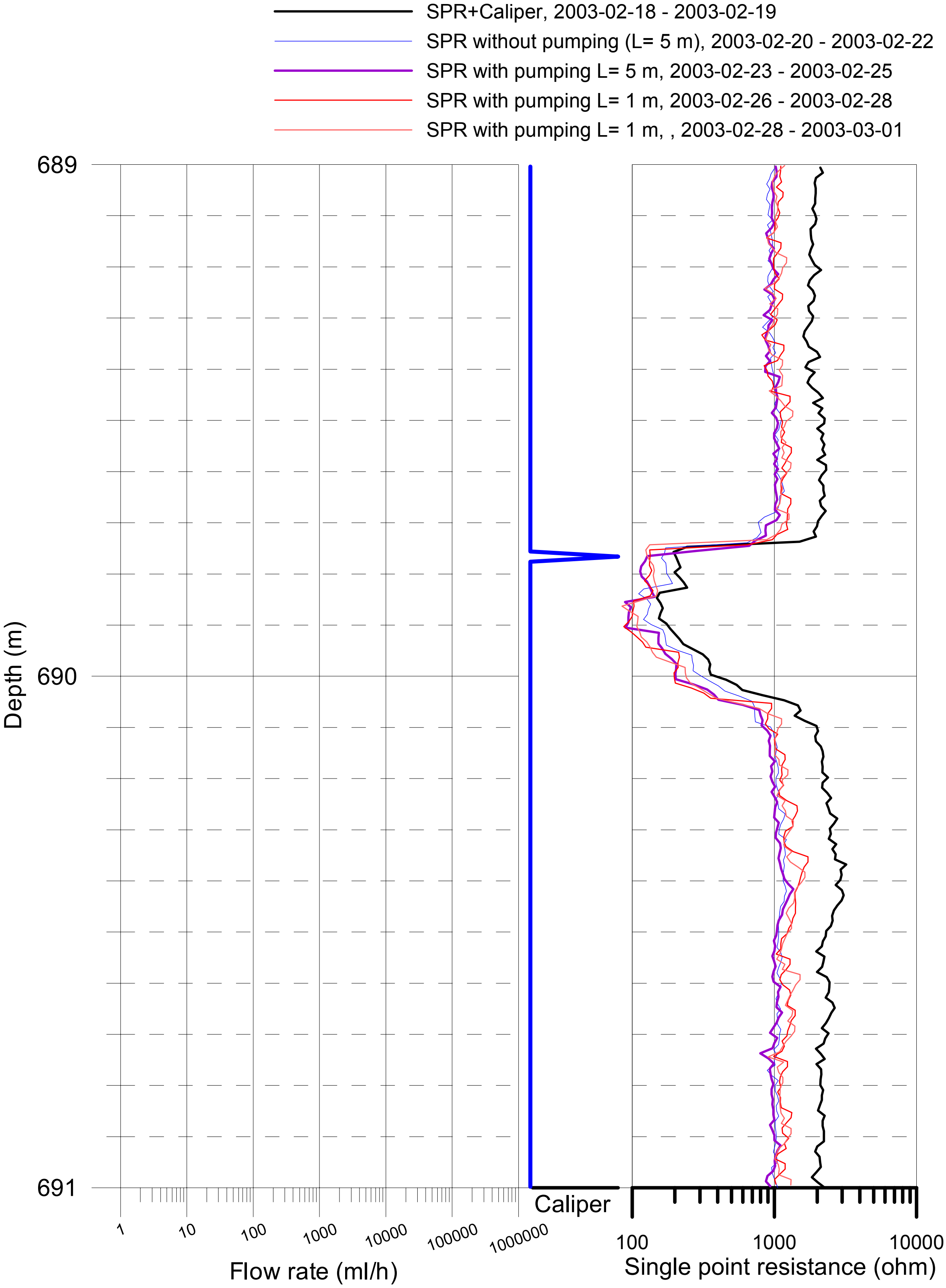

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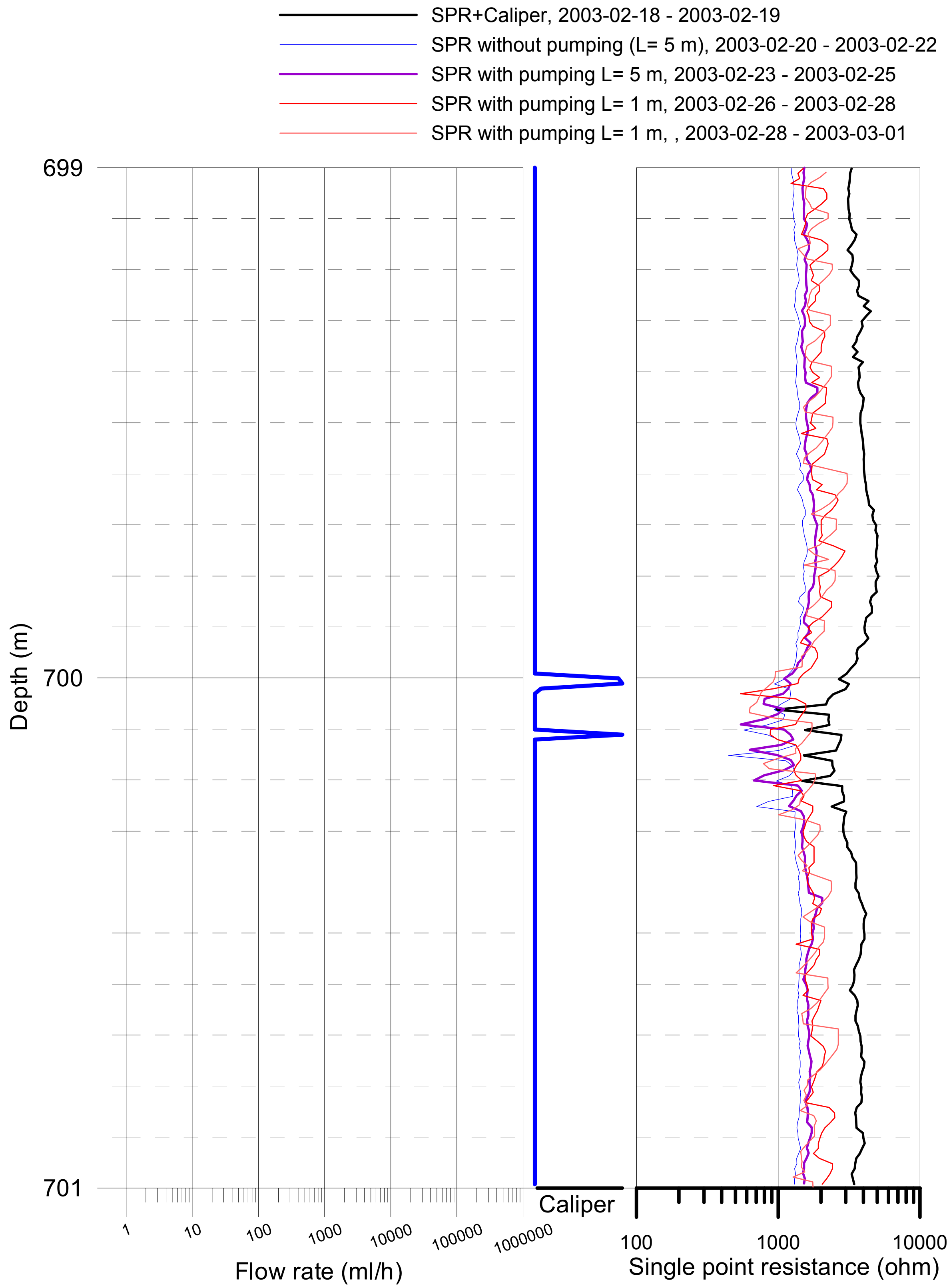

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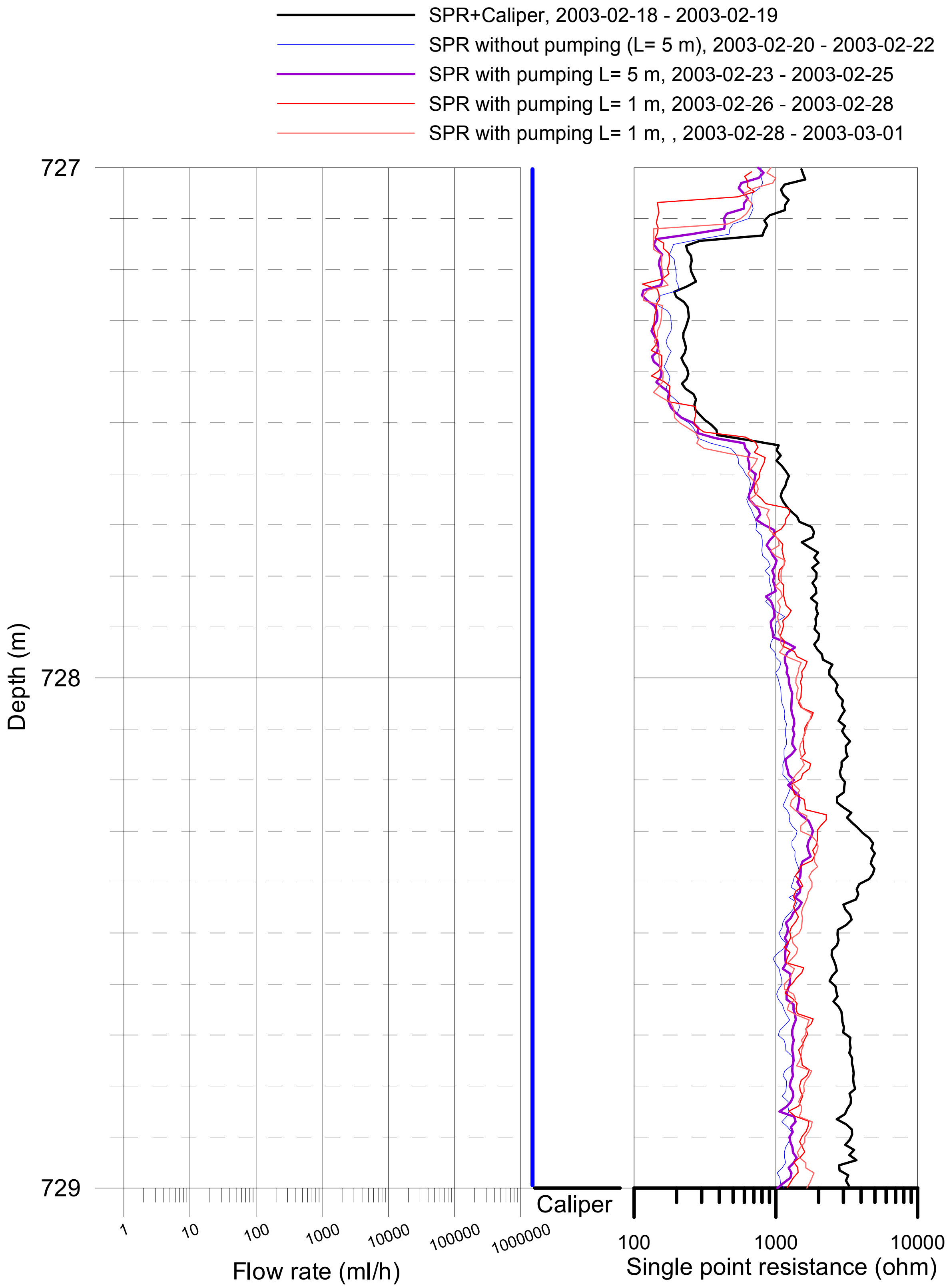

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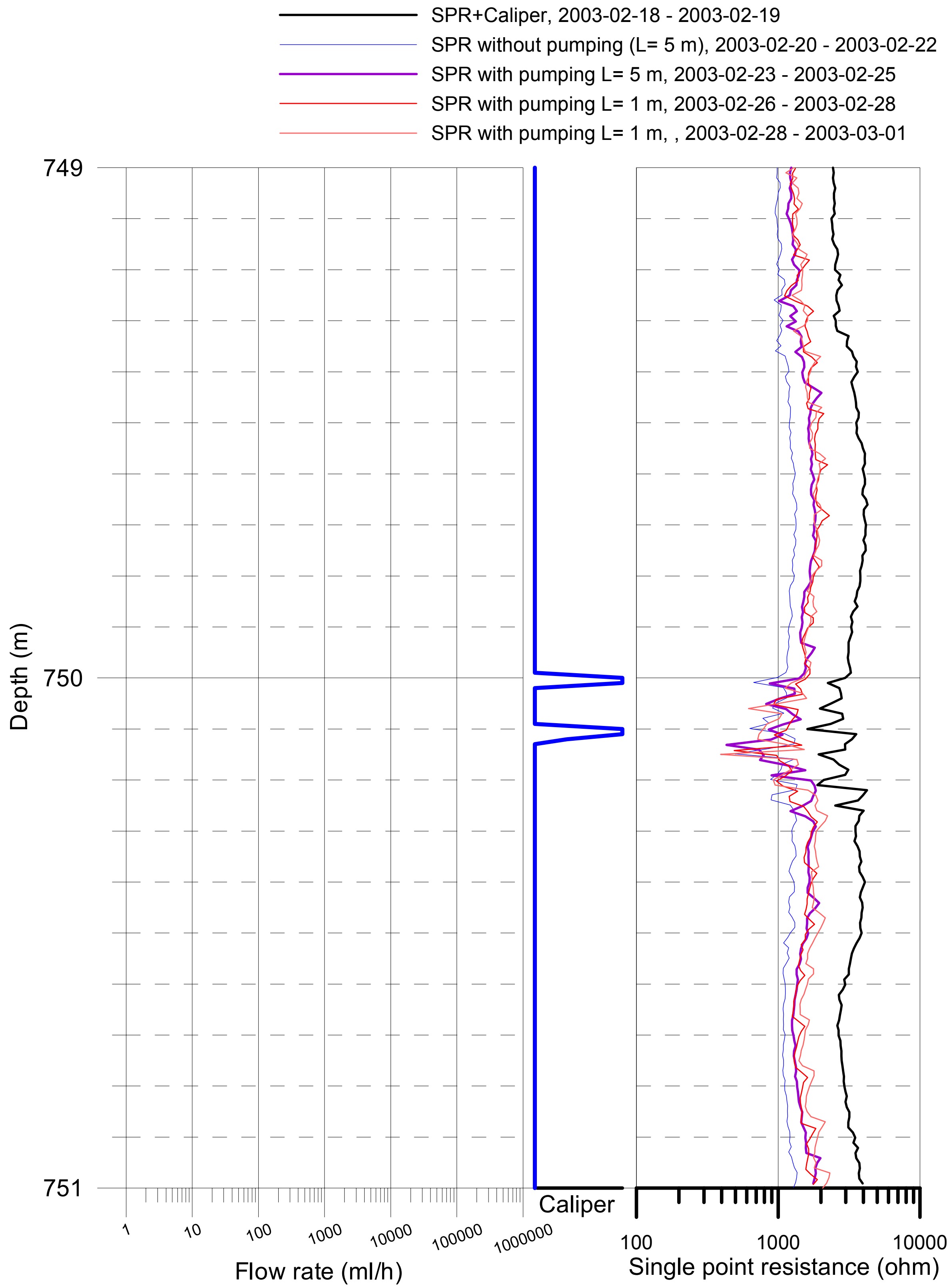

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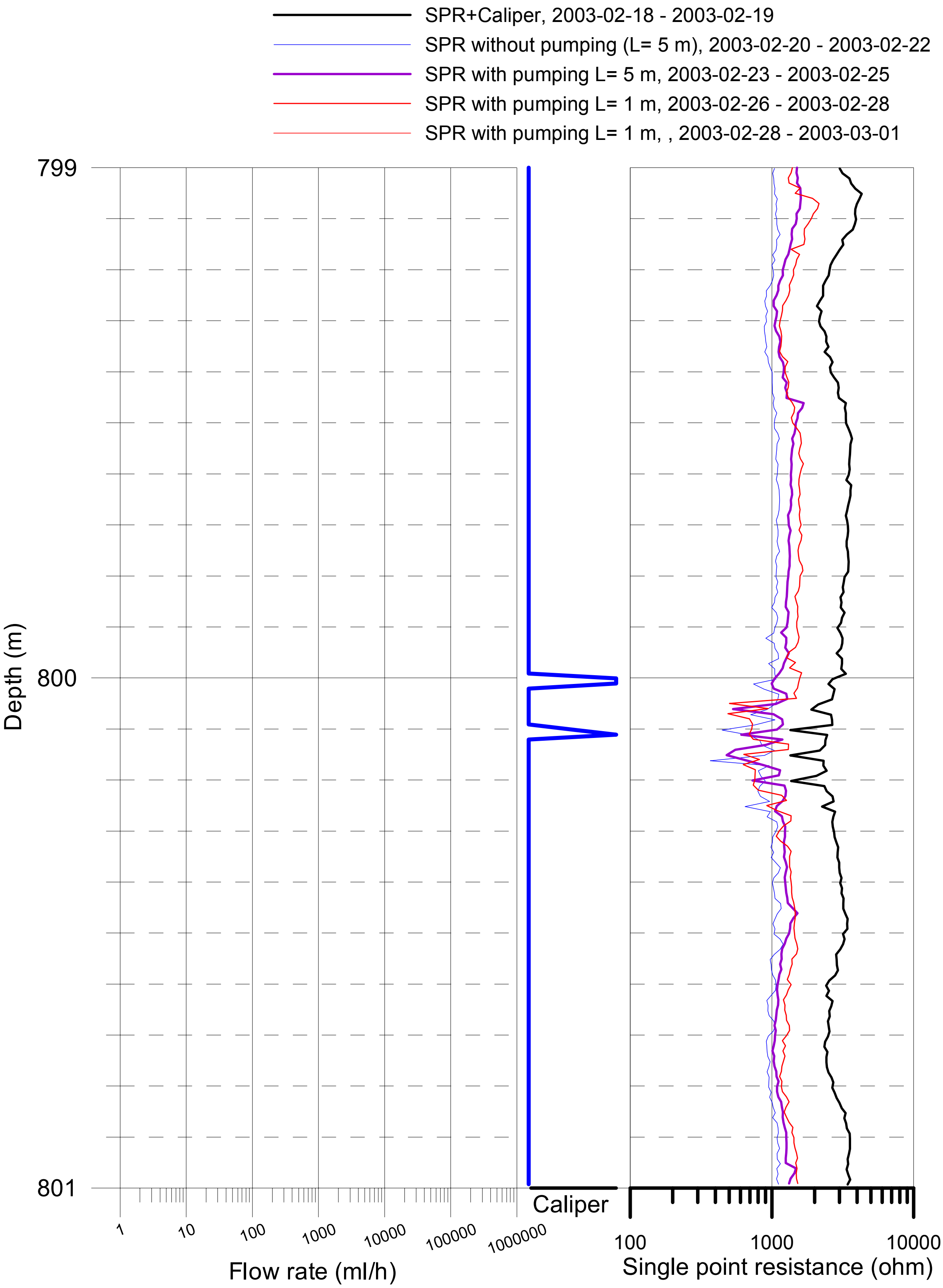

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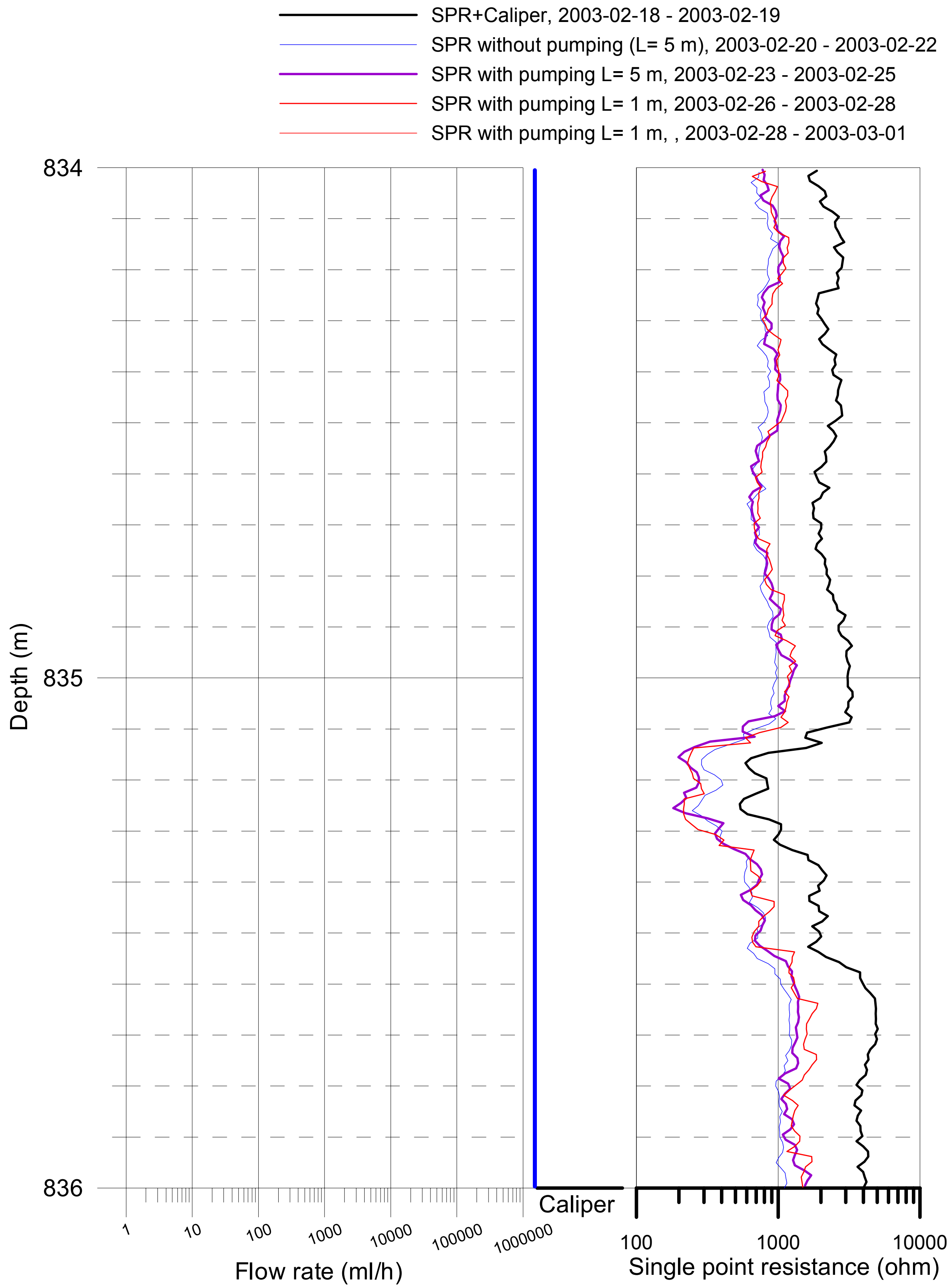
SPR and Caliper results after depth correction



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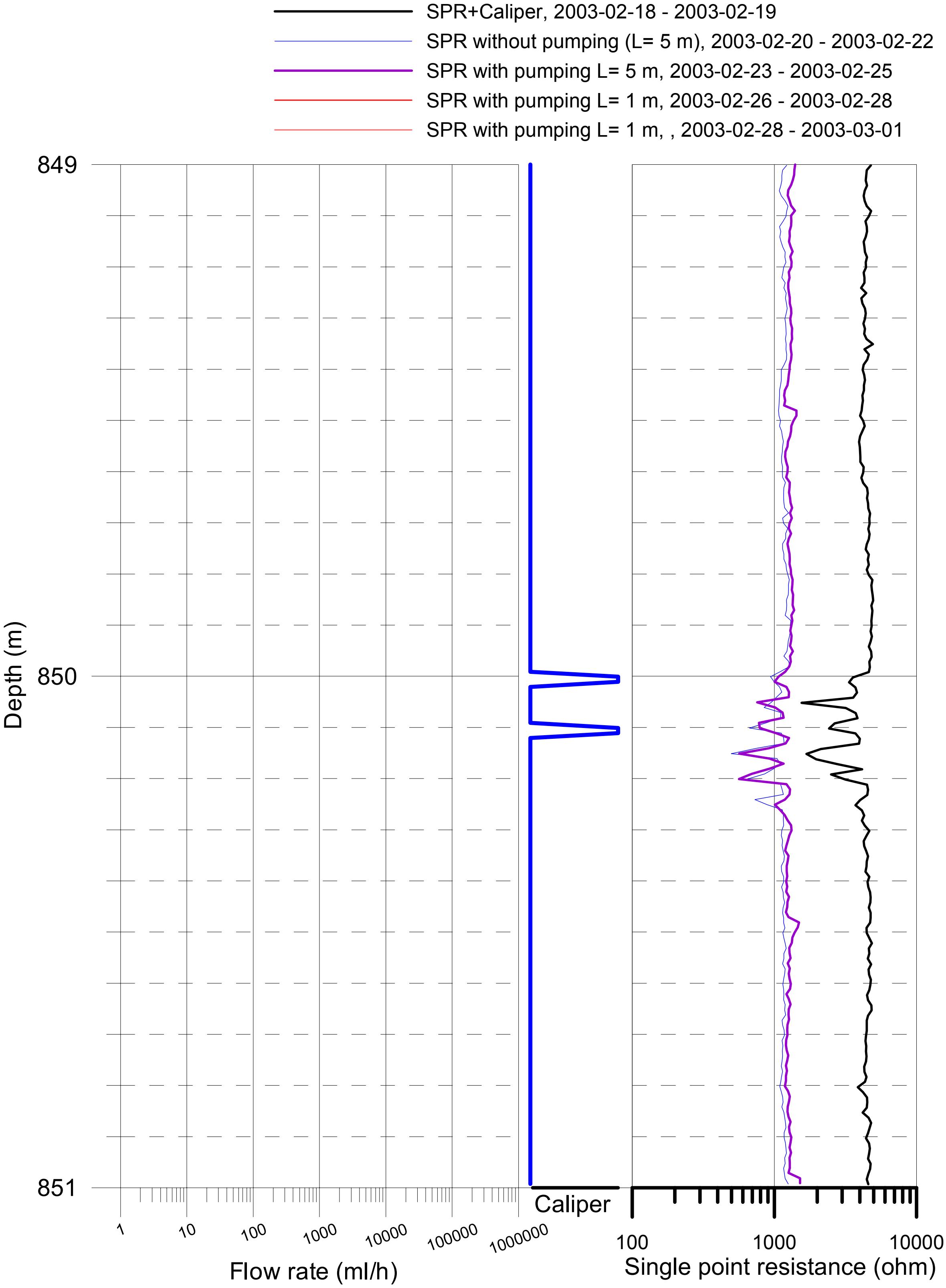

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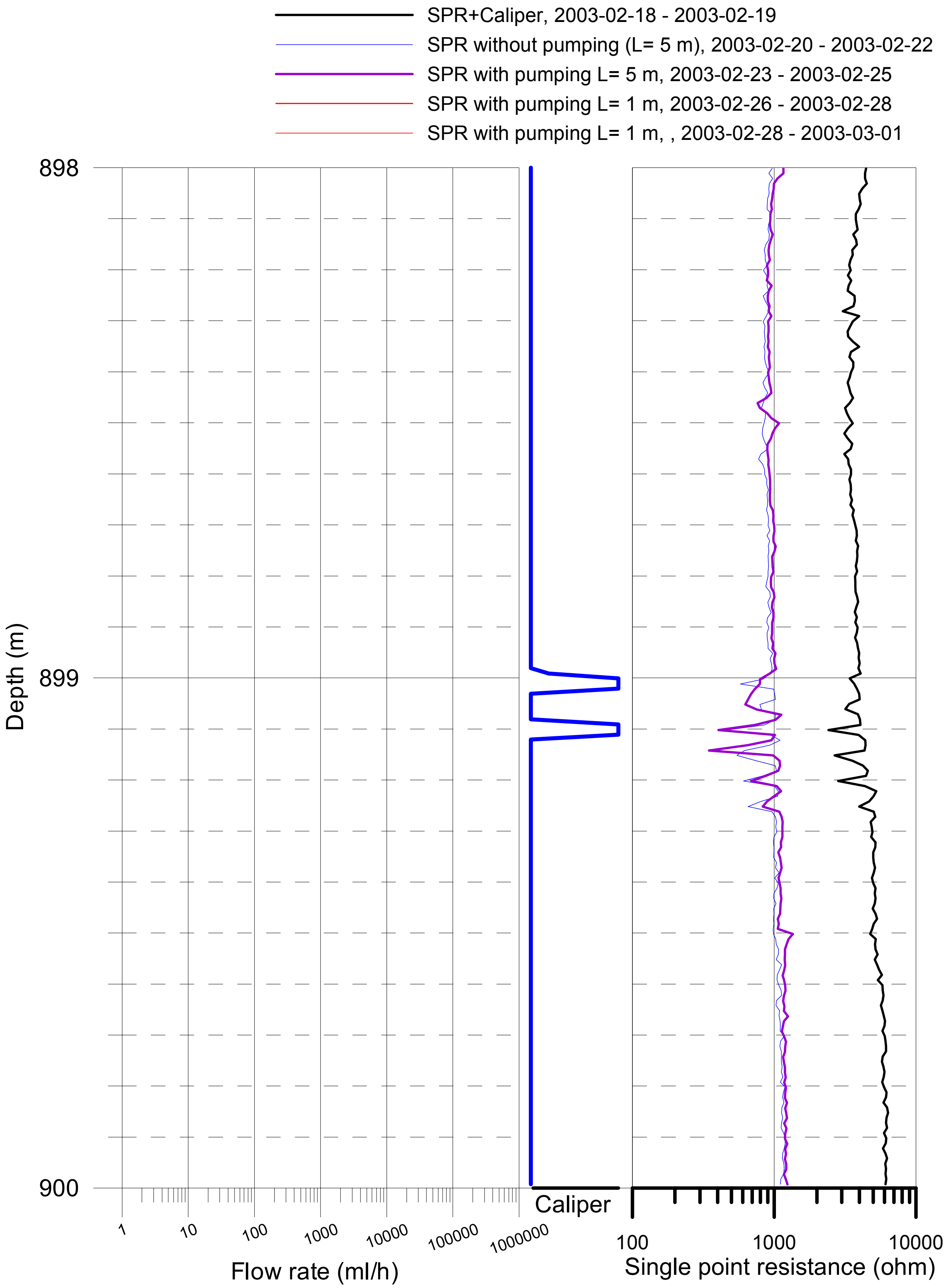
SPR and Caliper results after depth correction



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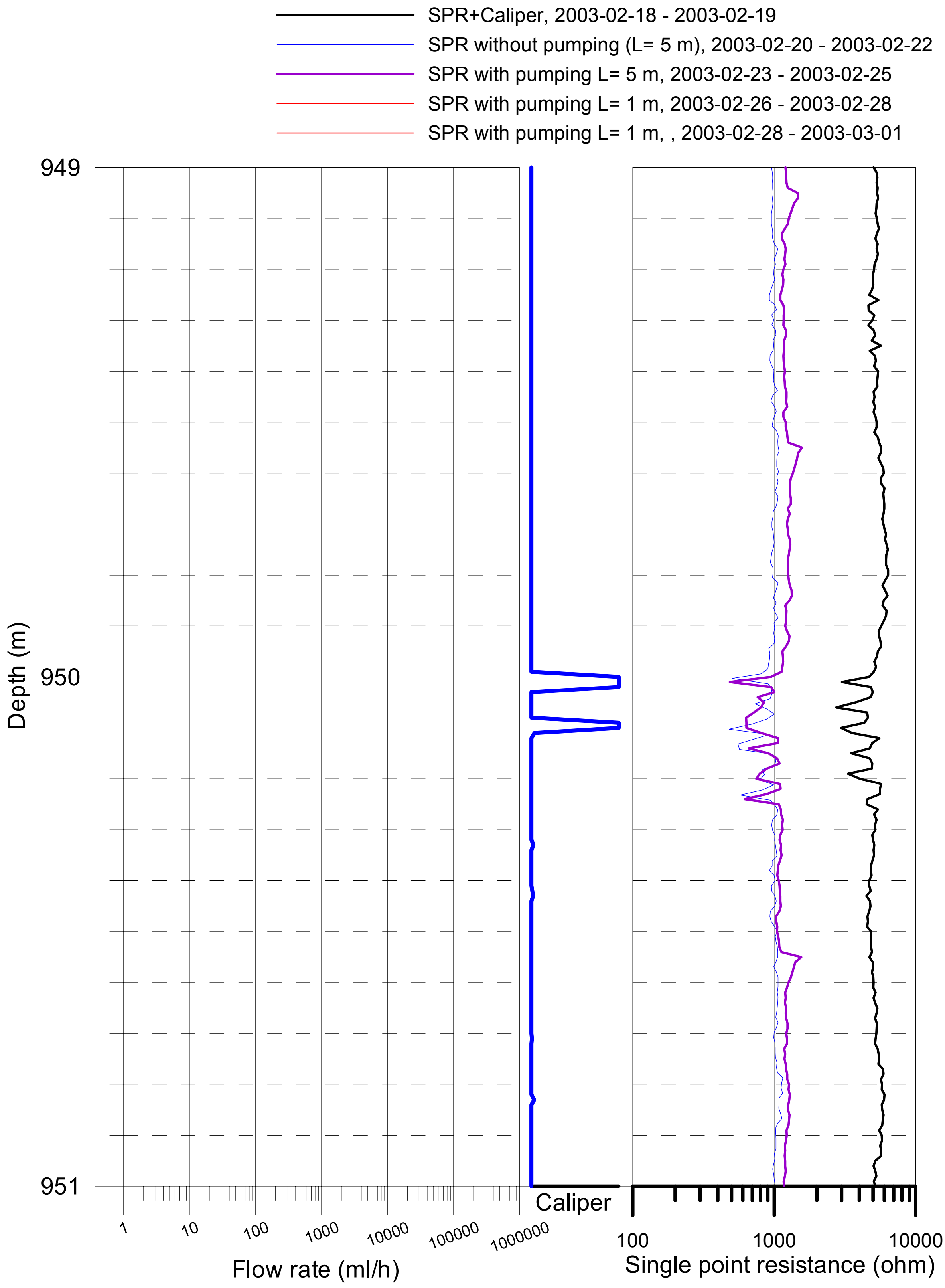
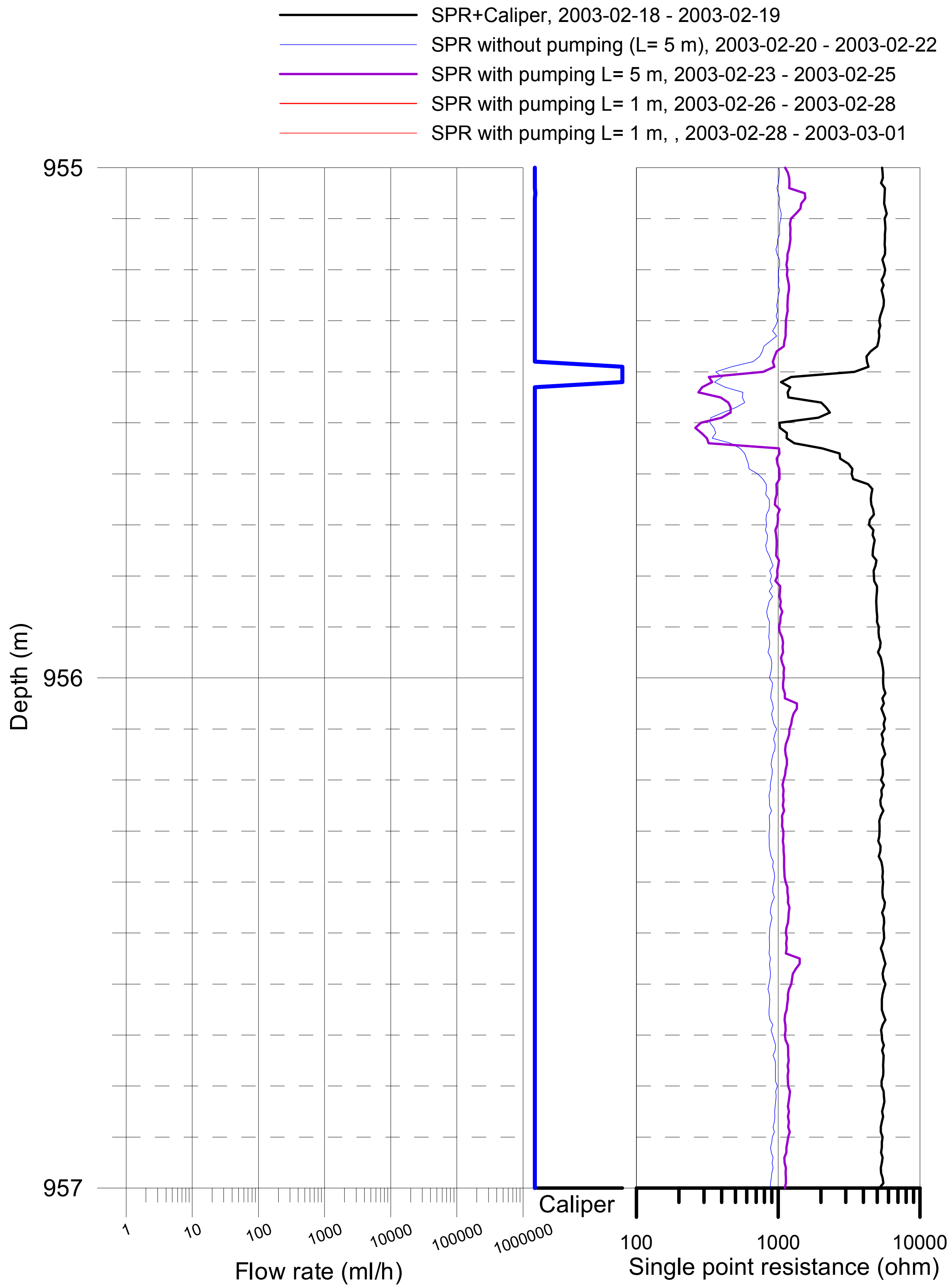
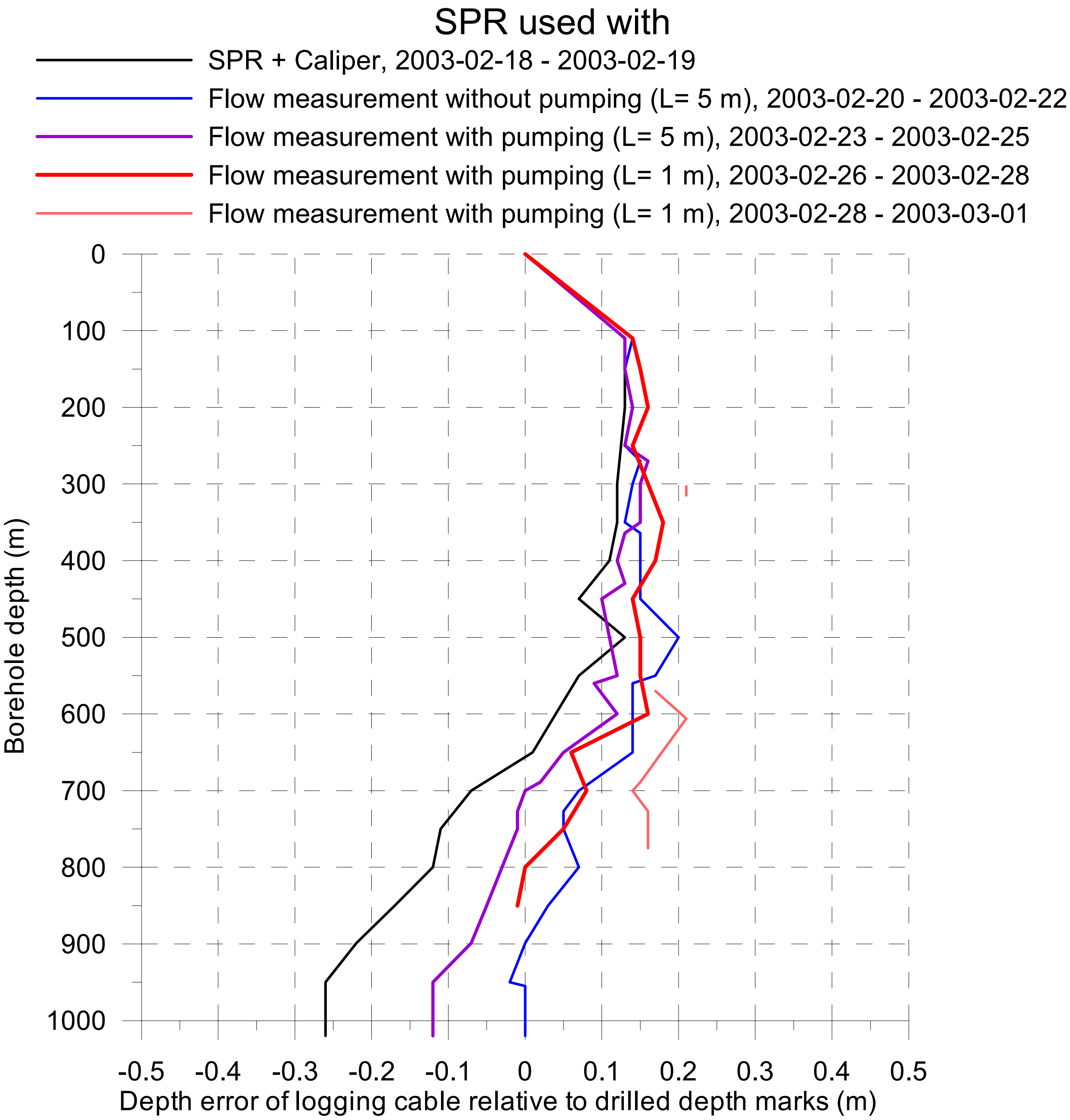
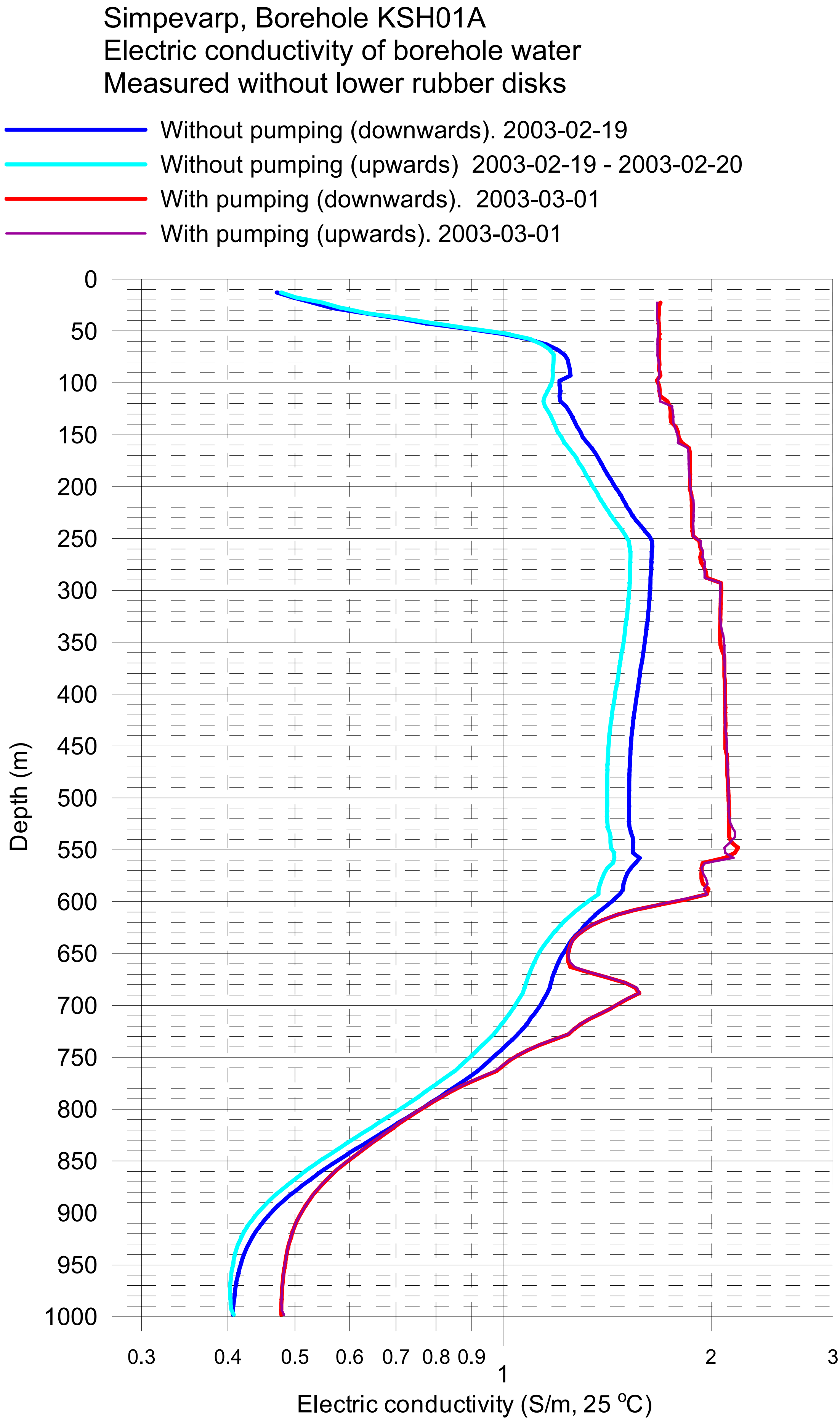
SPR and Caliper results after depth correction

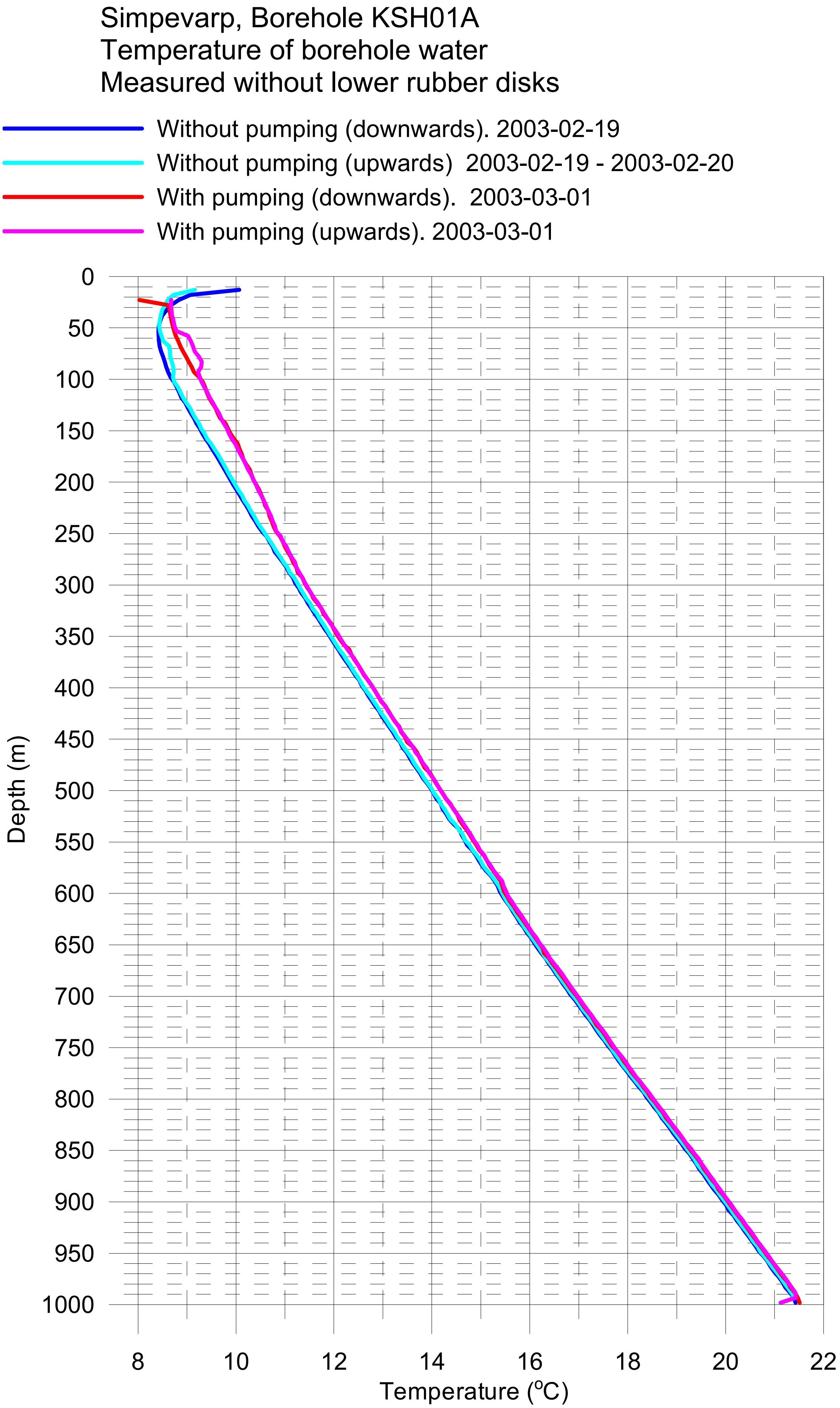


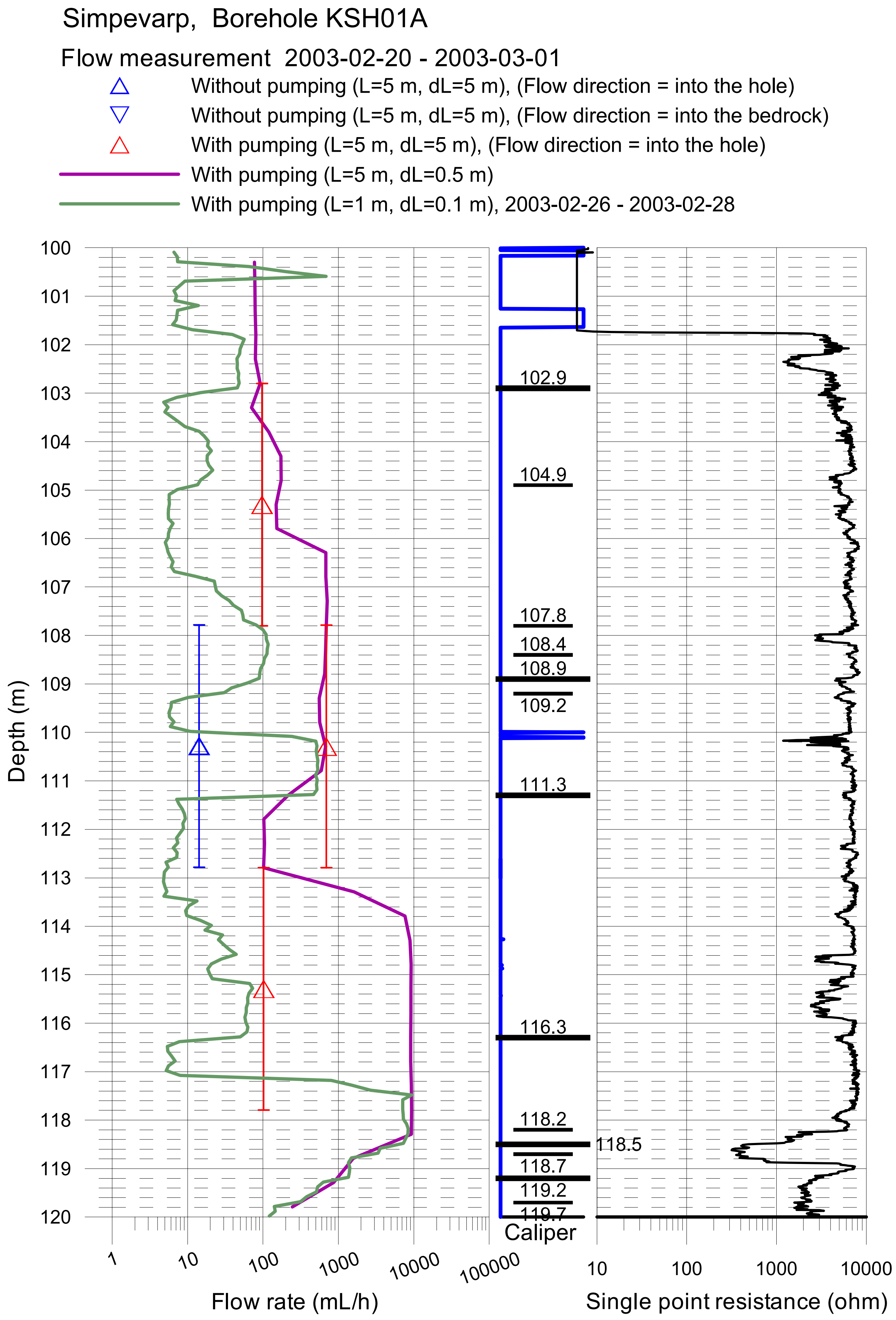
Simpevarp, KSH01A
SPR and Caliper results after depth correction



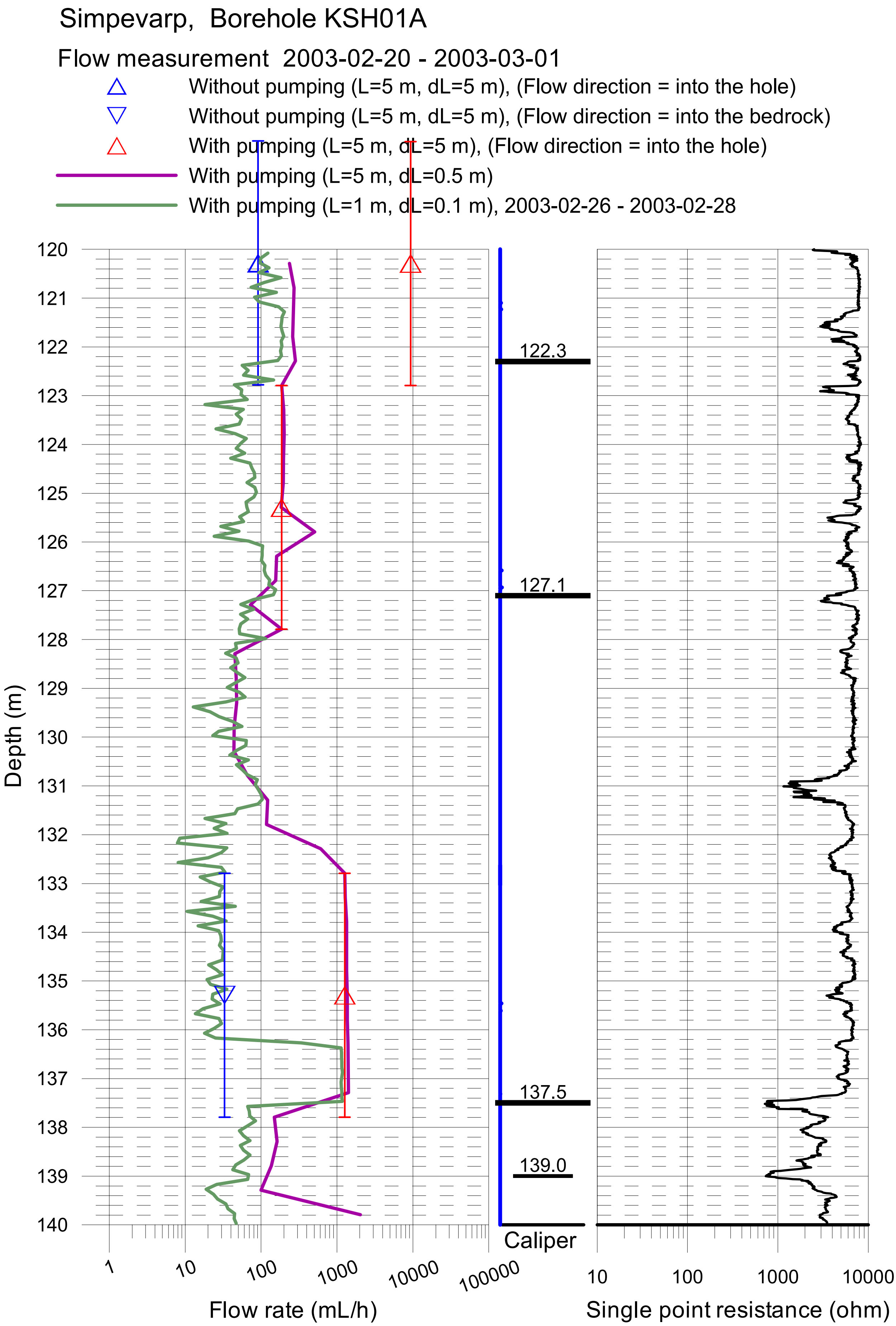

SPR used with
SPR + Caliper, 2003-02-18 - 2003-02-19
Flow measurement without pumping (L= 5 m), 2003-02-20 - 2003-02-22
Flow measurement with pumping (L= 5 m), 2003-02-23 - 2003-02-25
Flow measurement with pumping (L= 1 m), 2003-02-26 - 2003-02-28
Flow measurement with pumping (L= 1 m), 2003-02-28 - 2003-03-01
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 of logging cable relative to drilled depth marks (m)


Simpevarp, Borehole KSH01A
Electric conductivity of borehole water
Measured without lower rubber disks
Without pumping (downwards). 2003-02-19
Without pumping (upwards) 2003-02-19 - 2003-02-20
With pumping (downwards). 2003-03-01
With pumping (upwards). 2003-03-01
Depth (m)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2
3
Electric conductivity (S/m, 25 °C)

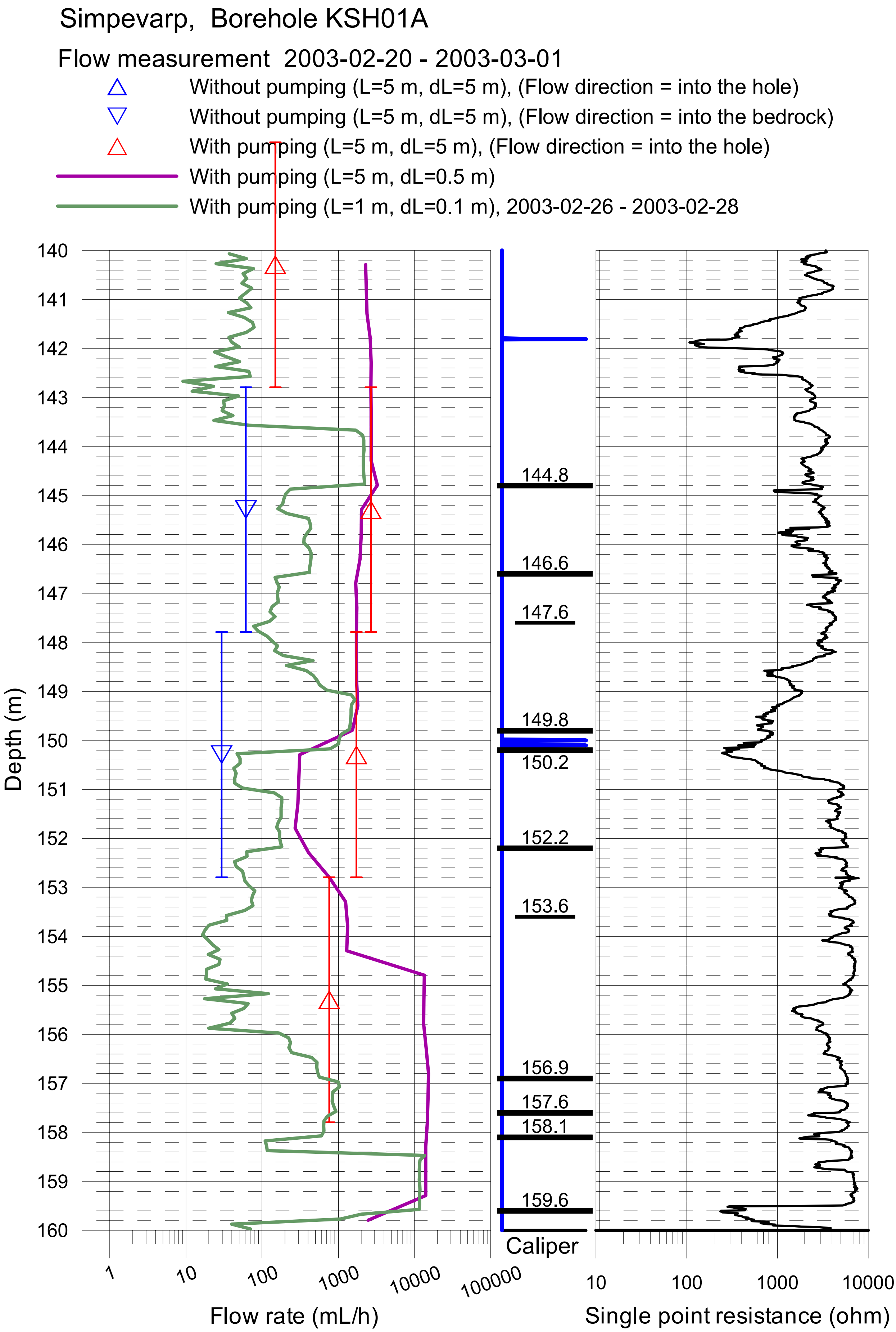

Simpevarp, Borehole KSH01A
Temperature of borehole water
Measured without lower rubber disks
Without pumping (downwards). 2003-02-19
Without pumping (upwards) 2003-02-19 - 2003-02-20
With pumping (downwards). 2003-03-01
With pumping (upwards). 2003-03-01
Depth (m)
Temperature (°C)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
8
10
12
14
16
18
20
22



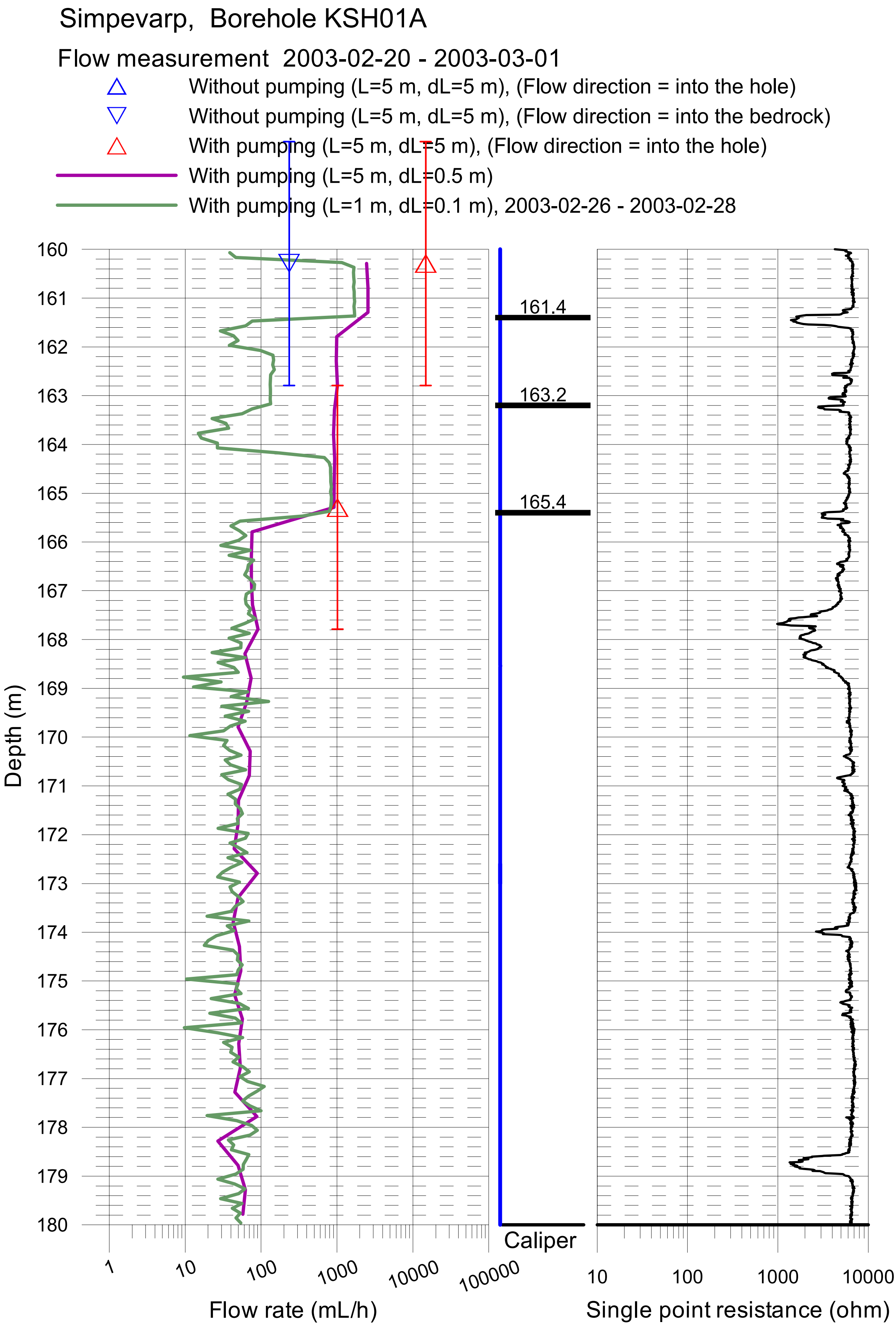
Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
Depth (m)
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
102.9
104.9
107.8
108.4
108.9
109.2
111.3
116.3
118.2
118.5
118.7
119.2
119.7
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

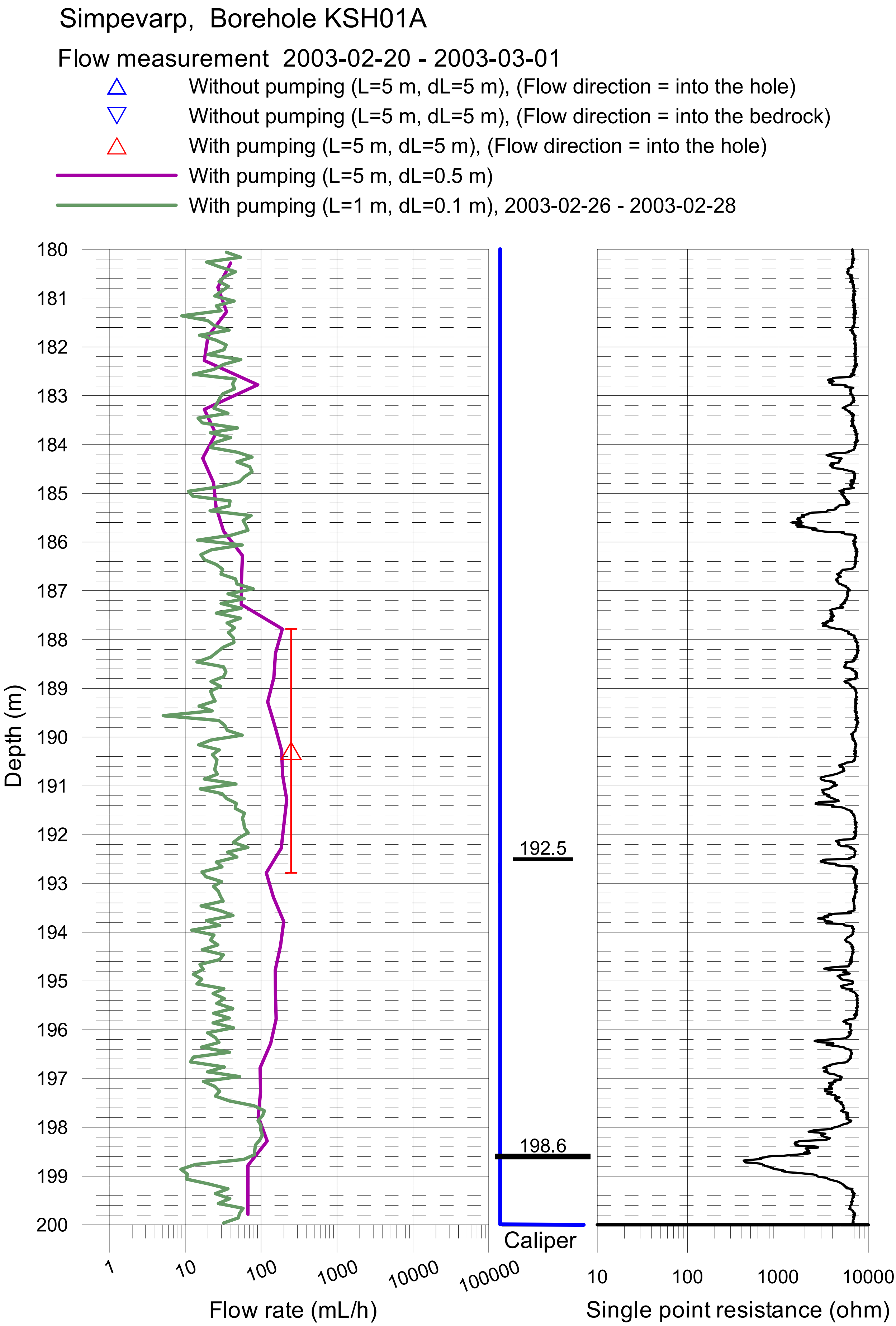


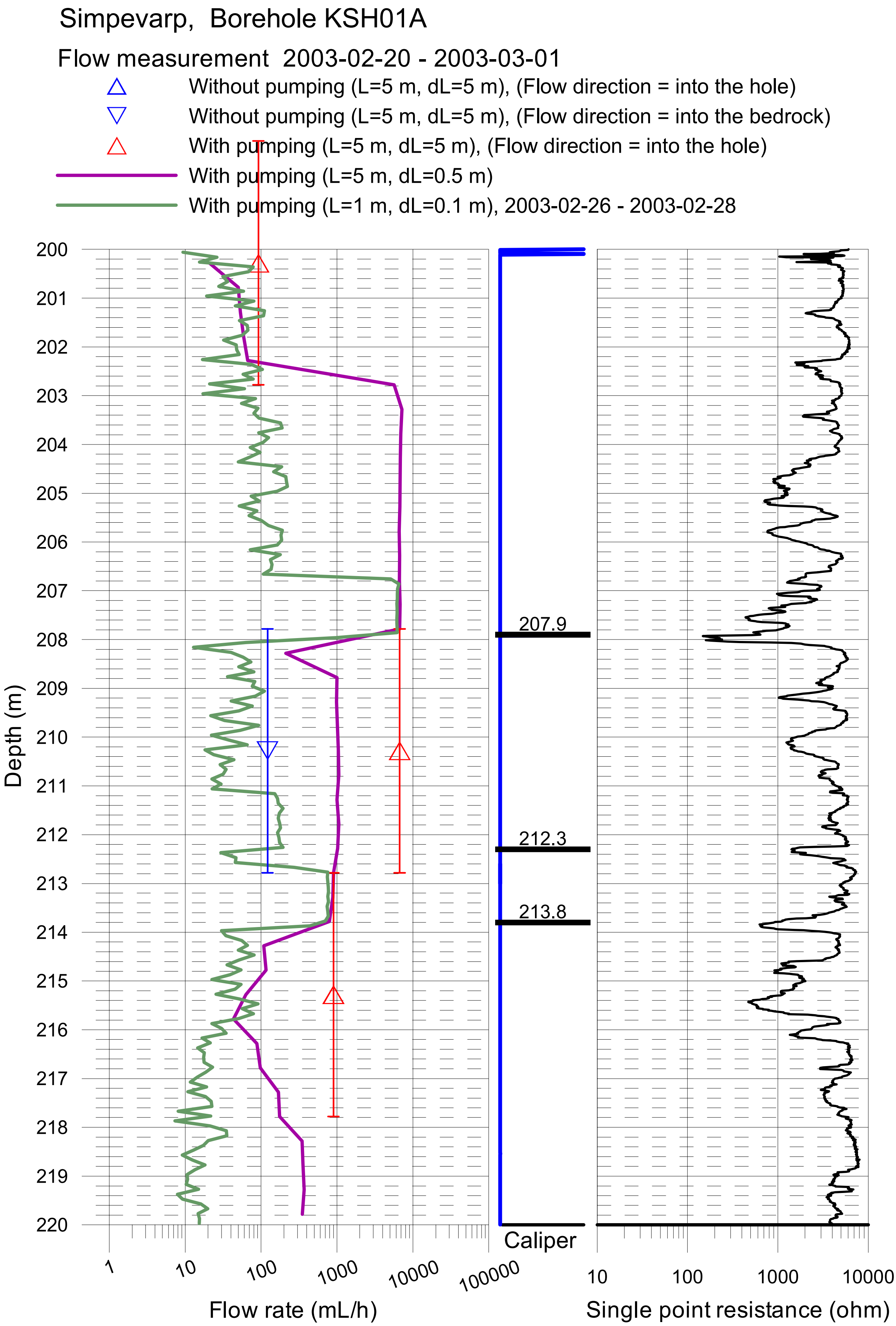
Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
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)
122.3
127.1
137.5
139.0
Caliper
10
100
1000
10000
Single point resistance (ohm)

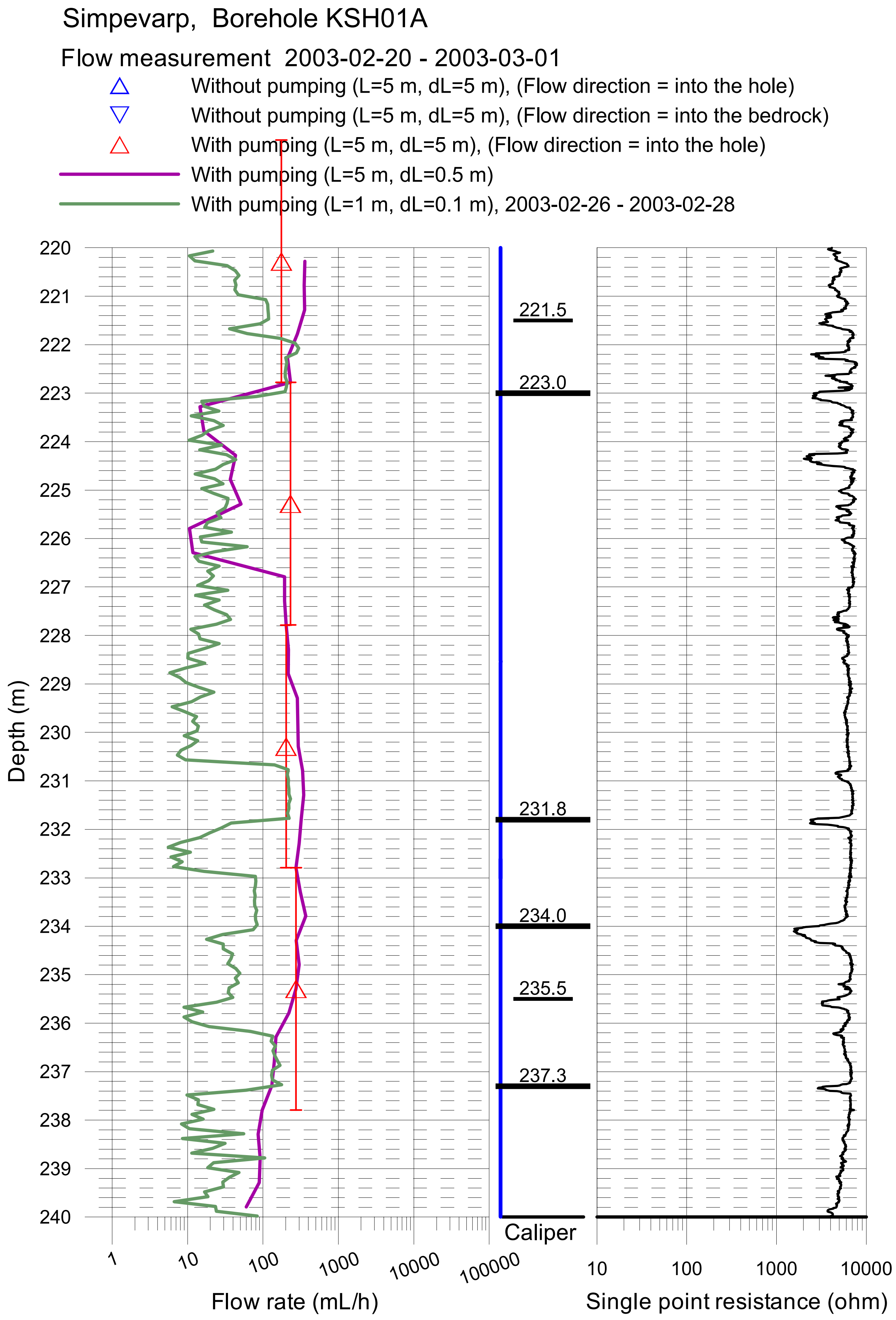


Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
Depth (m)
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
144.8
146.6
147.6
149.8
150.2
152.2
153.6
156.9
157.6
158.1
159.6
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

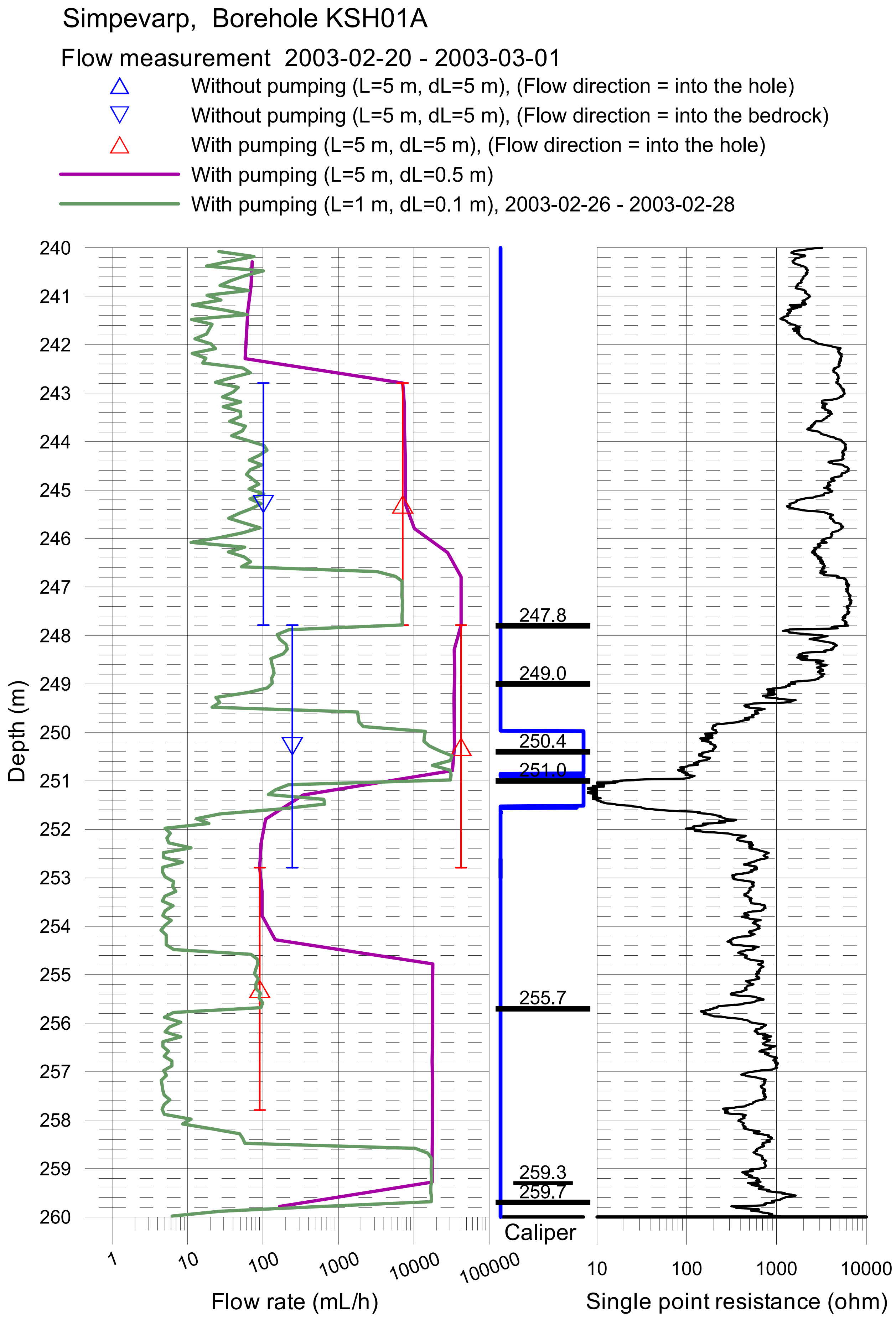

Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
Depth (m)
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
161.4
163.2
165.4
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

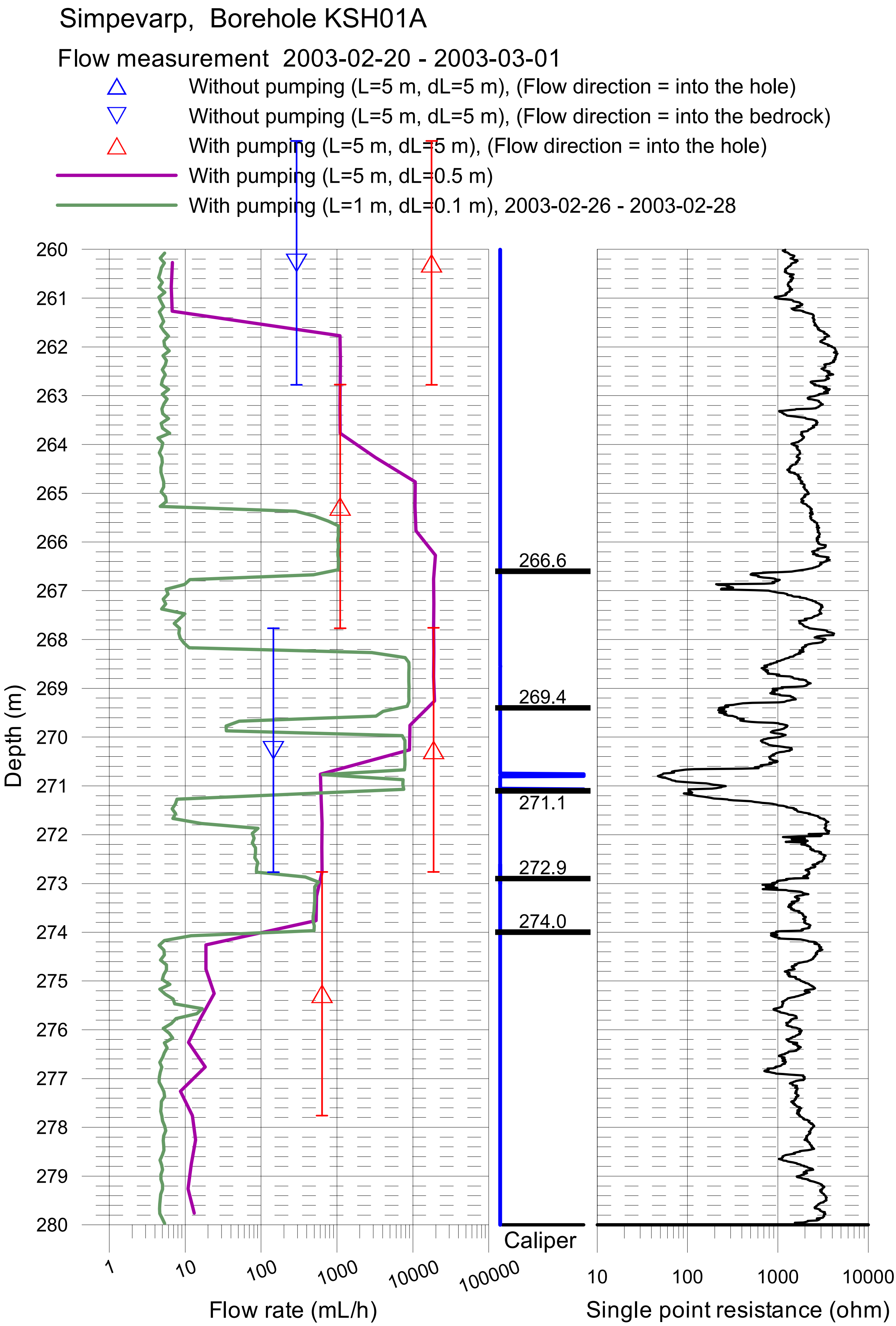

Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
Depth (m)
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
192.5
198.6
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

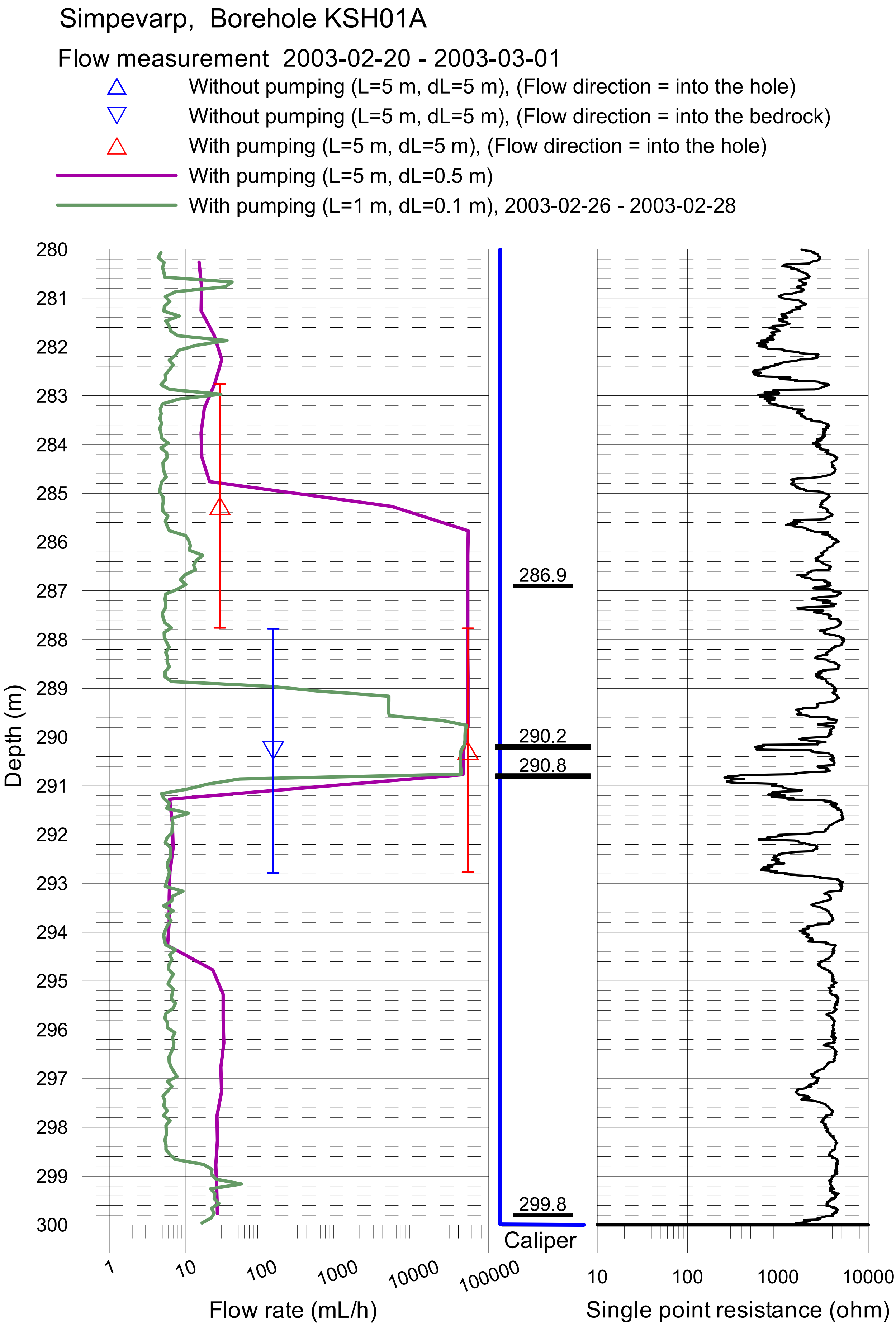

Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
Depth (m)
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
207.9
212.3
213.8
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

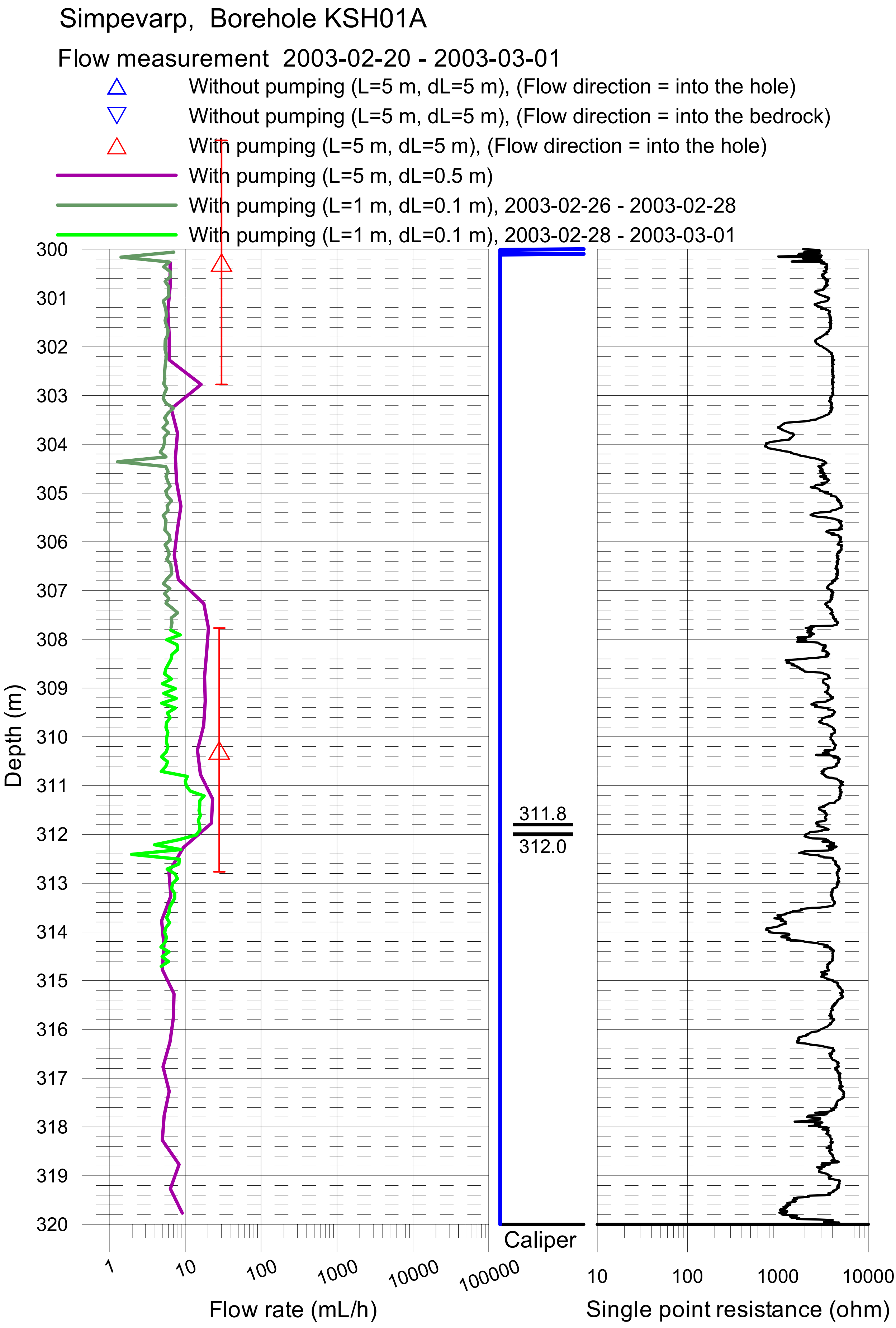


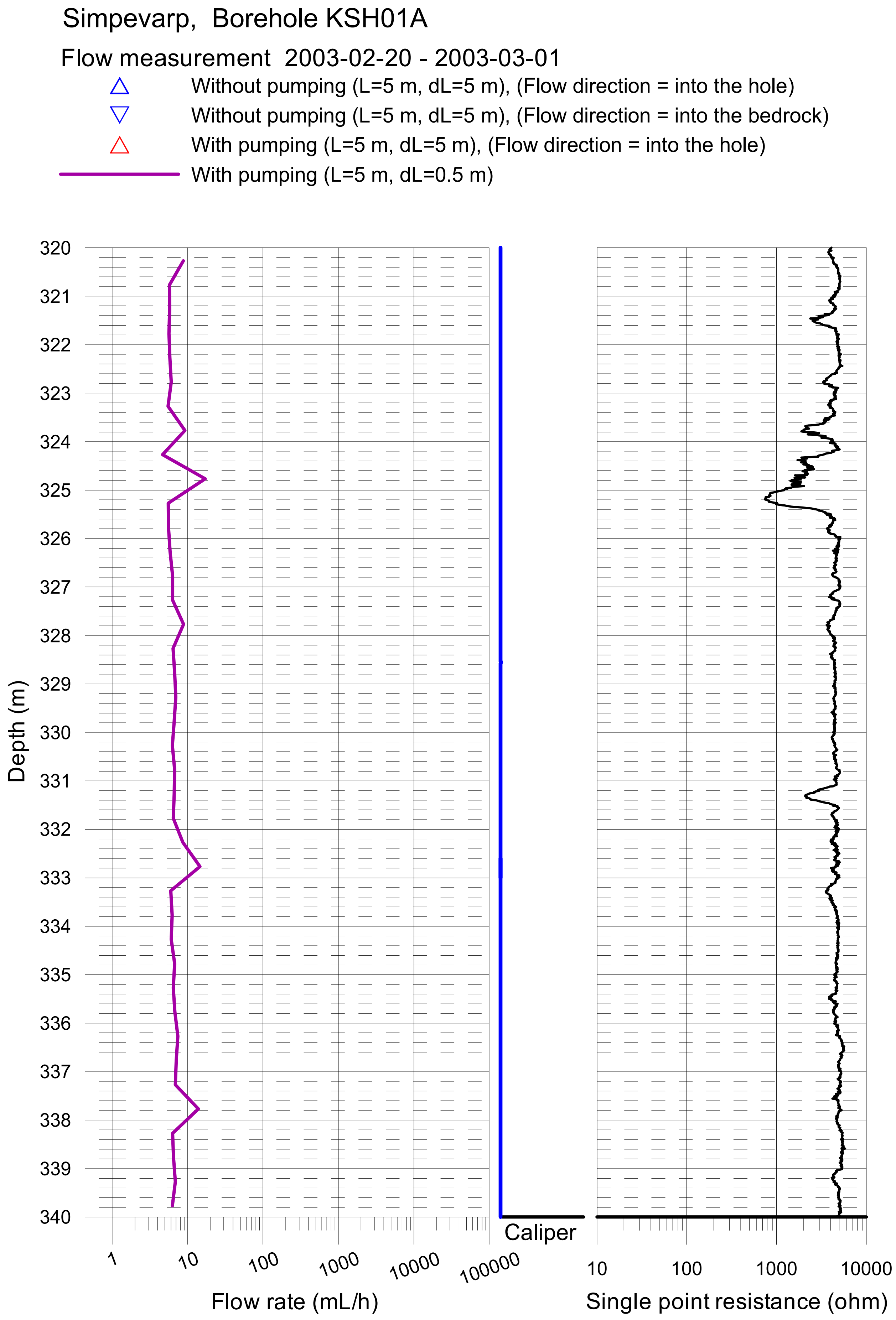
Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
Depth (m)
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
221.5
223.0
231.8
234.0
235.5
237.3
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)


Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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), 2003-02-26 - 2003-02-28
Depth (m)
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
247.8
249.0
250.4
251.0
255.7
259.3
259.7
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)


Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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), 2003-02-26 - 2003-02-28
Depth (m)
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
266.6
269.4
271.1
272.9
274.0
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

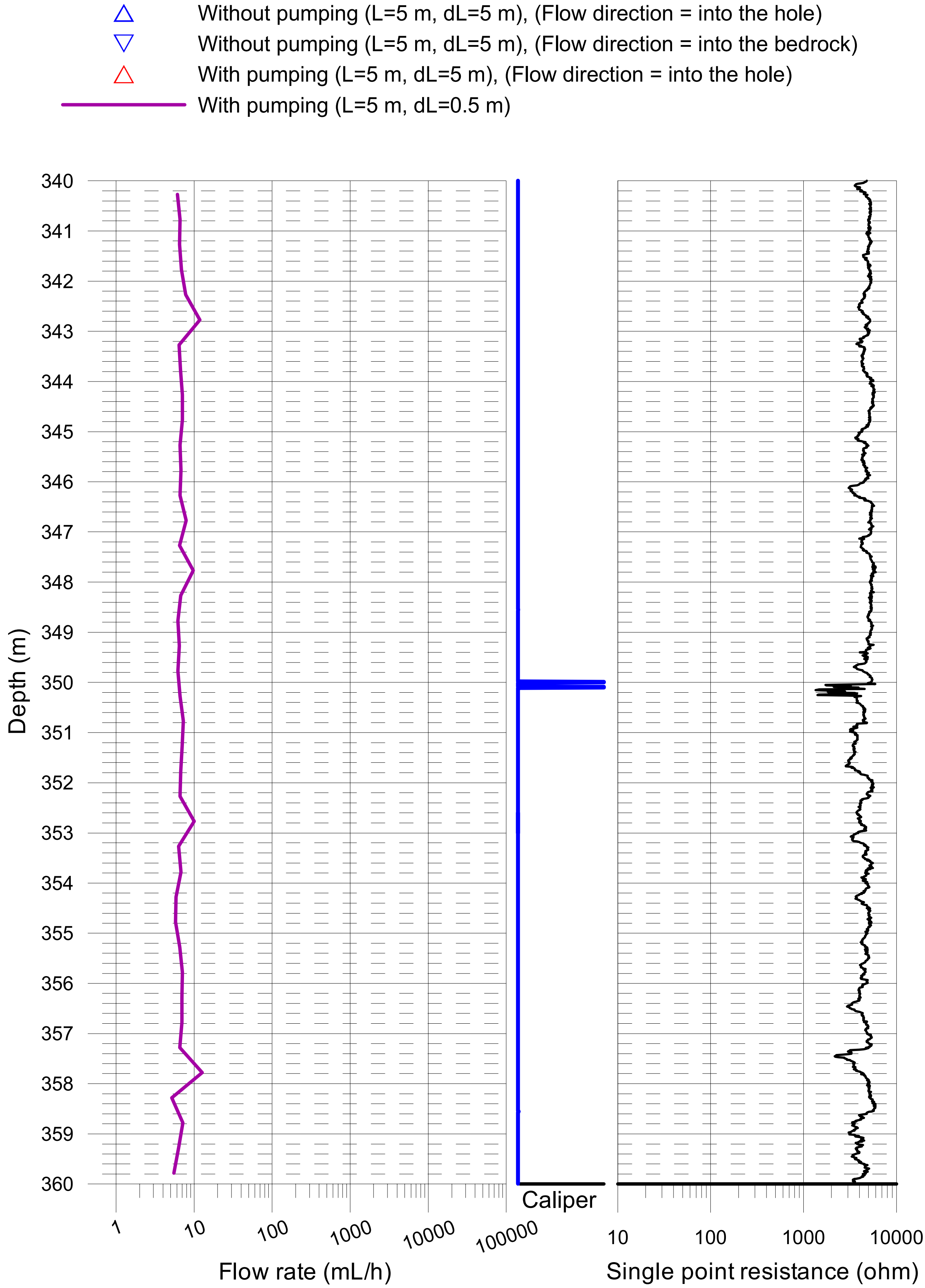

Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
Depth (m)
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
286.9
290.2
290.8
299.8
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)


Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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), 2003-02-26 - 2003-02-28
With pumping (L=1 m, dL=0.1 m), 2003-02-28 - 2003-03-01
Depth (m)
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
311.8
312.0
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)


Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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)
Depth (m)
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

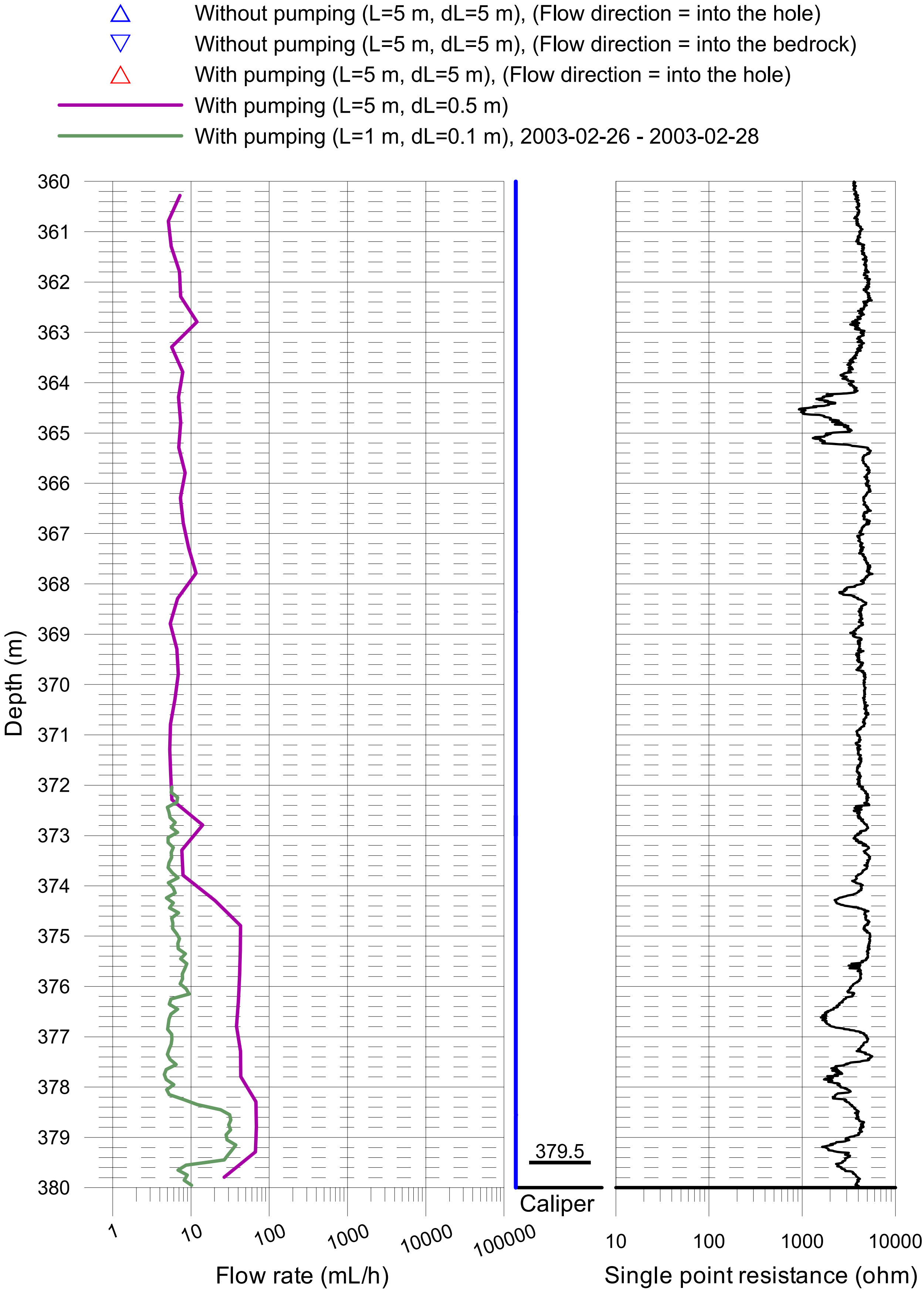
Simpevarp, Borehole KSH01A

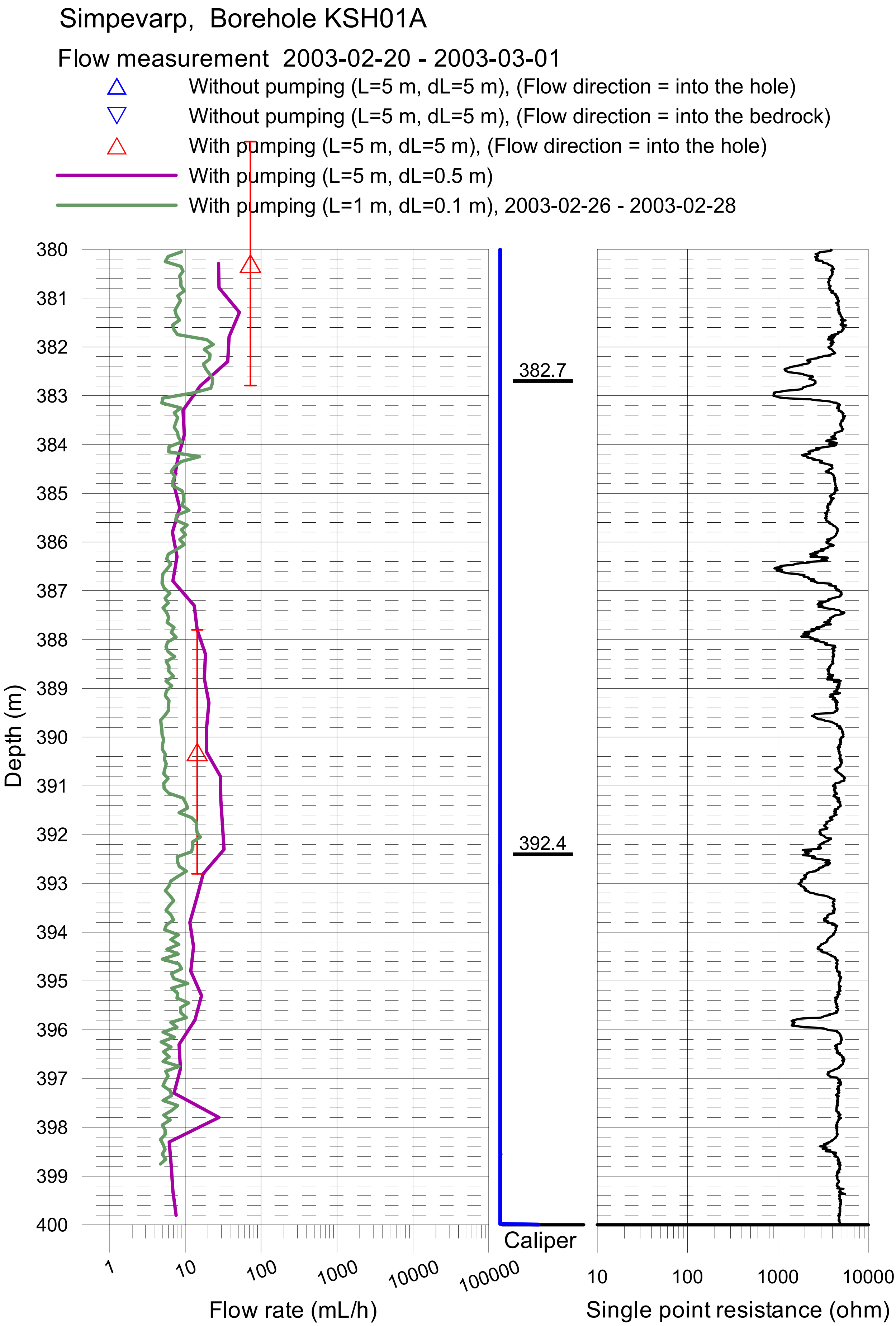
Flow measurement 2003-02-20 - 2003-03-01



Simpevarp, Borehole KSH01A

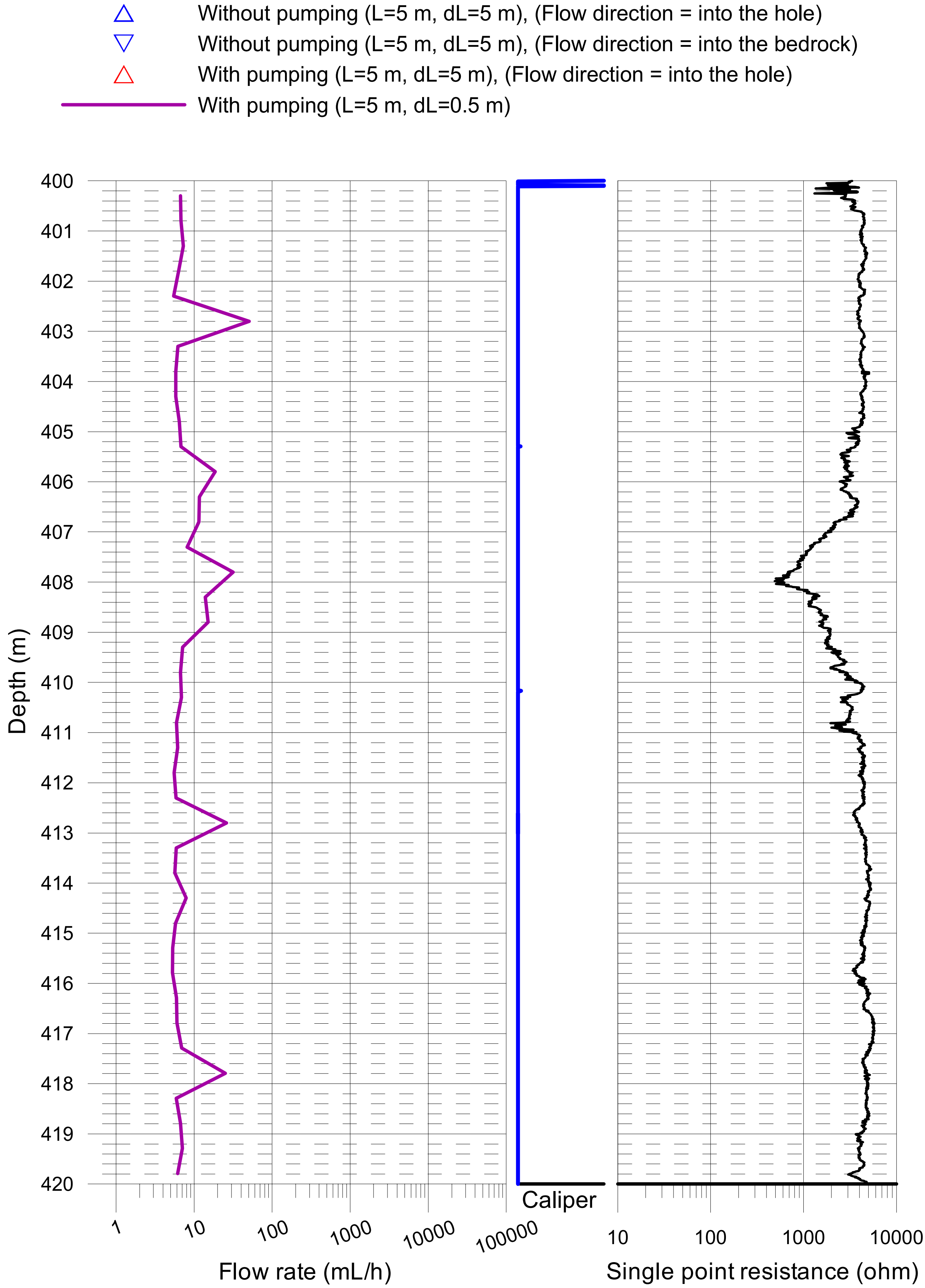
Flow measurement 2003-02-20 - 2003-03-01




Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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), 2003-02-26 - 2003-02-28
Depth (m)
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
382.7
392.4
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

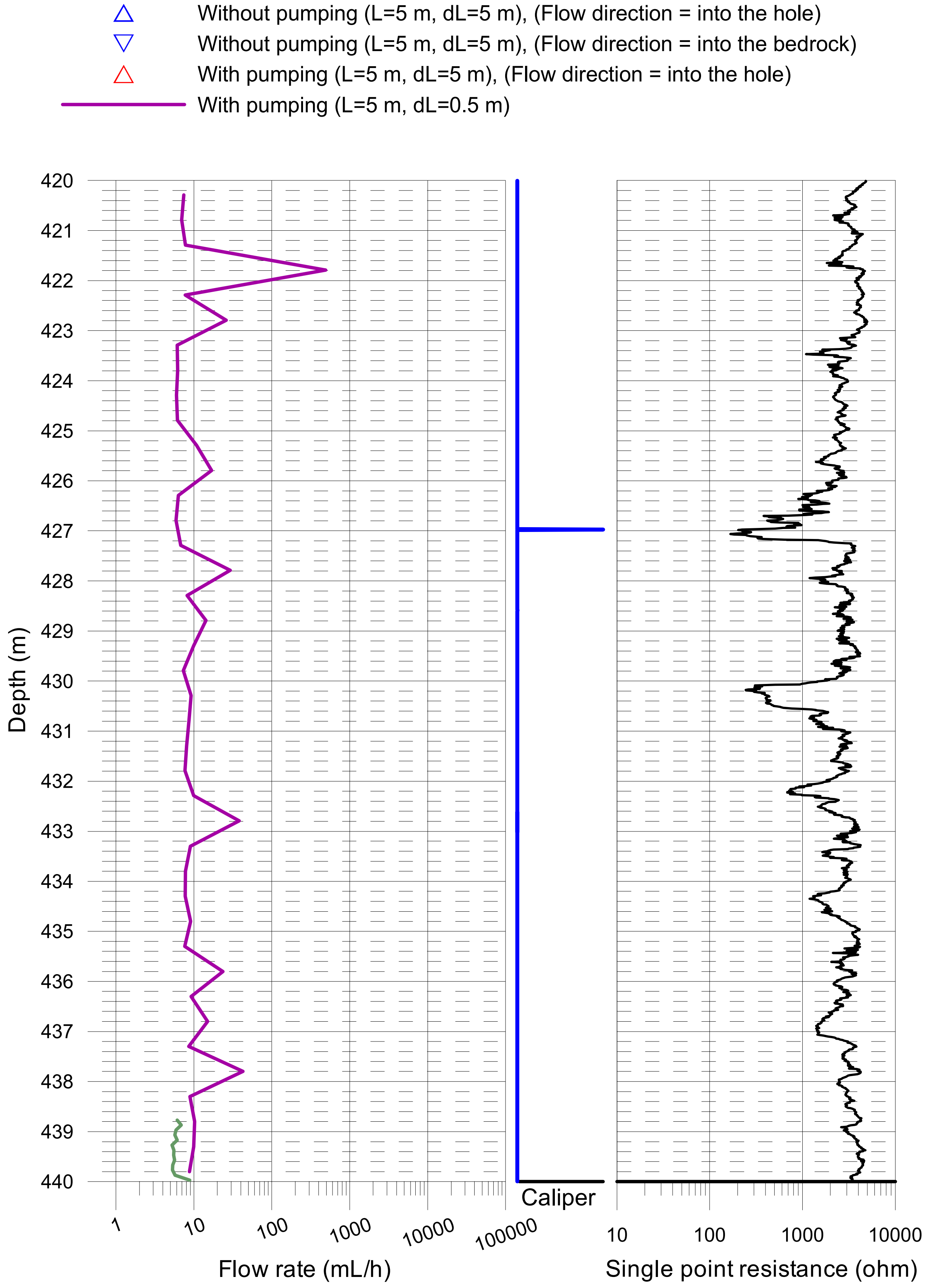
Simpevarp, Borehole KSH01A

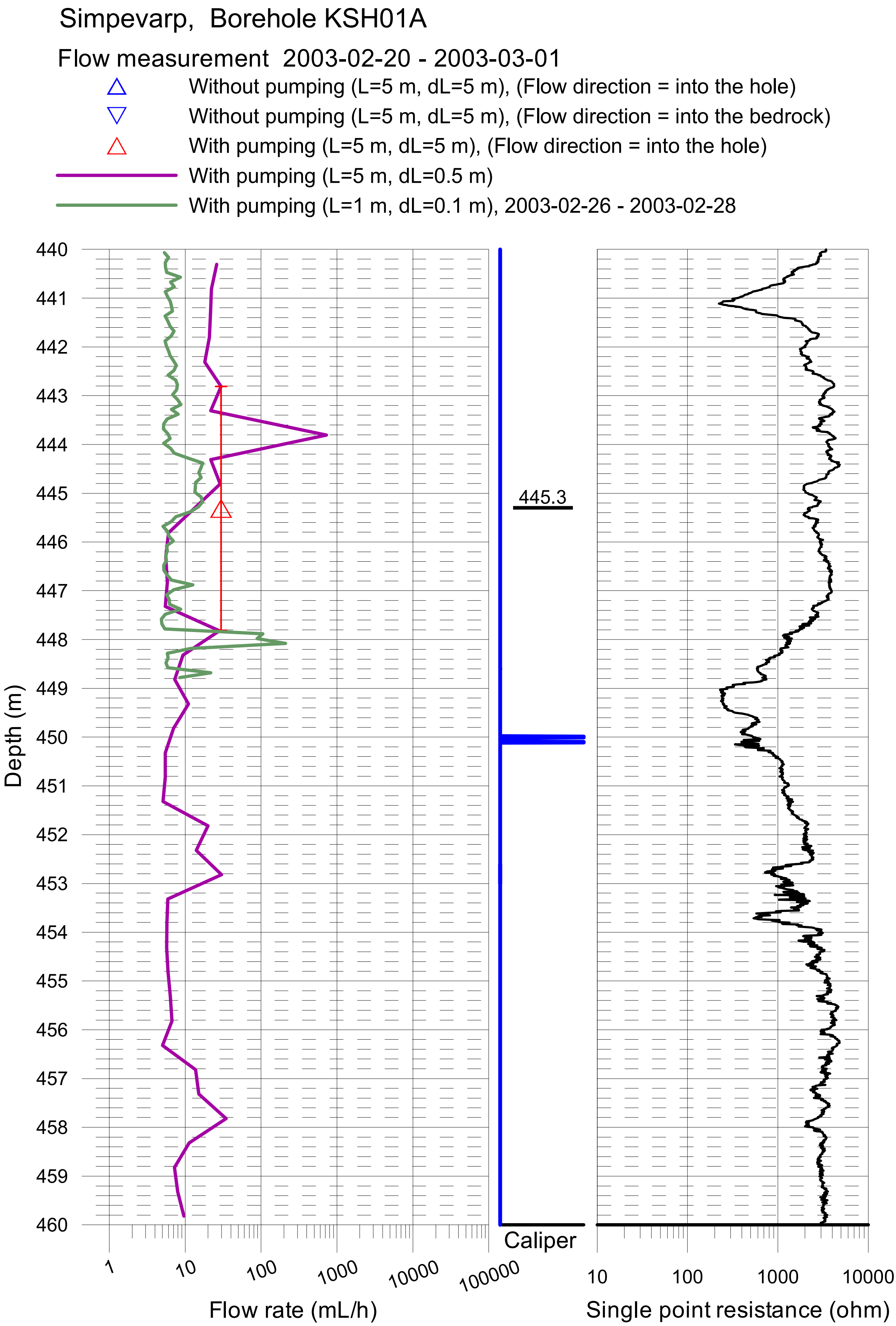
Flow measurement 2003-02-20 - 2003-03-01



Simpevarp, Borehole KSH01A

Flow measurement 2003-02-20 - 2003-03-01

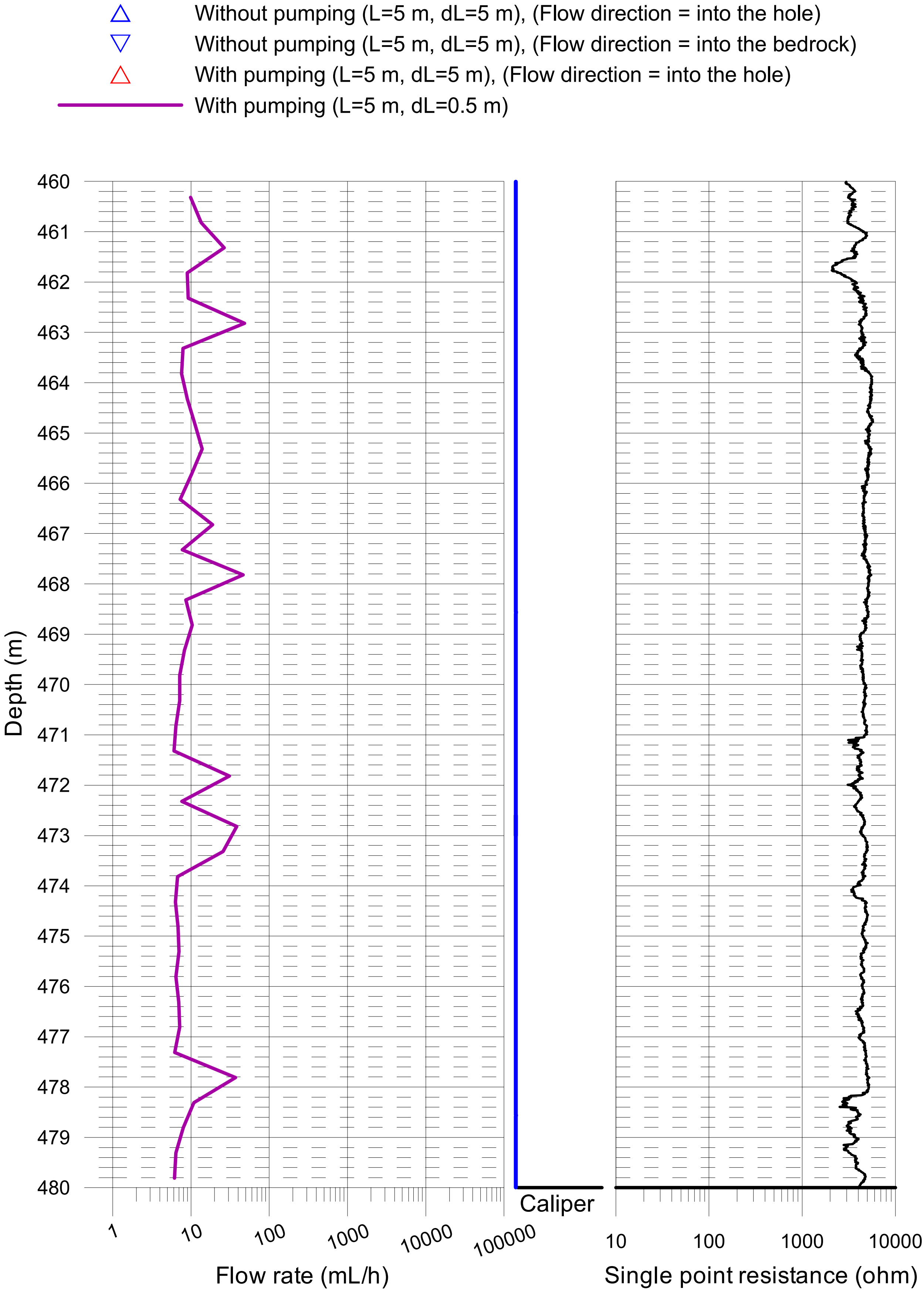


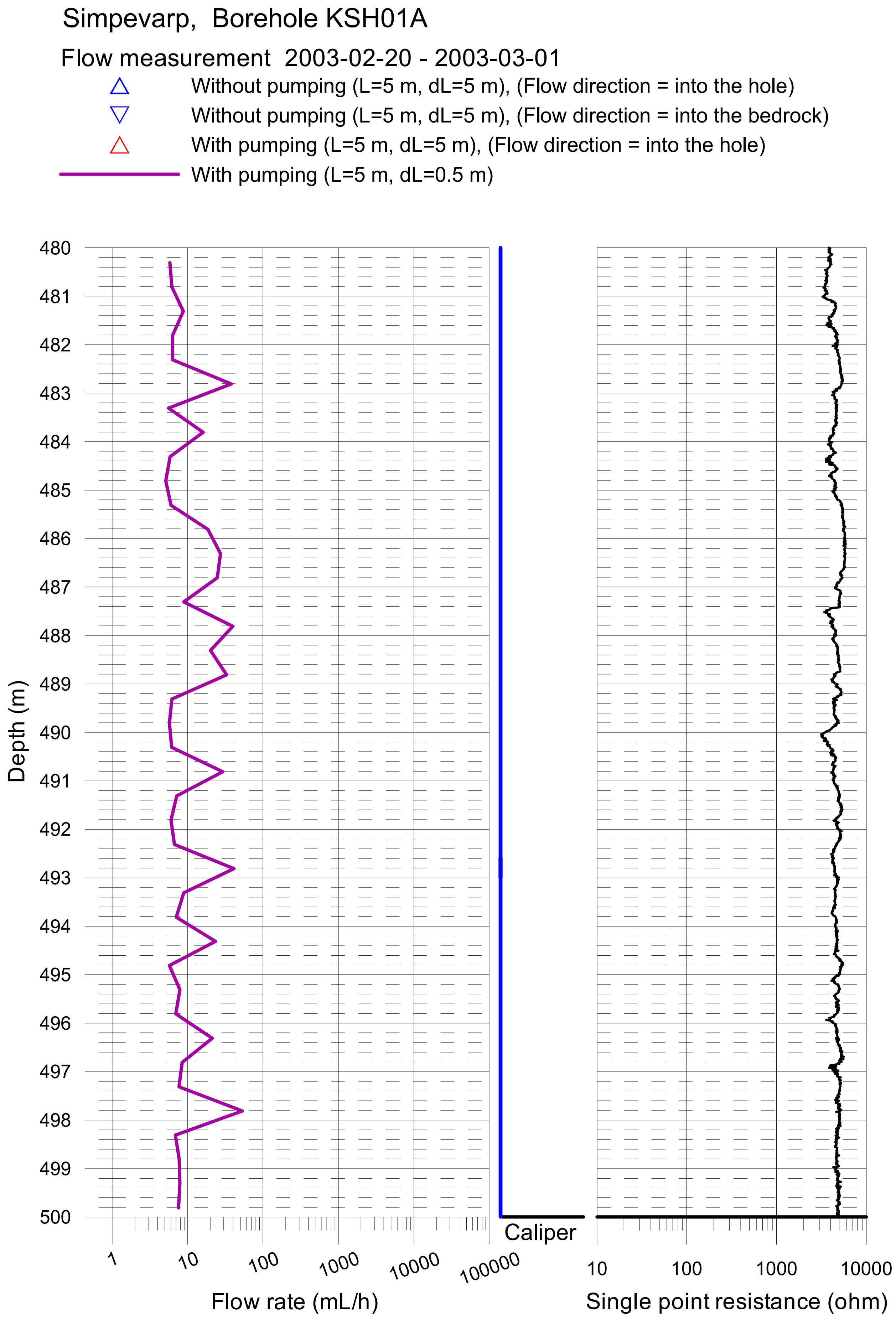


Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
Depth (m)
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
445.3
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

Simpevarp, Borehole KSH01A

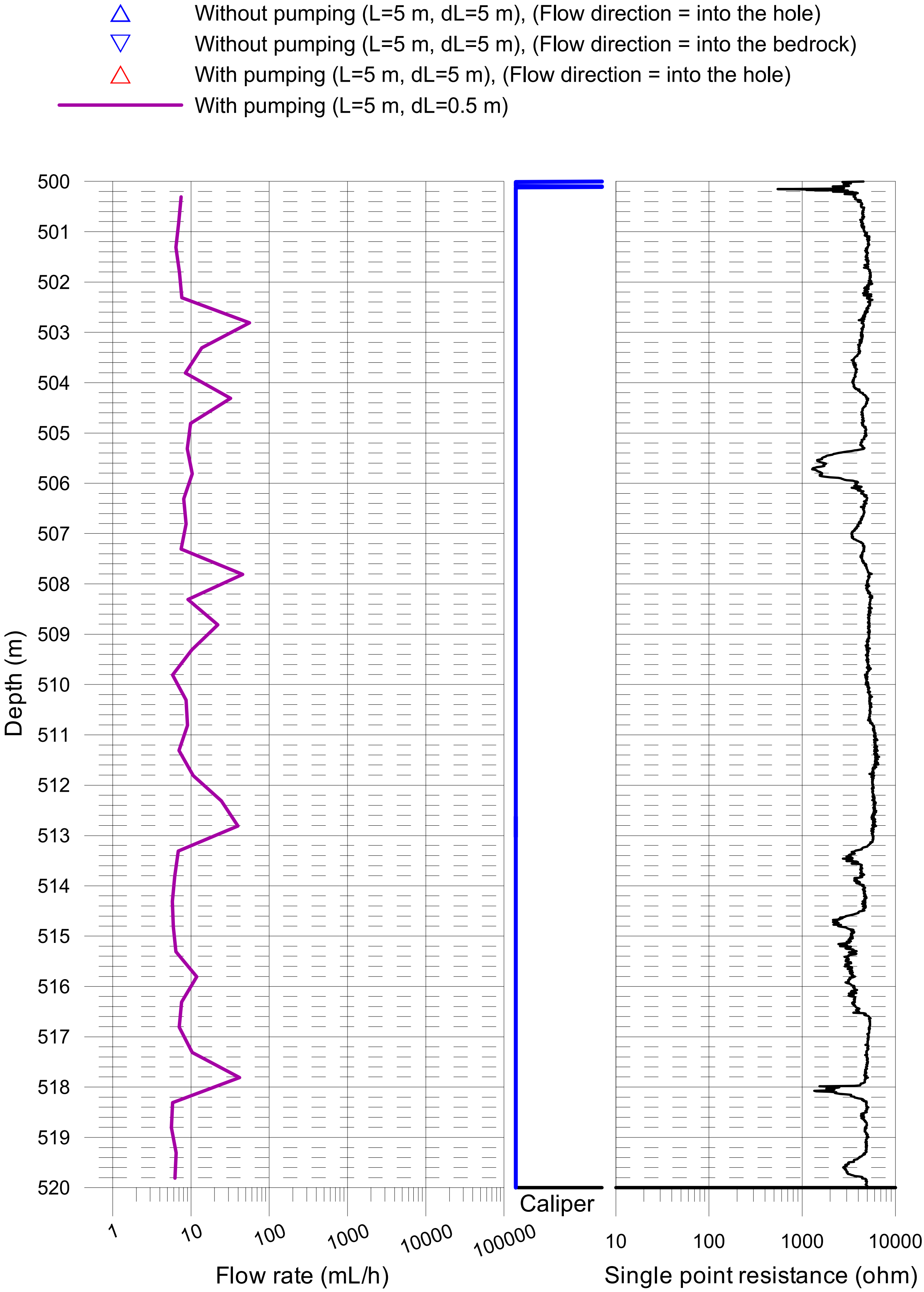
Flow measurement 2003-02-20 - 2003-03-01




Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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)
Depth (m)
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

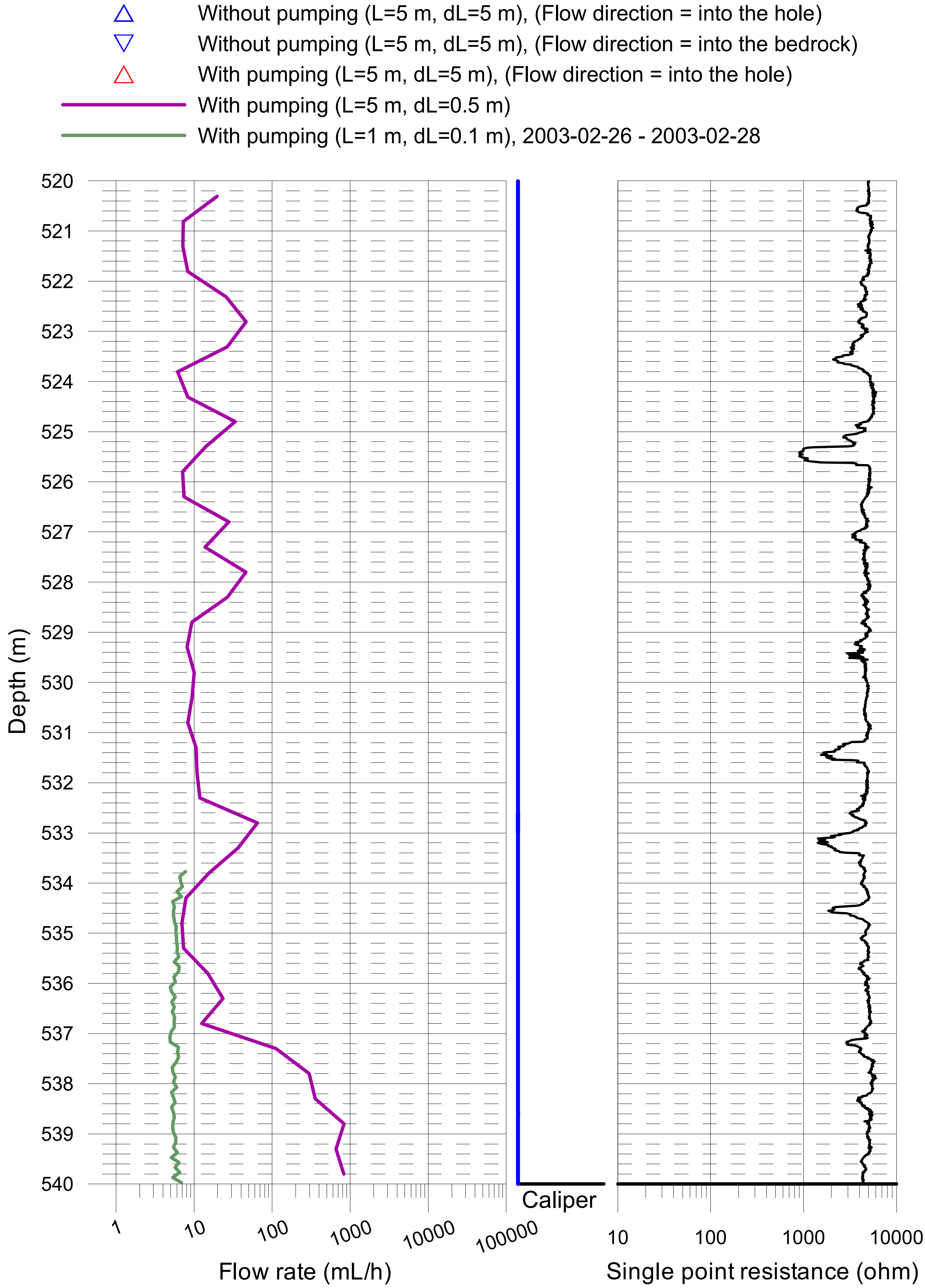
Simpevarp, Borehole KSH01A

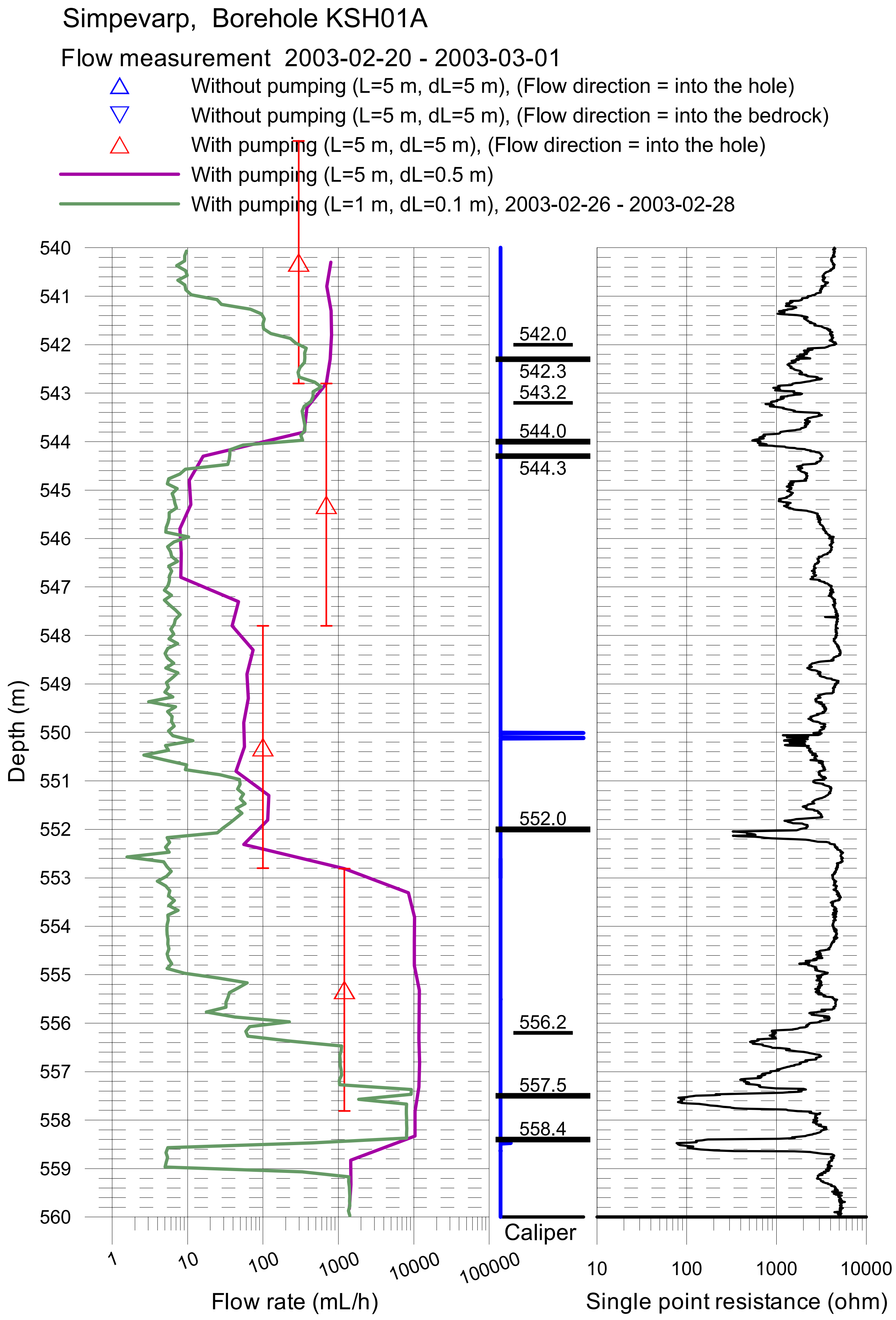
Flow measurement 2003-02-20 - 2003-03-01



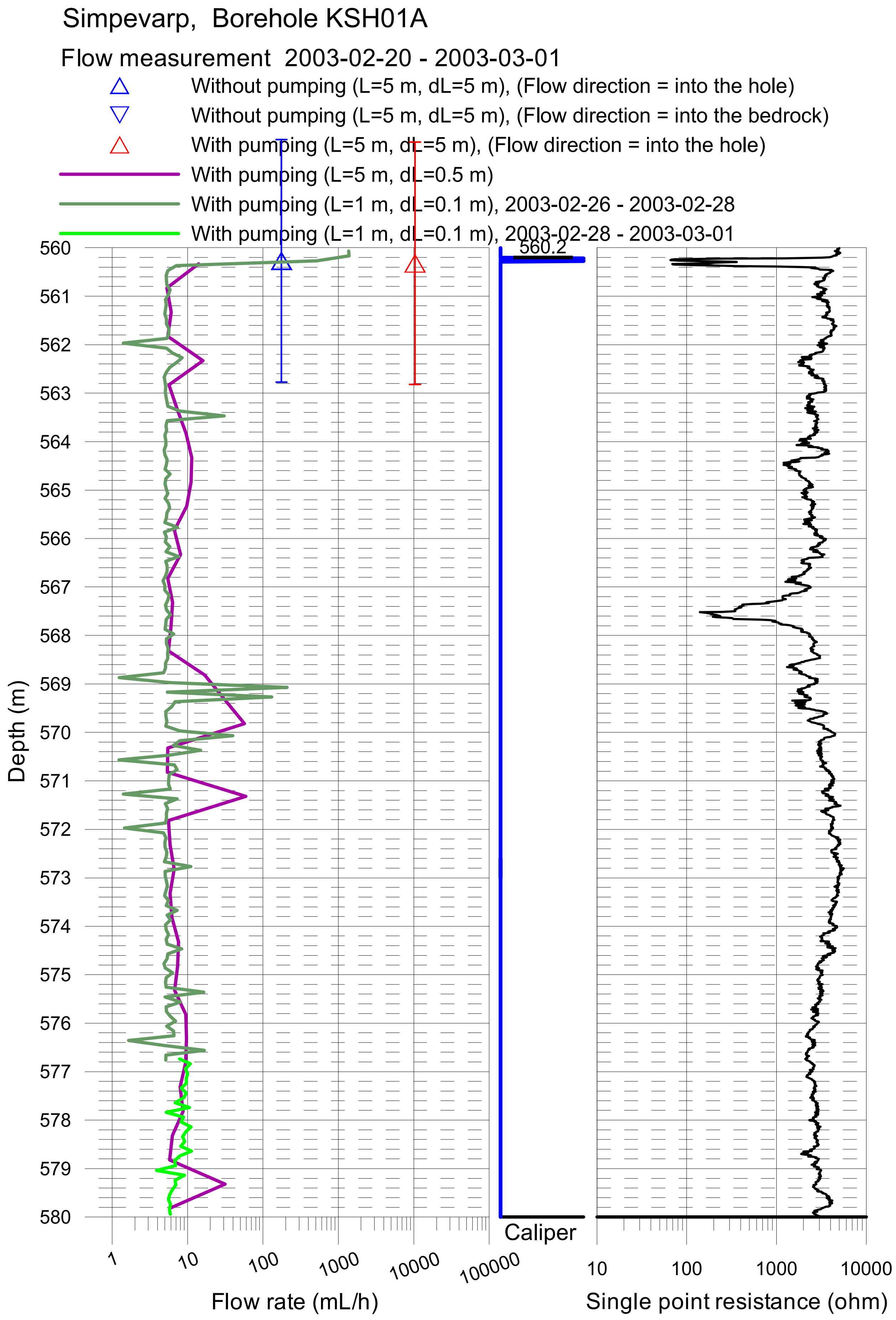
Simpevarp, Borehole KSH01A

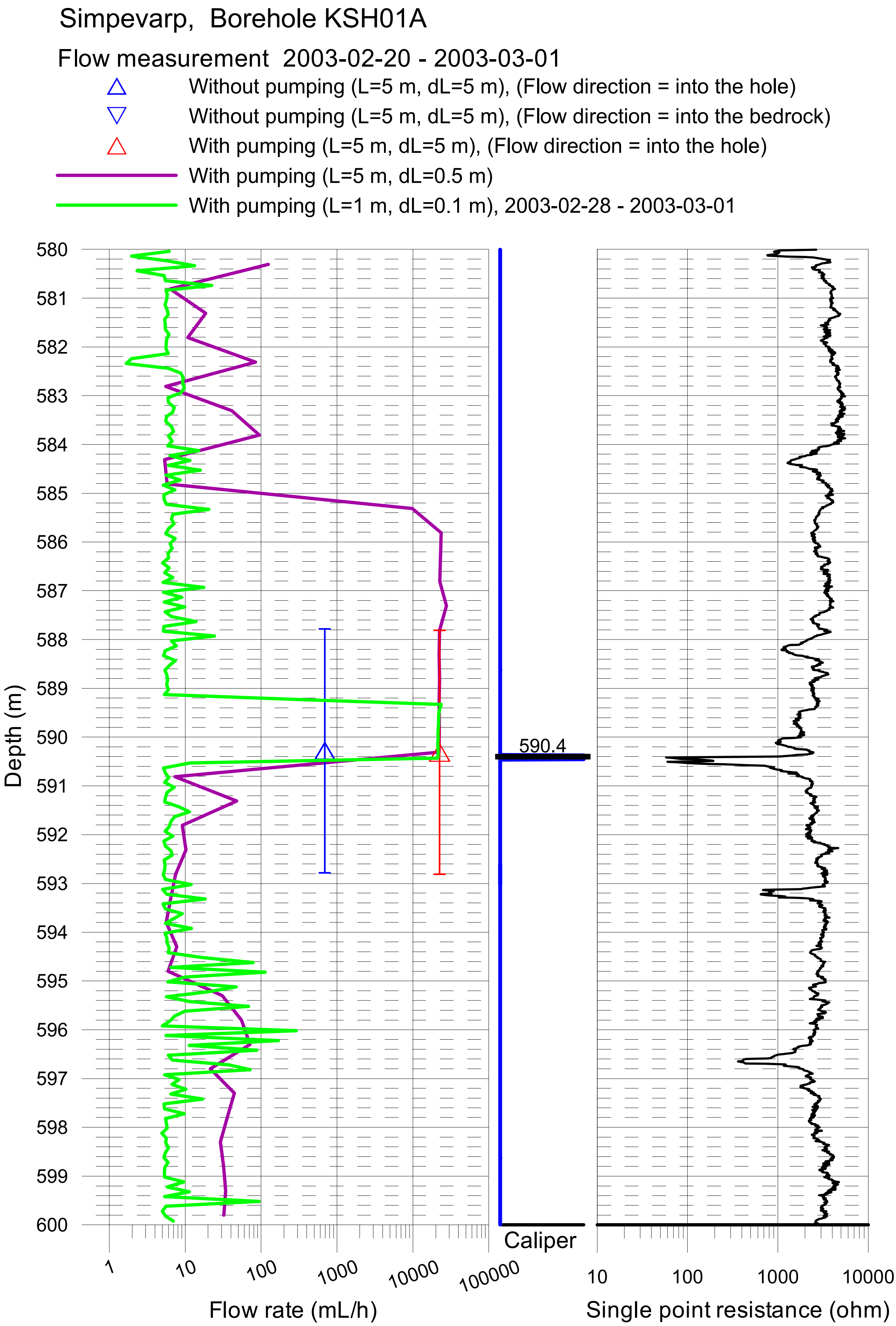
Flow measurement 2003-02-20 - 2003-03-01



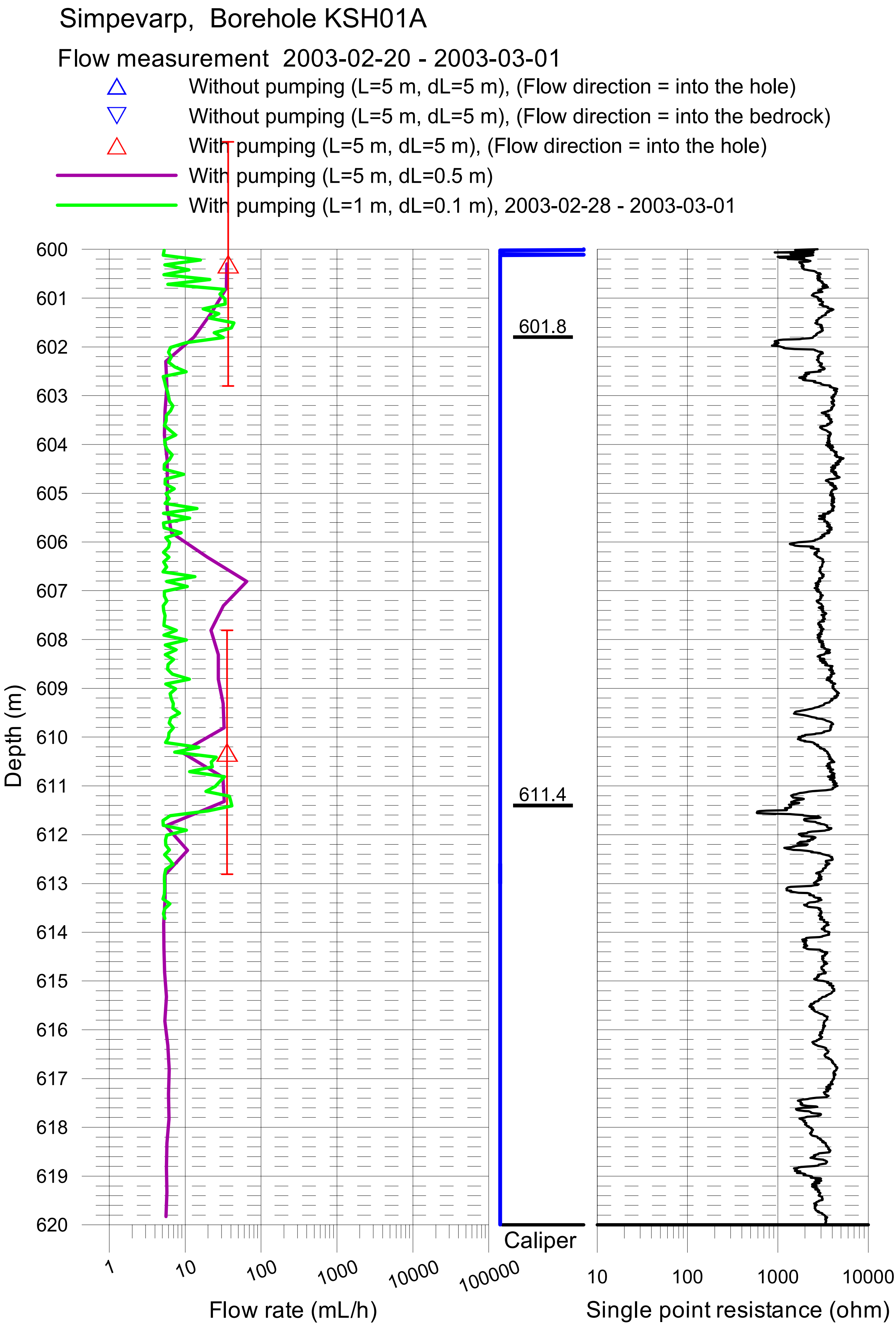


Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
Depth (m)
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
542.0
542.3
543.2
544.0
544.3
552.0
556.2
557.5
558.4
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)


Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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), 2003-02-26 - 2003-02-28
With pumping (L=1 m, dL=0.1 m), 2003-02-28 - 2003-03-01
560.2
Depth (m)
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)



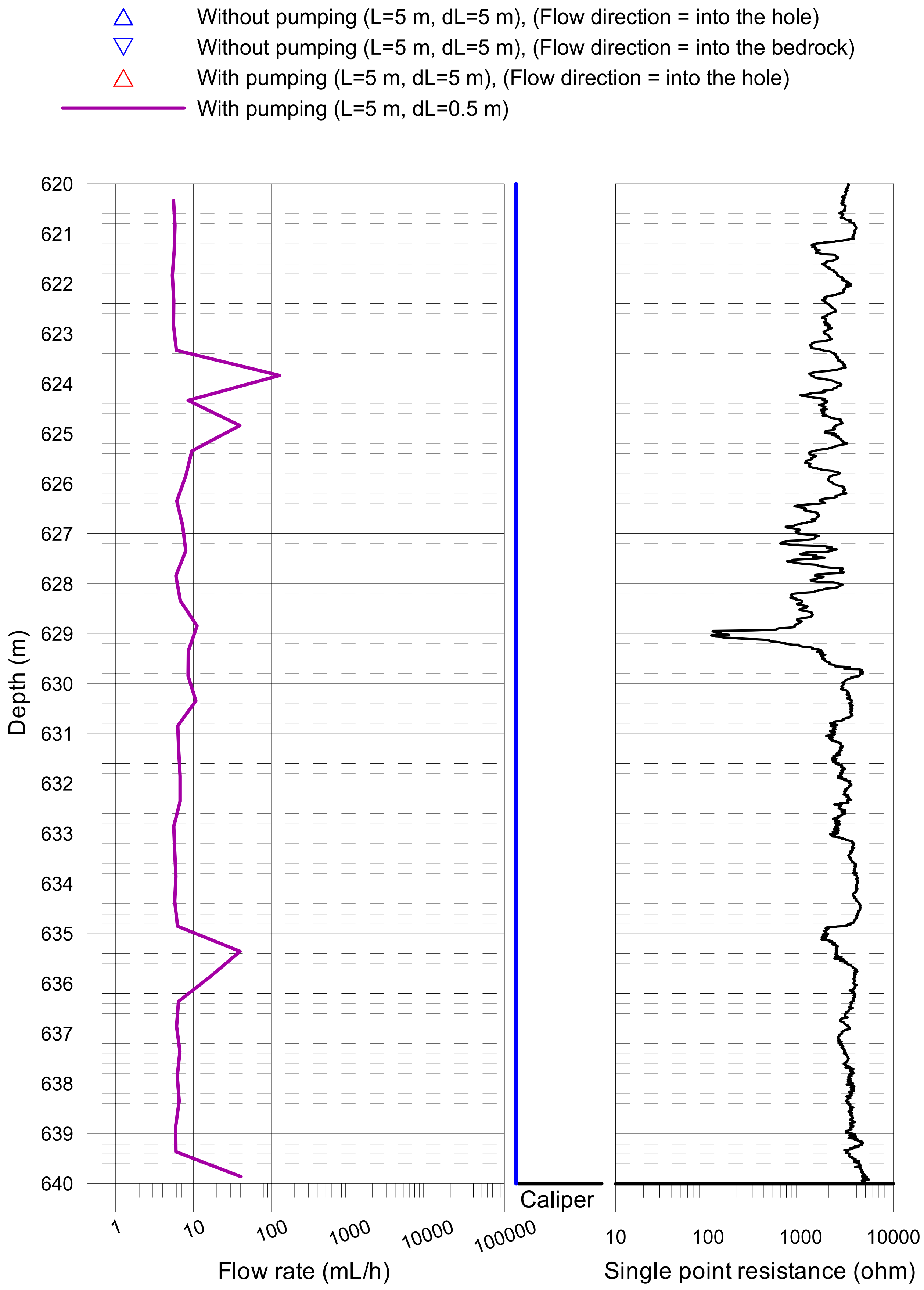
Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-28 - 2003-03-01
Depth (m)
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
590.4
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)



Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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), 2003-02-28 - 2003-03-01
Depth (m)
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
601.8
611.4
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

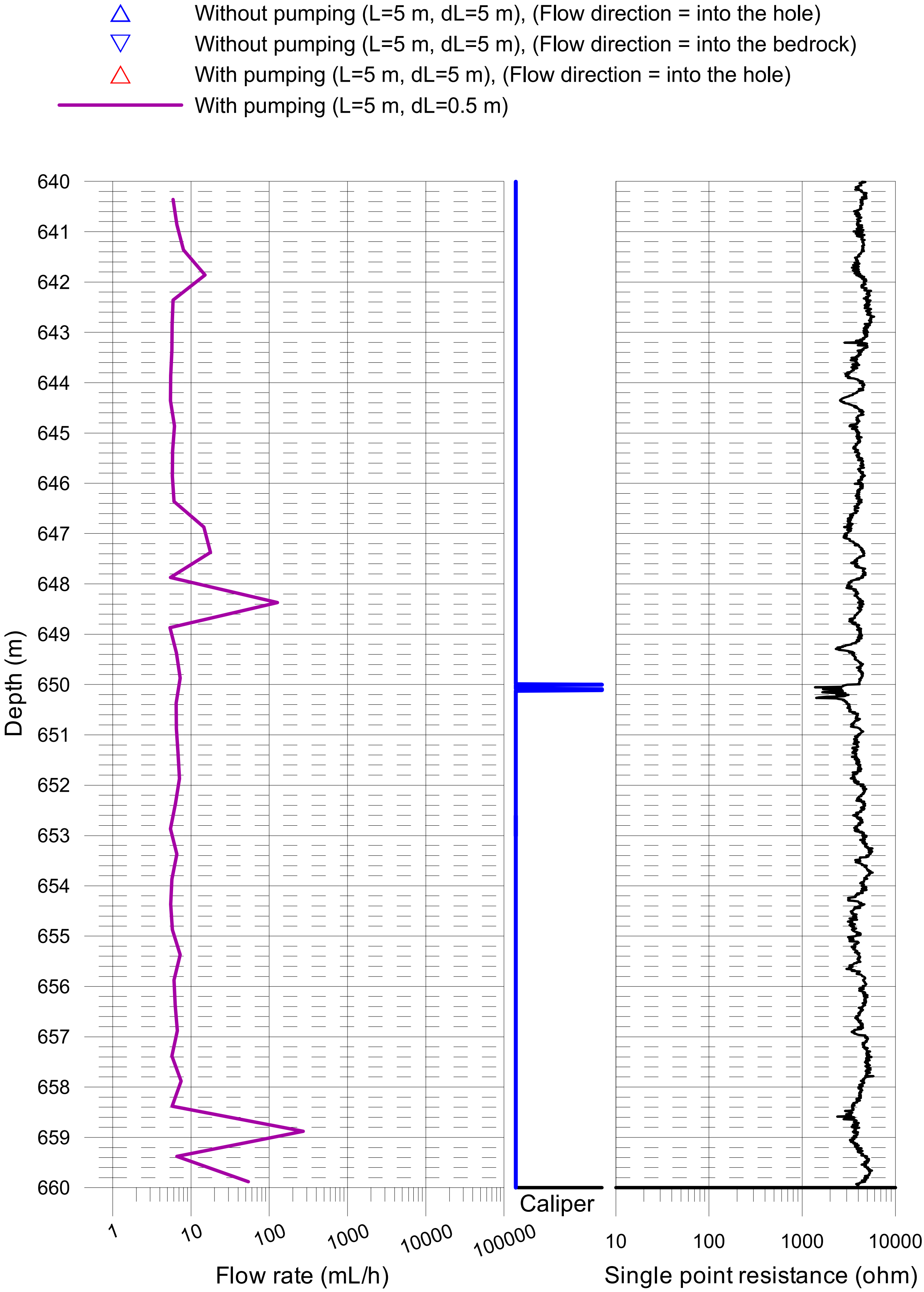
Simpevarp, Borehole KSH01A

Flow measurement 2003-02-20 - 2003-03-01



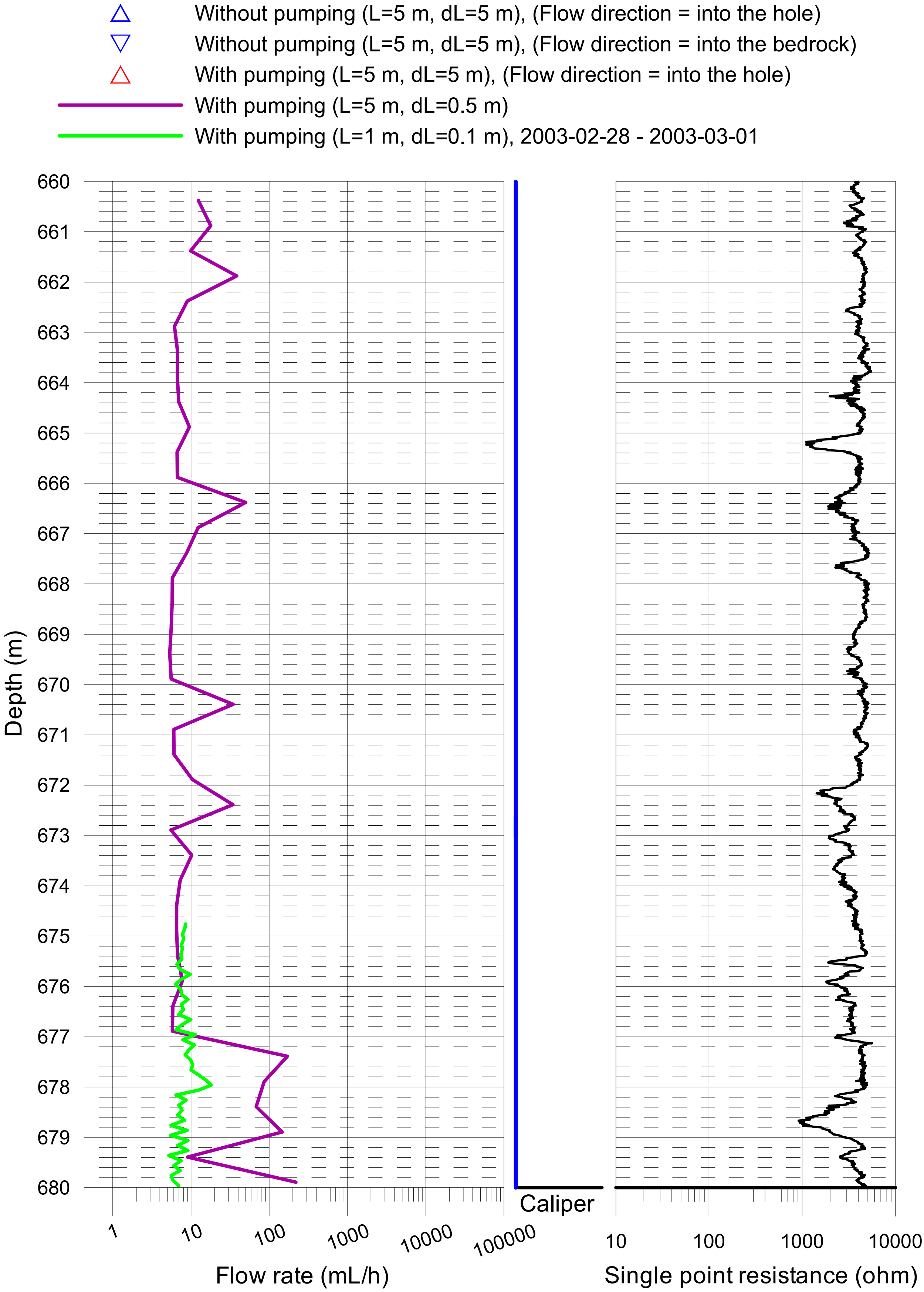
Simpevarp, Borehole KSH01A

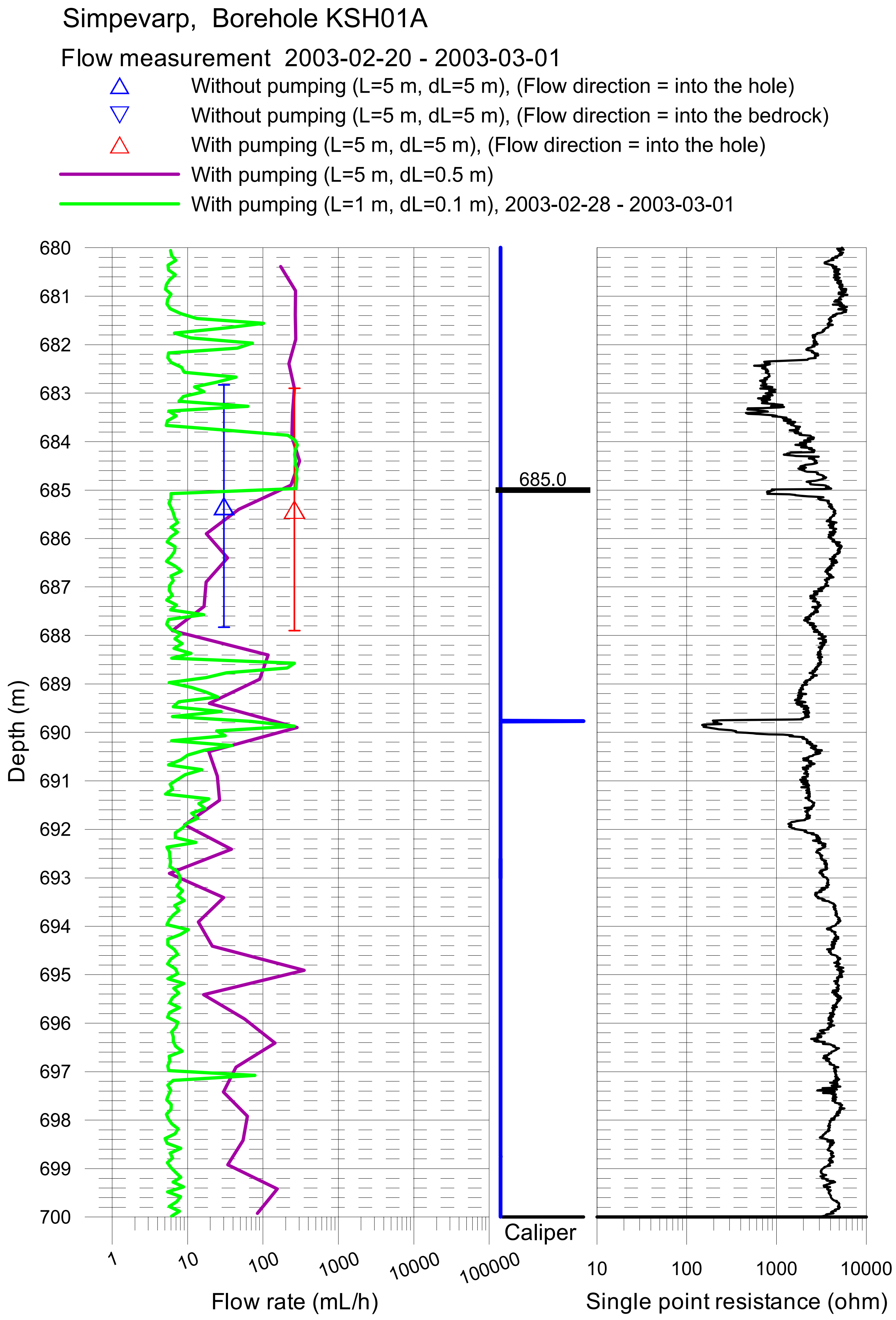
Flow measurement 2003-02-20 - 2003-03-01



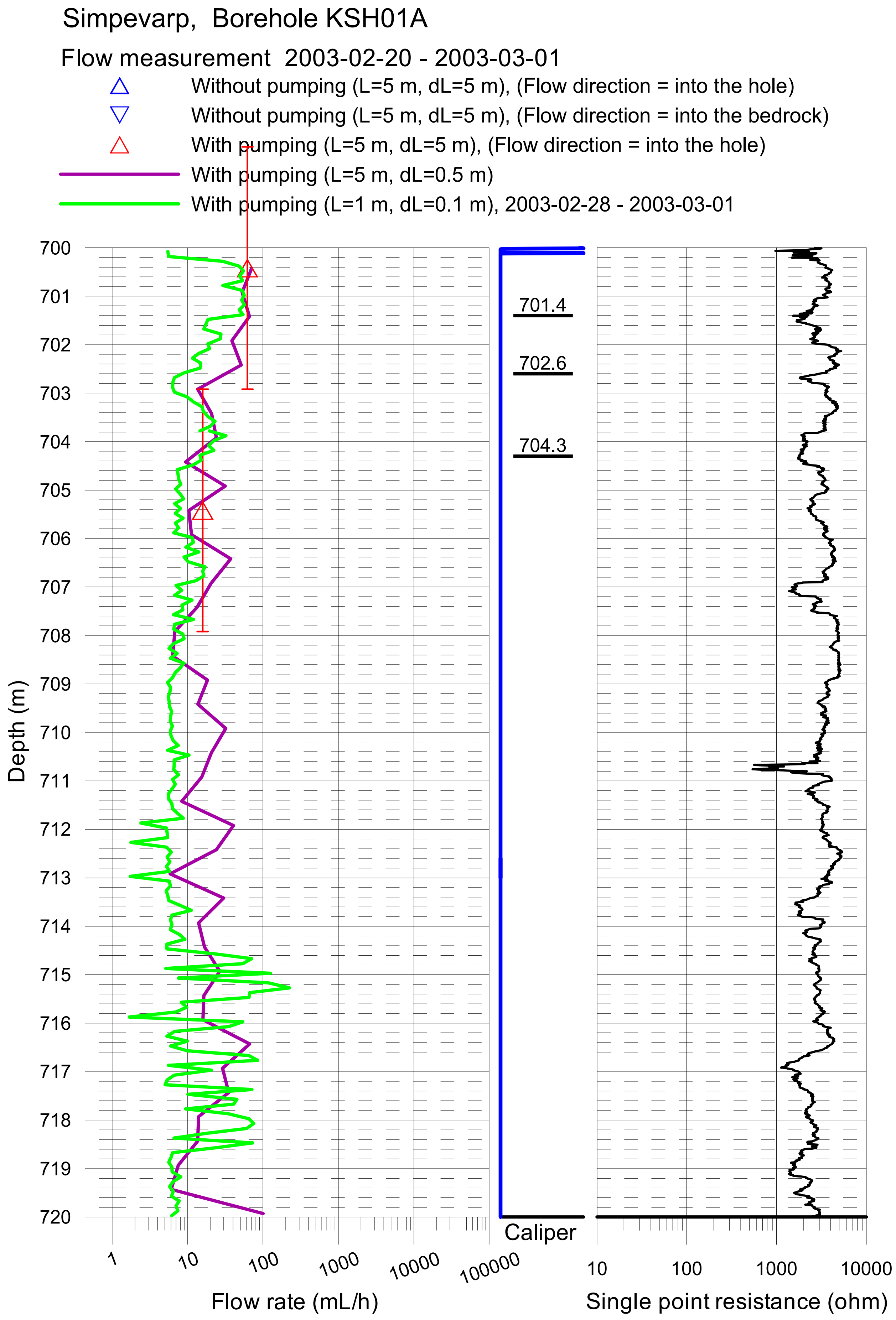
Simpevarp, Borehole KSH01A

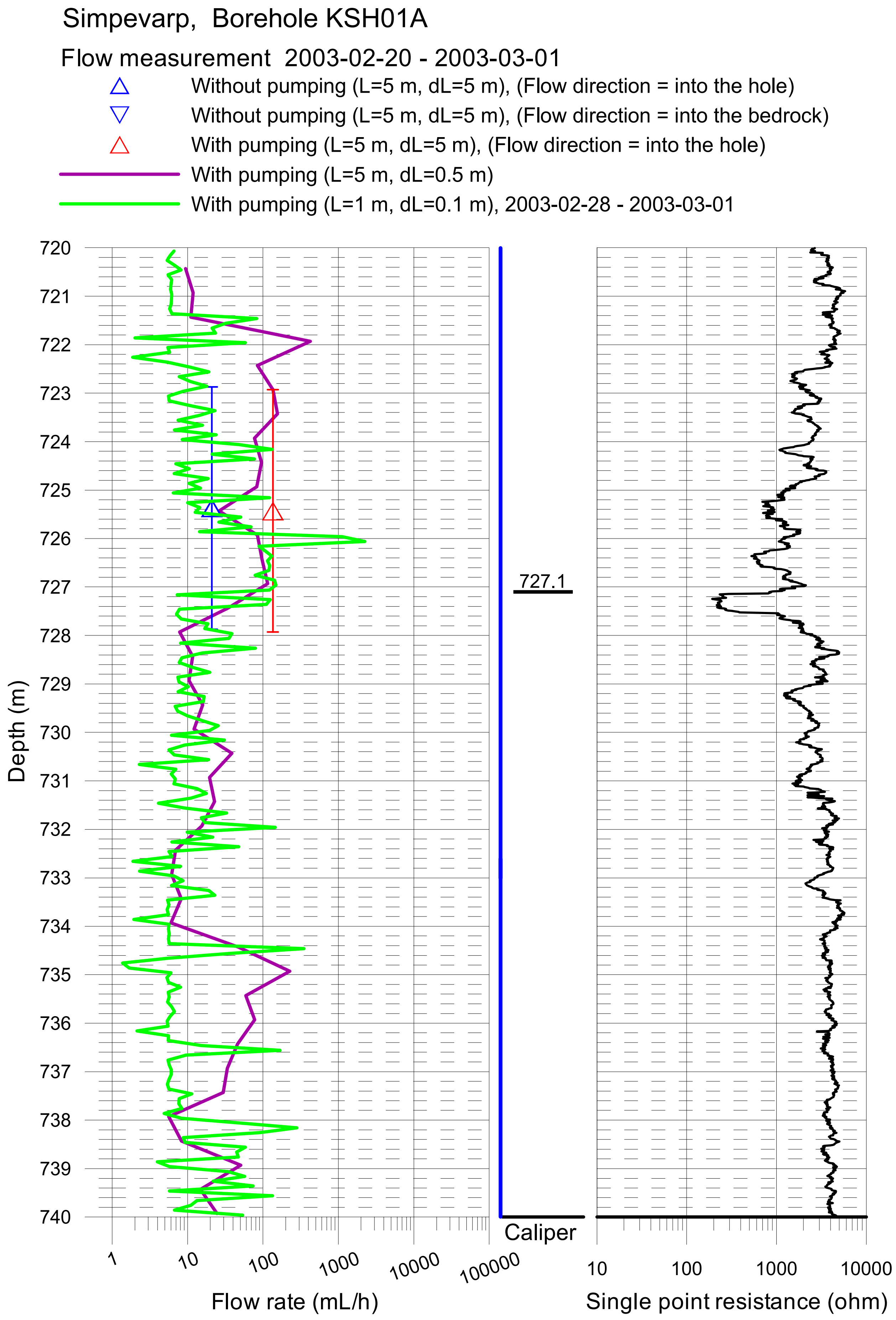
Flow measurement 2003-02-20 - 2003-03-01





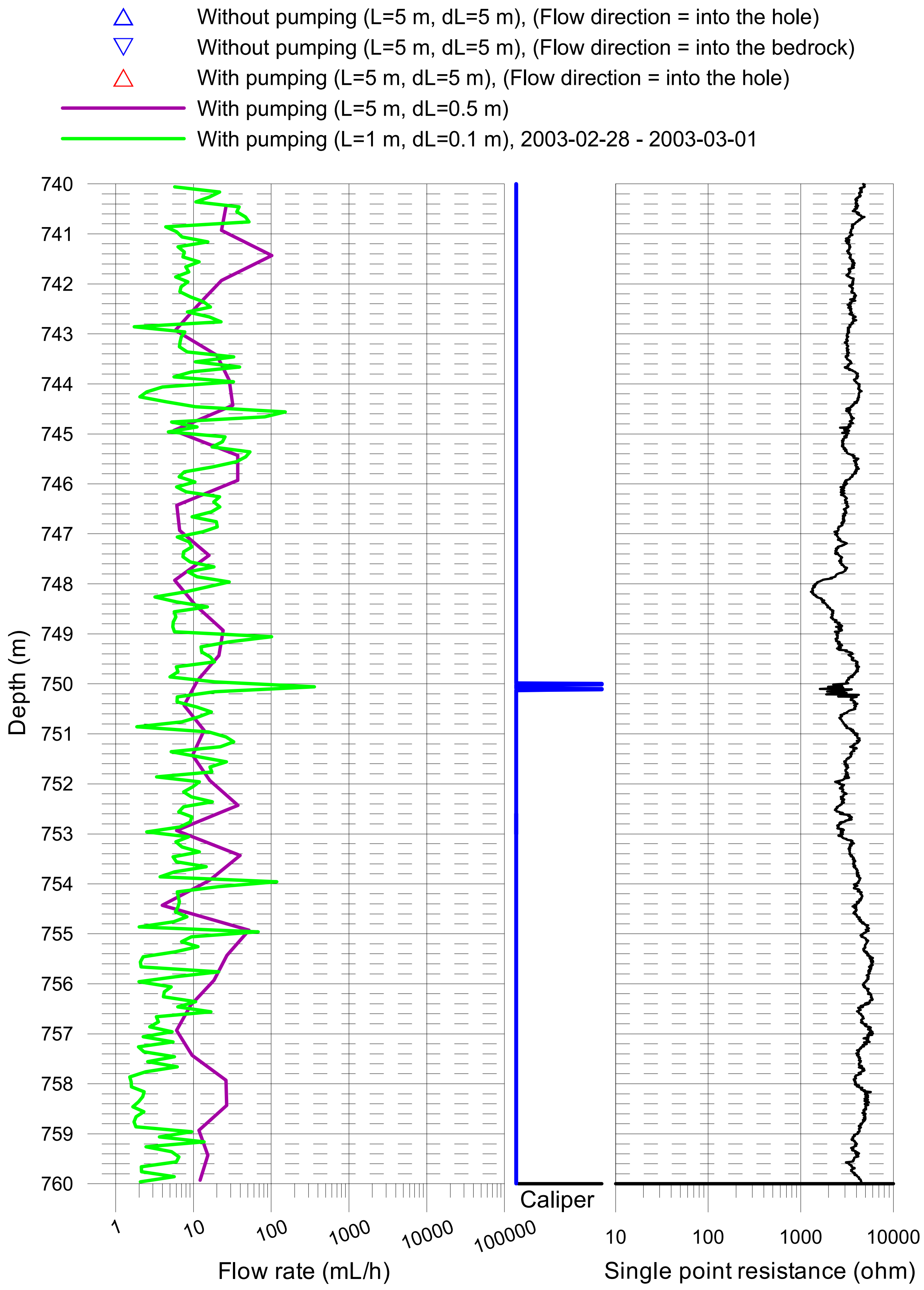
Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-28 - 2003-03-01
Depth (m)
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
685.0
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)


Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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), 2003-02-28 - 2003-03-01
Depth (m)
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
701.4
702.6
704.3
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

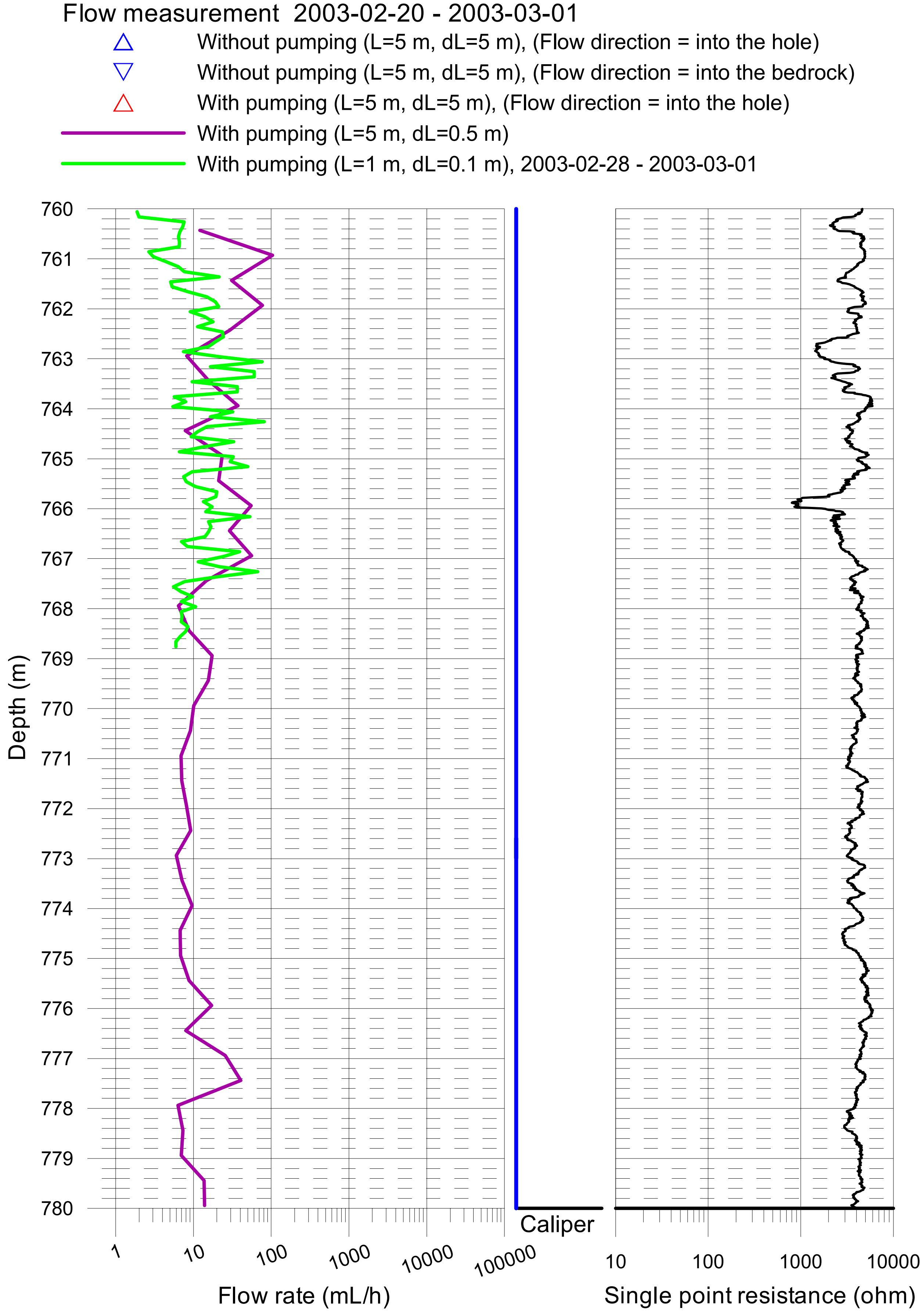

Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-28 - 2003-03-01
Depth (m)
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
727.1
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

Simpevarp, Borehole KSH01A

Flow measurement 2003-02-20 - 2003-03-01

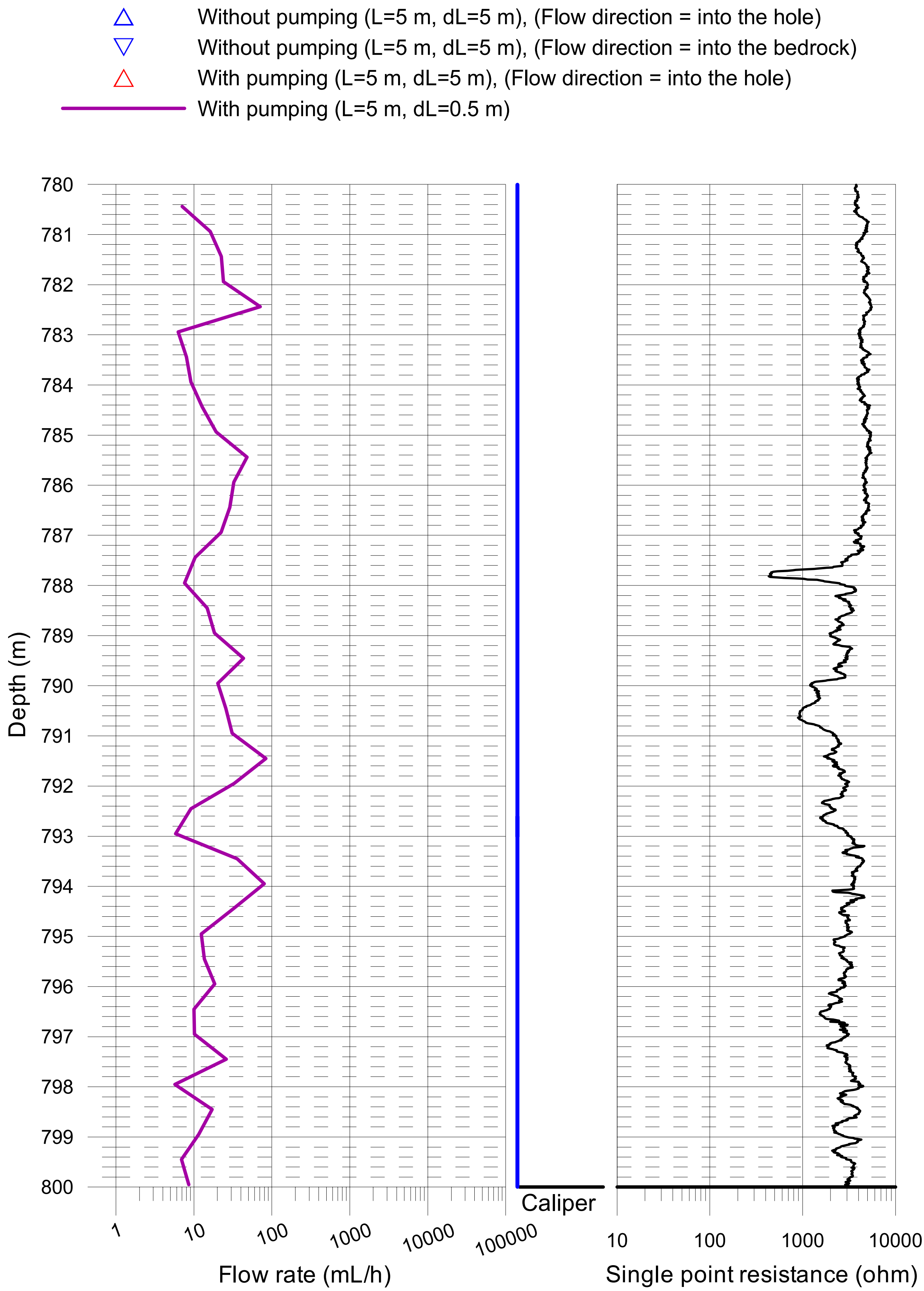


Simpevarp, Borehole KSH01A



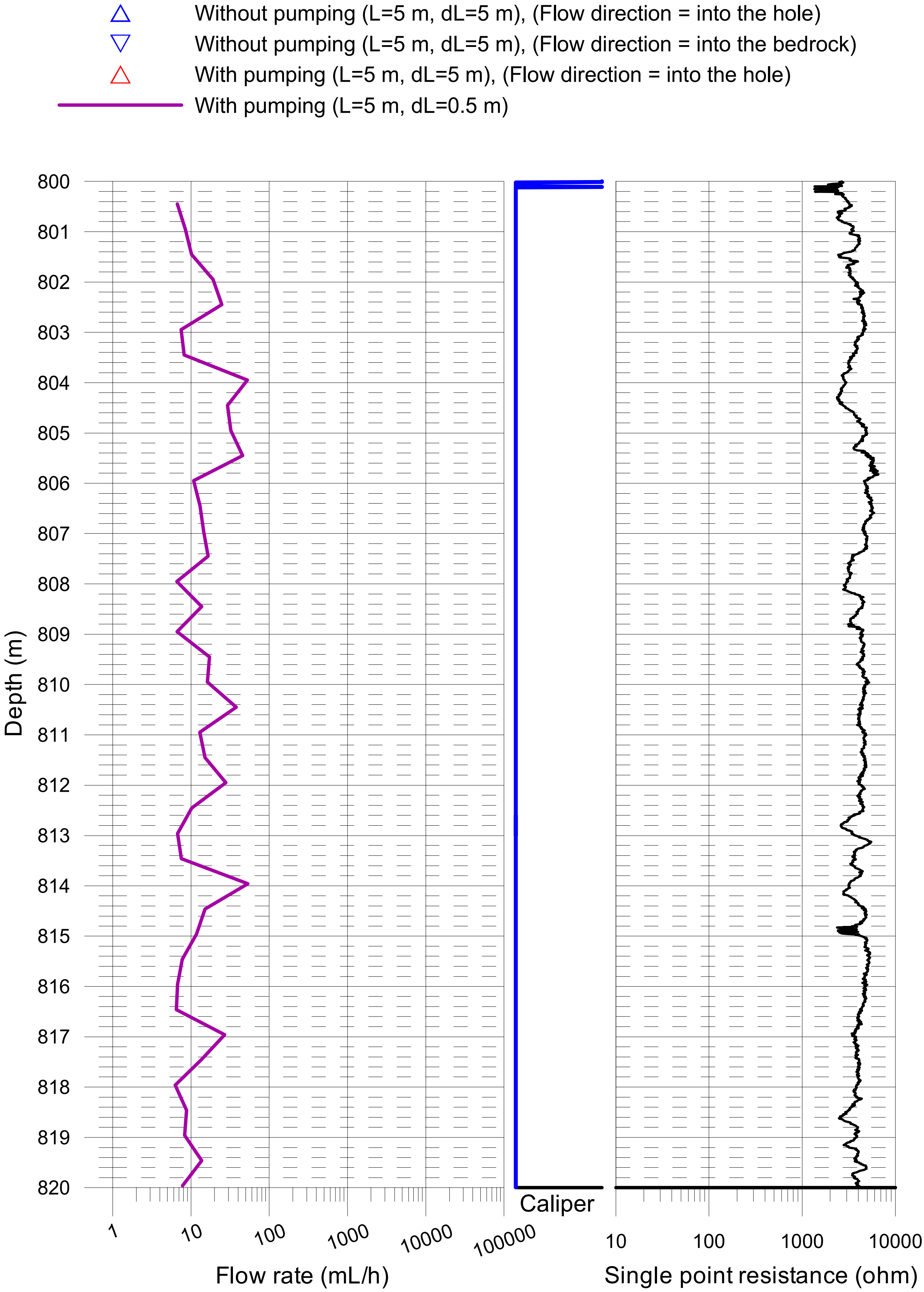
Simpevarp, Borehole KSH01A

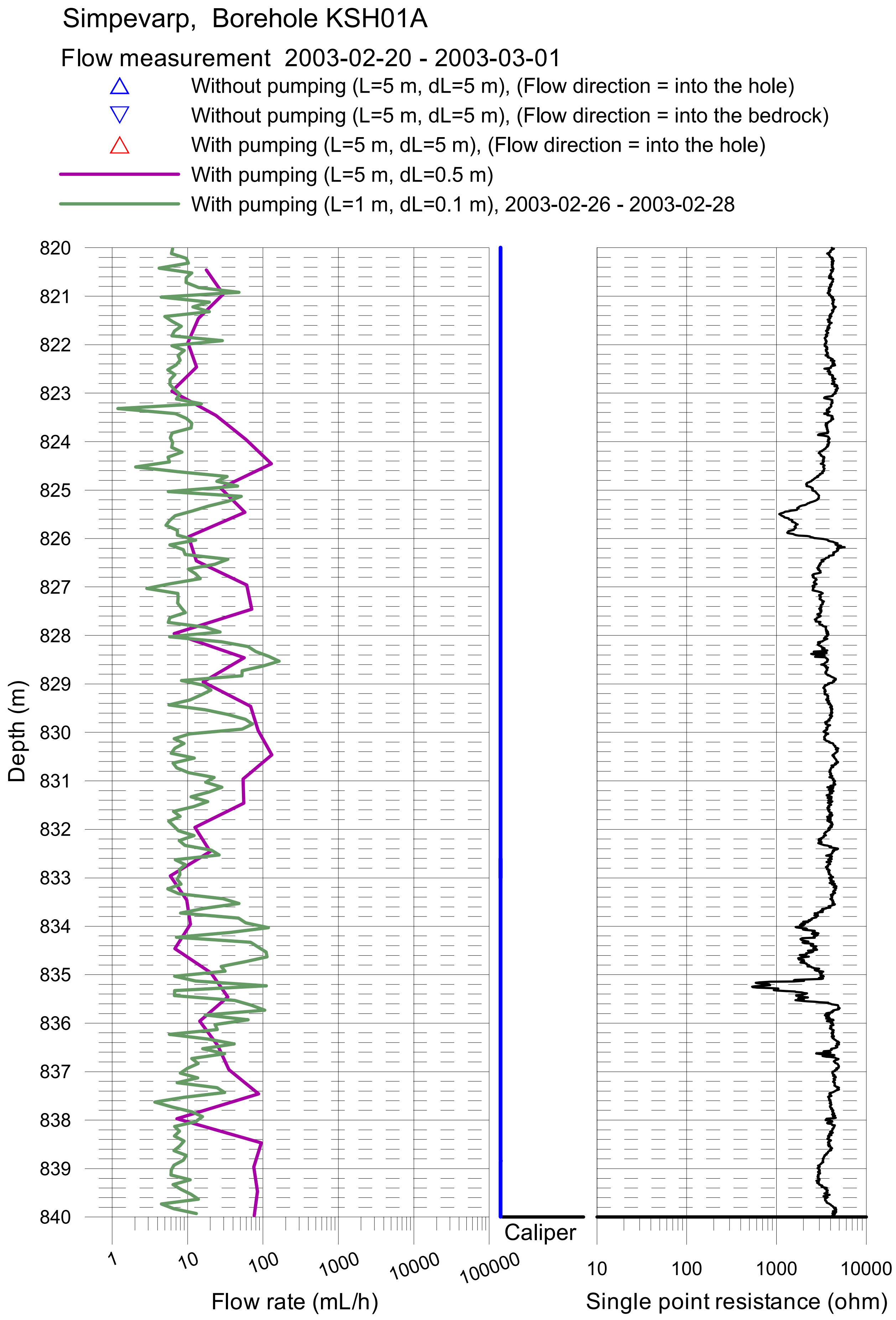
Flow measurement 2003-02-20 - 2003-03-01

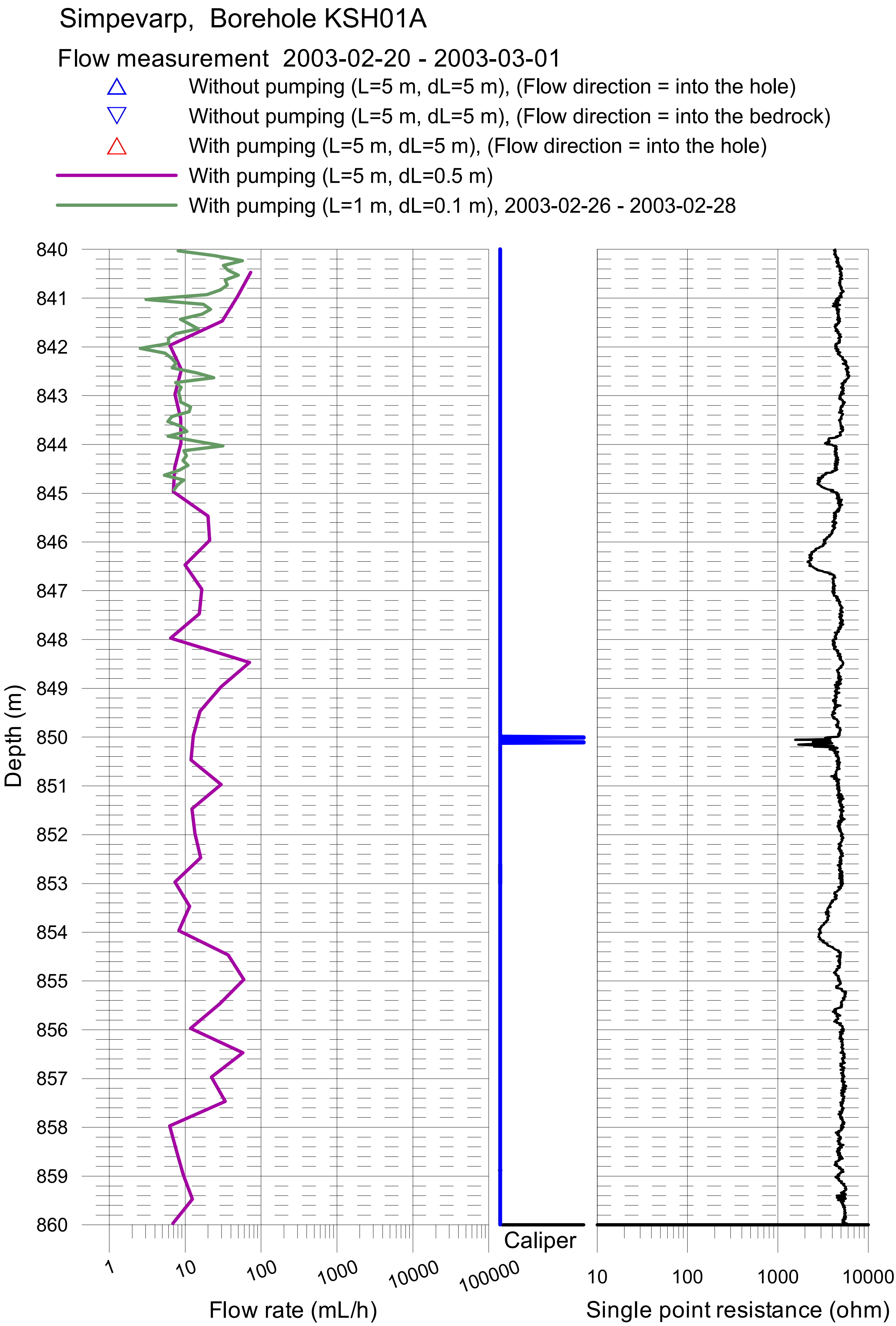


Simpevarp, Borehole KSH01A

Flow measurement 2003-02-20 - 2003-03-01



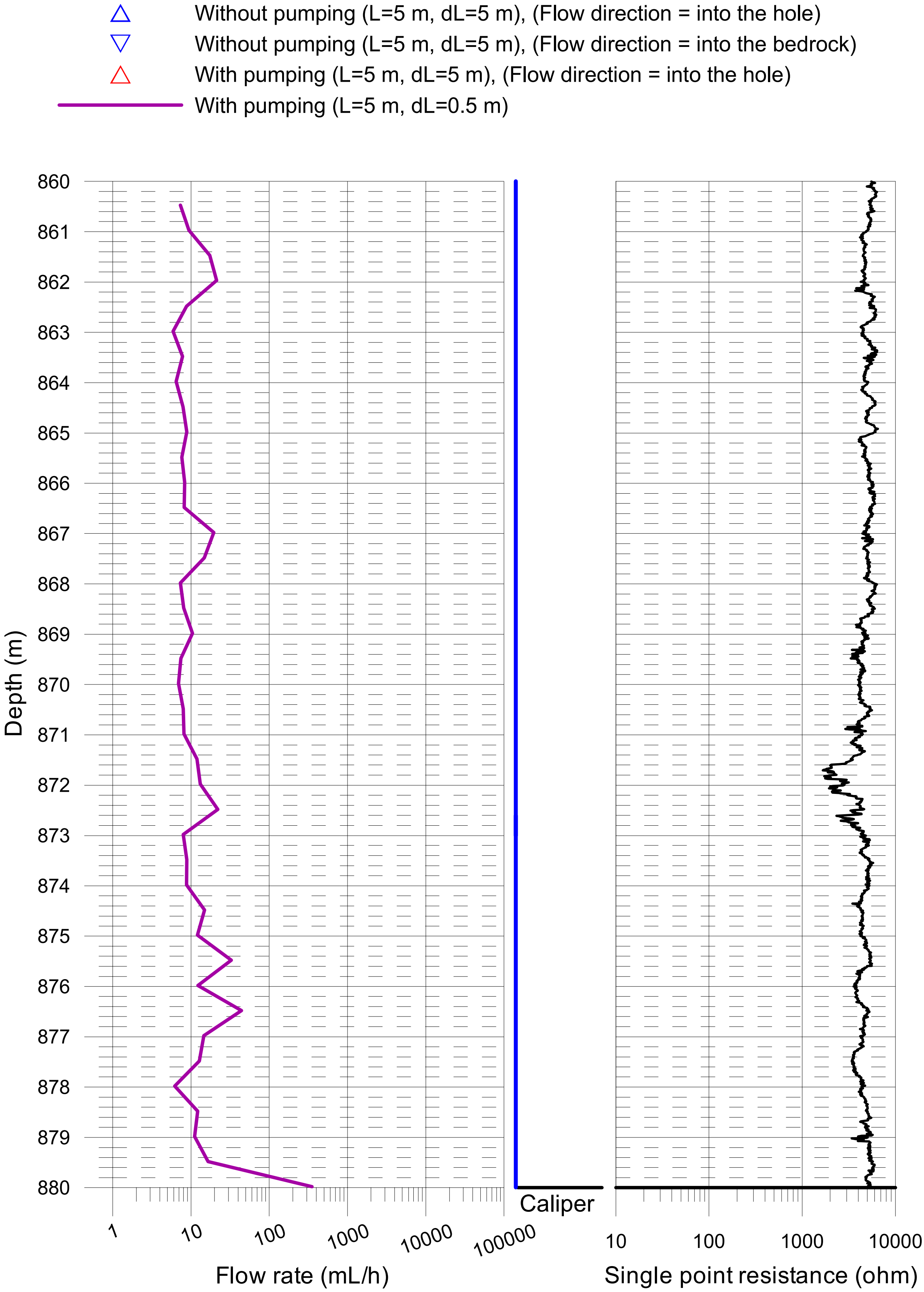

Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
With pumping (L=1 m, dL=0.1 m), 2003-02-26 - 2003-02-28
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
10
100
1000
10000
Single point resistance (ohm)



Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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), 2003-02-26 - 2003-02-28
Depth (m)
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
1
10
100
1000
10000
100000
Flow rate (mL/h)
Caliper
10
100
1000
10000
Single point resistance (ohm)

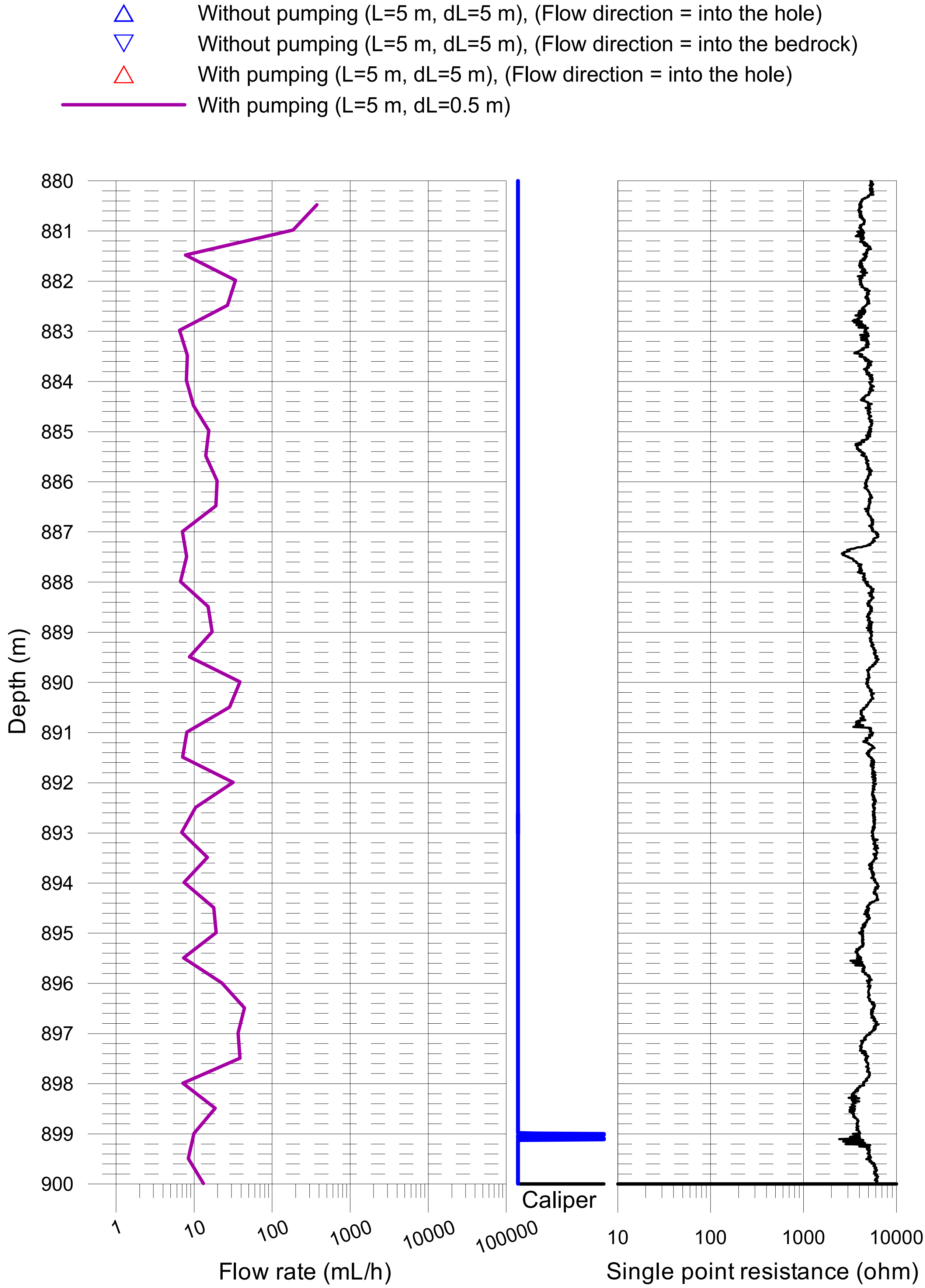
Simpevarp, Borehole KSH01A

Flow measurement 2003-02-20 - 2003-03-01



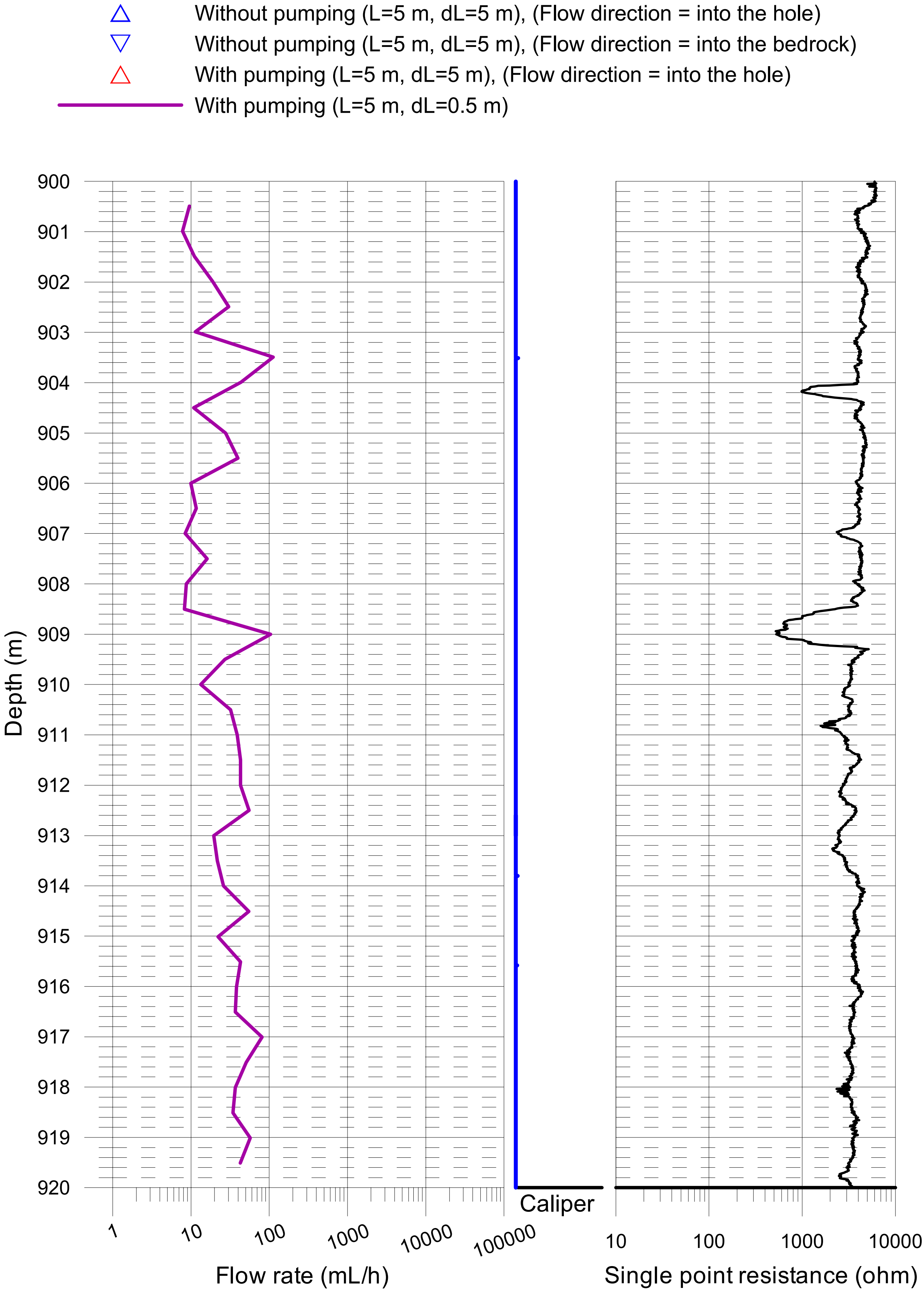
Simpevarp, Borehole KSH01A

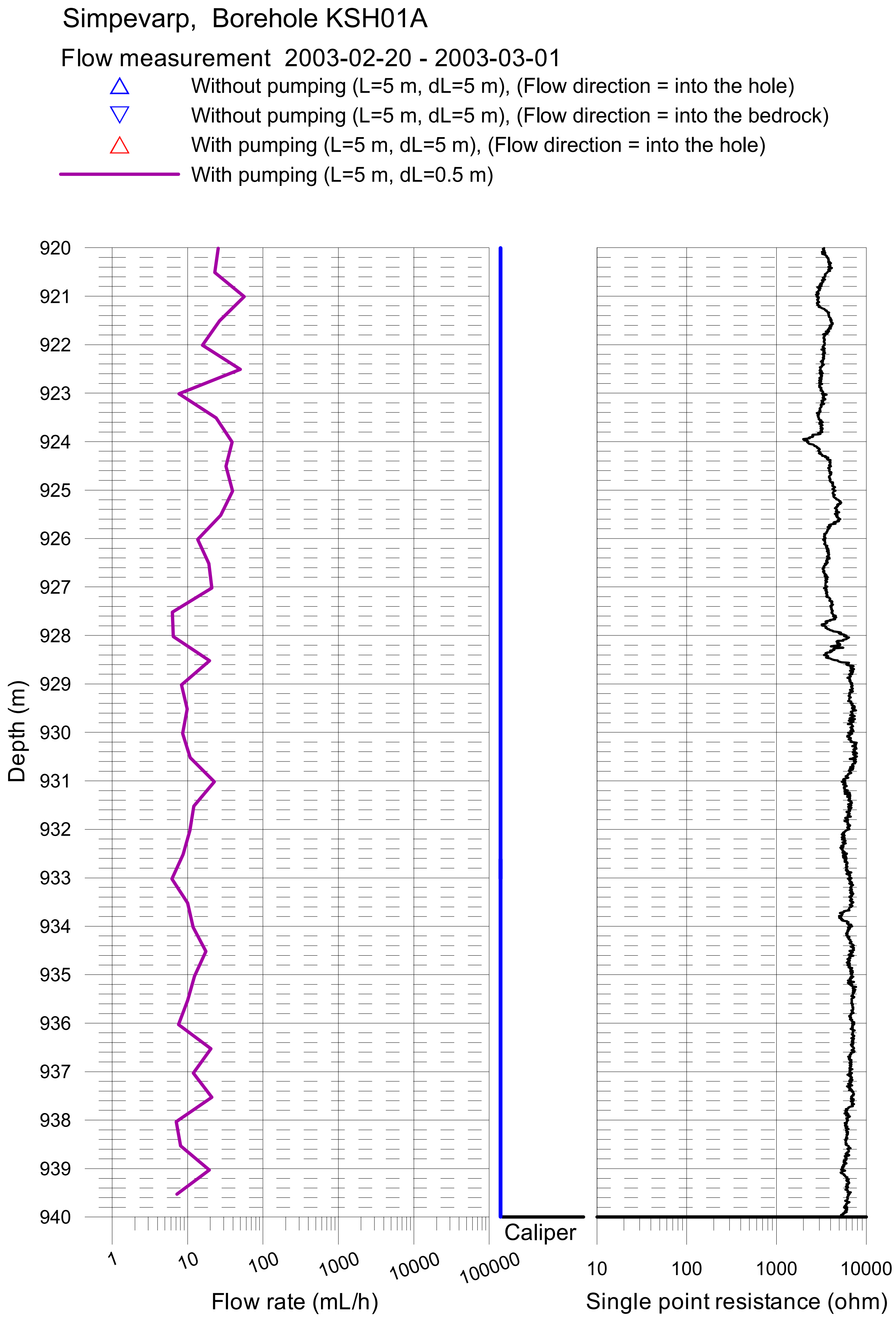
Flow measurement 2003-02-20 - 2003-03-01



Simpevarp, Borehole KSH01A

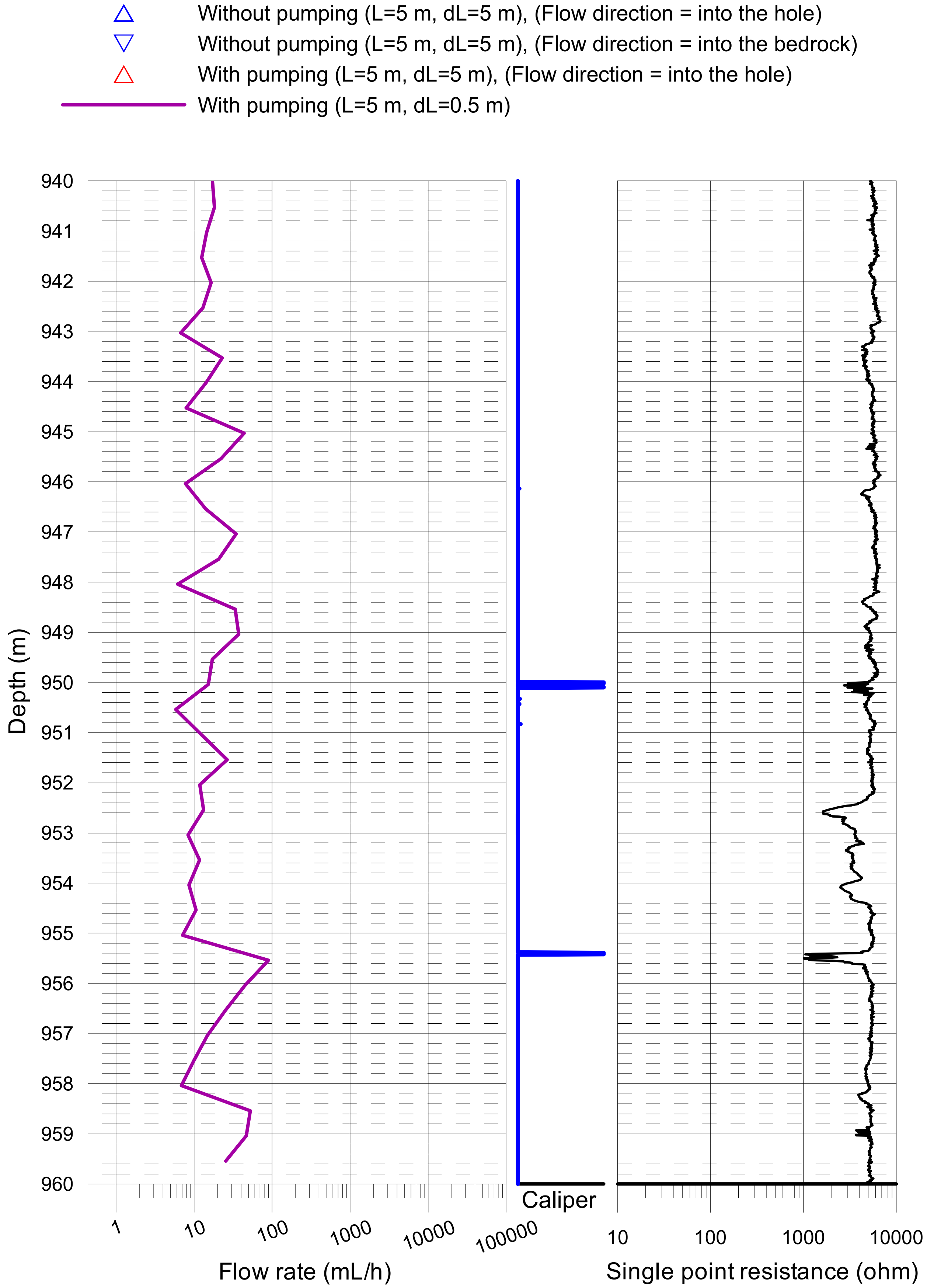
Flow measurement 2003-02-20 - 2003-03-01

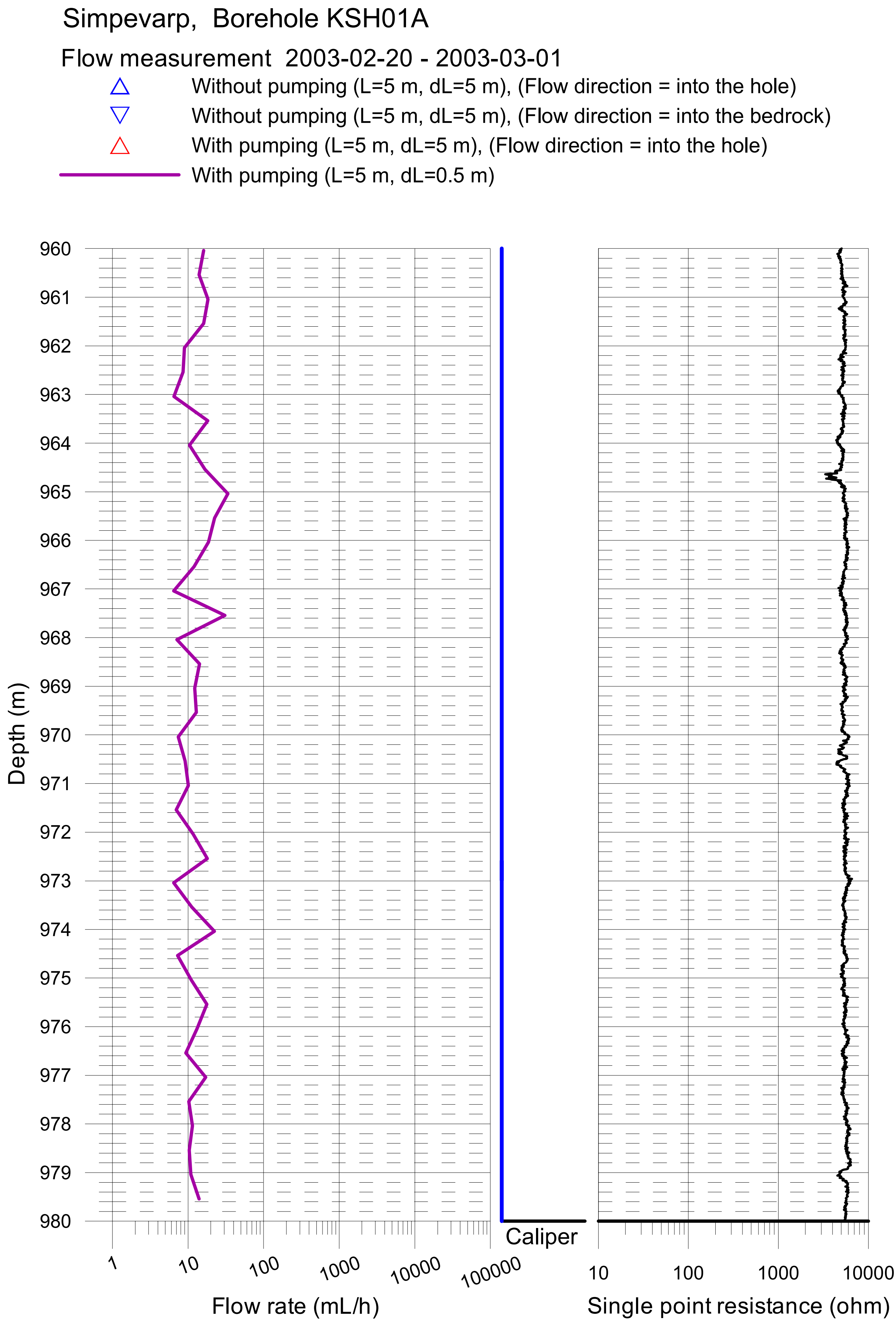



Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
With pumping (L=5 m, dL=0.5 m)
Depth (m)
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
Caliper
1
10
100
1000
10000
100000
Flow rate (mL/h)
10
100
1000
10000
Single point resistance (ohm)

Simpevarp, Borehole KSH01A

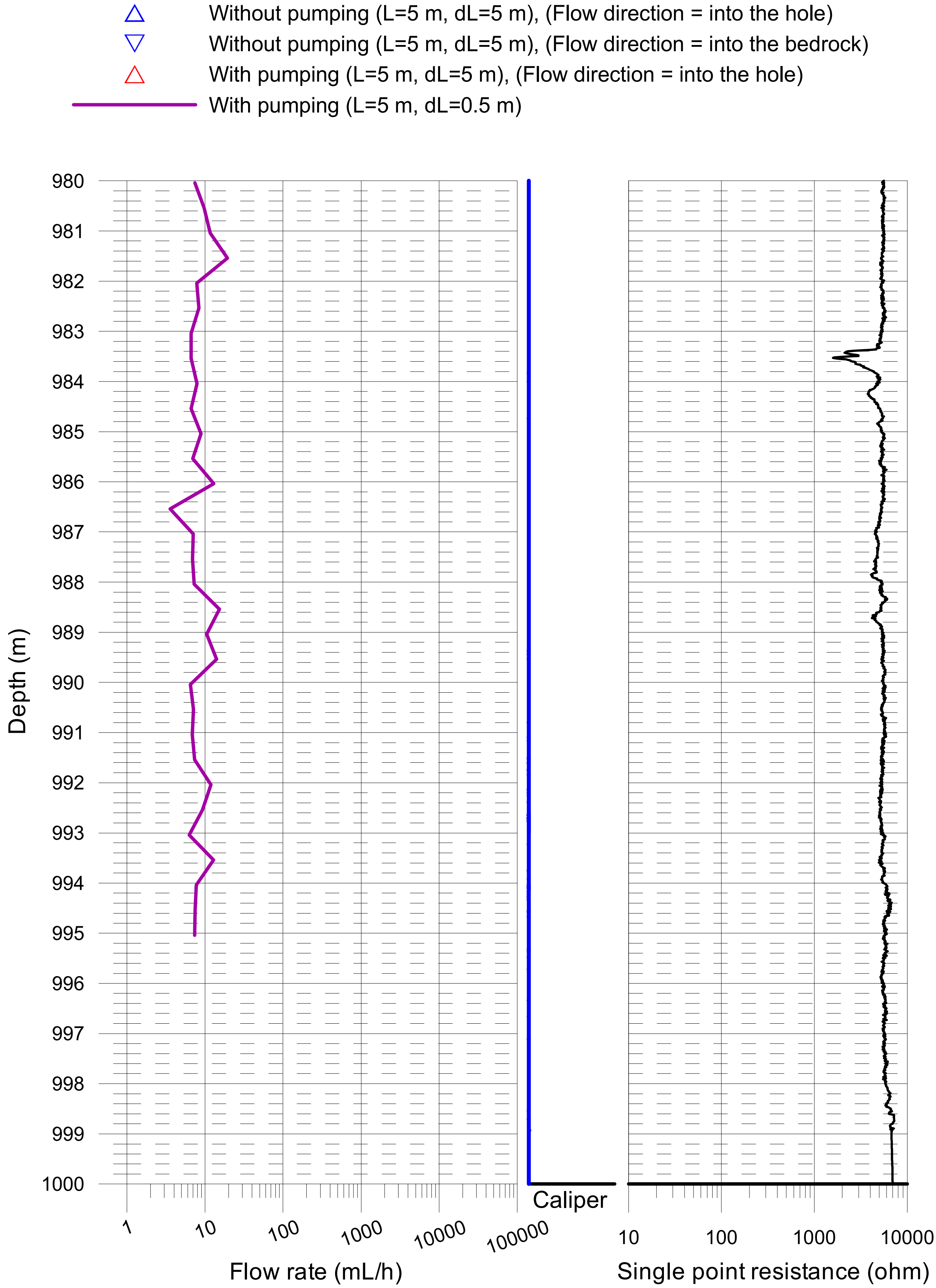
Flow measurement 2003-02-20 - 2003-03-01




Simpevarp, Borehole KSH01A
Flow measurement 2003-02-20 - 2003-03-01
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)
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
10
100
1000
10000
Single point resistance (ohm)

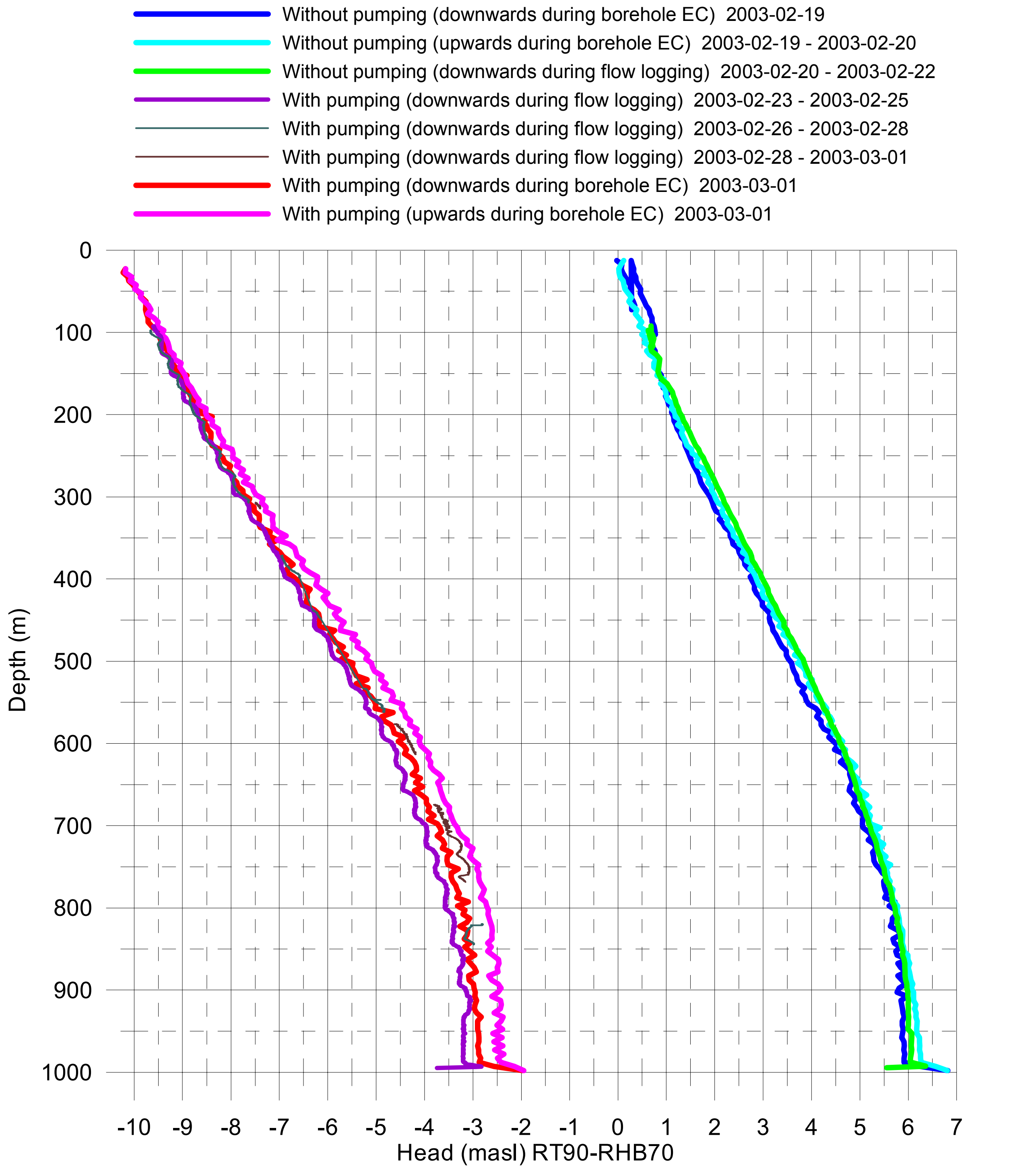
Simpevarp, Borehole KSH01A

Flow measurement 2003-02-20 - 2003-03-01



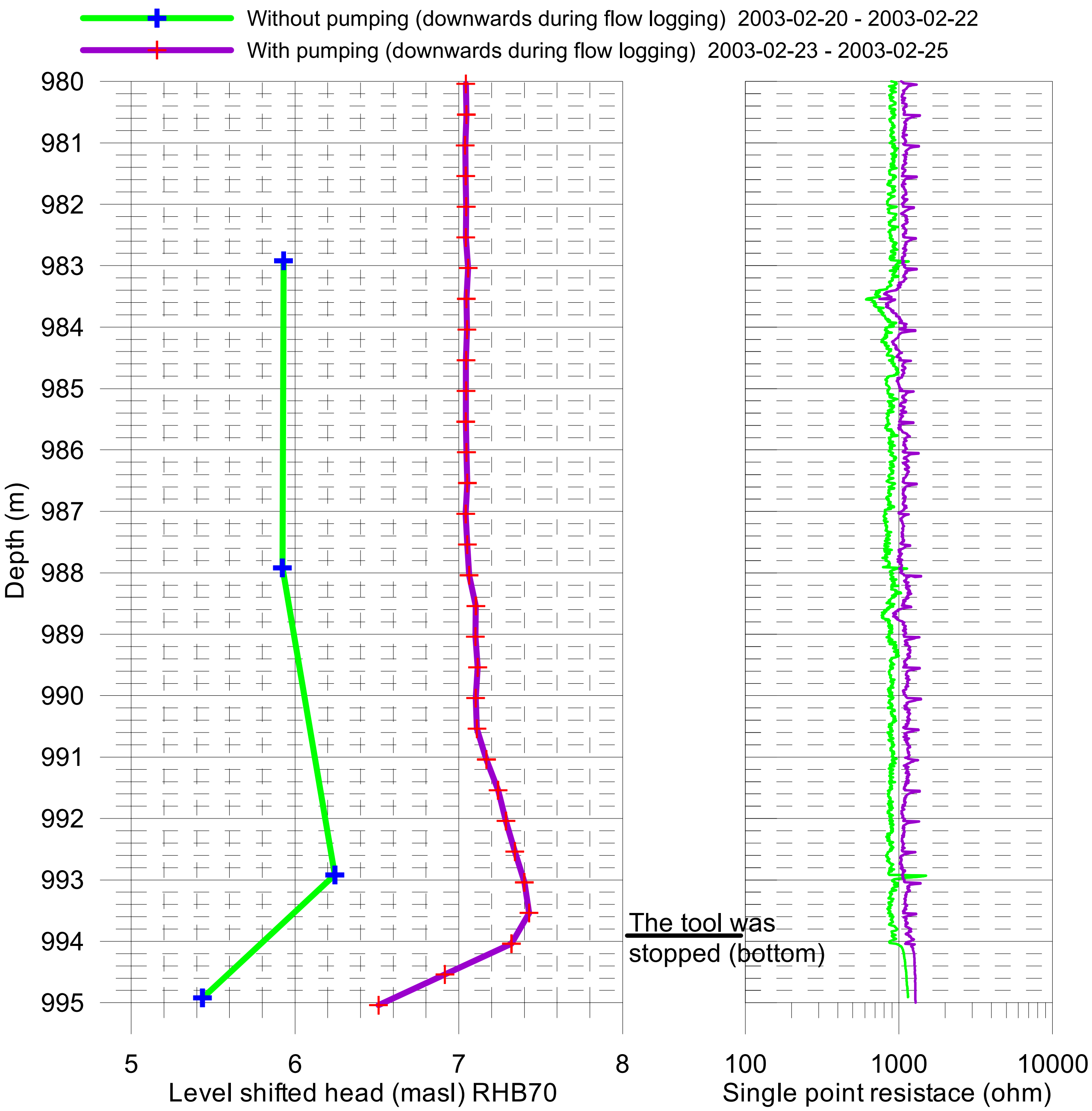
Head during flow logging in borehole KSH01A

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)



Level shifted head and SPR during flow logging in borehole KSH01A

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)
Level shifted head (masl) = Head (masl) - Water level (masl)



Results of the sequential logging

Depth1(m)	Borehole Head1(masl)	Flow1(ml/h)	Depth2(m)	Borehole Head2(masl)	Flow2(ml/h)	Formation Head(masl)	K(m/s)
105.29	0.726	0	105.3	-9.465	97		5.22E-10
110.28	0.729	14	110.29	-9.436	692	0.94	3.67E-09
115.28	0.691	0	115.29	-9.444	102		5.54E-10
120.28	0.683	91	120.29	-9.439	9316	0.78	5.01E-08
125.28	0.753	0	125.29	-9.399	186		1.01E-09
130.28	0.836	0	130.29	-9.305	0		
135.29	0.858	-33	135.29	-9.242	1263	0.6	7.05E-09
140.29	0.847	0	140.29	-9.228	149		8.15E-10
145.29	0.835	-61	145.29	-9.238	2680	0.61	1.50E-08
150.29	0.848	-29	150.29	-9.212	1731	0.68	9.61E-09
155.29	0.885	0	155.29	-9.107	760		4.18E-09
160.29	0.966	-234	160.29	-9.028	14725	0.81	8.22E-08
165.29	1.042	0	165.29	-8.991	1016		5.56E-09
170.29	1.1	0	170.29	-8.981	0		
175.29	1.136	0	175.29	-8.982	0		
180.28	1.167	0	180.28	-8.971	0		
185.28	1.194	0	185.28	-8.889	0		
190.28	1.229	0	190.28	-8.771	248		1.36E-09
195.28	1.26	0	195.28	-8.717	0		
200.28	1.302	0	200.28	-8.691	92		5.04E-10
205.28	1.341	0	205.28	-8.666	0		
210.28	1.384	-121	210.28	-8.641	6697	1.21	3.74E-08
215.28	1.427	0	215.28	-8.625	899		4.91E-09
220.28	1.467	0	220.28	-8.603	176		9.58E-10
225.28	1.507	0	225.28	-8.578	231		1.26E-09
230.29	1.547	0	230.29	-8.498	202		1.10E-09
235.29	1.586	0	235.29	-8.399	274		1.51E-09
240.29	1.64	0	240.29	-8.33	0		

Results of the sequential logging

Depth1(m)	Borehole Head1(masl)	Flow1(ml/h)	Depth2(m)	Borehole Head2(masl)	Flow2(ml/h)	Formation Head(masl)	K(m/s)
245.29	1.688	-101	245.29	-8.29	7102	1.55	3.97E-08
250.29	1.737	-245	250.29	-8.271	42264	1.68	2.33E-07
255.29	1.781	0	255.29	-8.264	90		4.94E-10
260.28	1.825	-293	260.28	-8.245	17613	1.66	9.77E-08
265.28	1.868	0	265.27	-8.178	1099		6.01E-09
270.27	1.909	-145	270.26	-8.069	18698	1.83	1.04E-07
275.27	1.952	0	275.26	-7.995	635		3.51E-09
280.27	1.992	0	280.26	-7.965	0		
285.27	2.029	0	285.26	-7.954	29		1.57E-10
290.28	2.071	-144	290.27	-7.95	53058	2.04	2.92E-07
295.28	2.117	0	295.27	-7.926	0		
300.28	2.16	0	300.27	-7.804	30		1.65E-10
305.28	2.192	0	305.27	-7.695	0		
310.28	2.232	0	310.27	-7.647	28		1.56E-10
315.28	2.274	0	315.27	-7.638	0		
320.28	2.314	0	320.27	-7.621	0		
325.28	2.363	0	325.27	-7.59	0		
330.29	2.412	0	330.27	-7.502	0		
335.29	2.446	0	335.27	-7.39	0		
340.29	2.482	0	340.27	-7.322	0		
345.29	2.524	0	345.27	-7.282	0		
350.29	2.562	0	350.27	-7.234	0		
355.29	2.6	0	355.27	-7.191	0		
360.28	2.646	0	360.28	-7.158	0		
365.27	2.702	0	365.29	-7.105	0		
370.27	2.746	0	370.29	-7.042	0		
375.27	2.769	0	375.29	-7.005	0		
380.27	2.81	0	380.29	-6.976	72		4.06E-10

Results of the sequential logging

Depth1(m)	Borehole Head1(masl)	Flow1(ml/h)	Depth2(m)	Borehole Head2(masl)	Flow2(ml/h)	Formation Head(masl)	K(m/s)
385.27	2.859	0	385.3	-6.949	0		
390.27	2.91	0	390.3	-6.923	14		8.04E-11
395.27	2.953	0	395.3	-6.894	0		
400.27	2.99	0	400.3	-6.792	0		
405.27	3.036	0	405.3	-6.679	0		
410.27	3.081	0	410.3	-6.619	0		
415.27	3.105	0	415.3	-6.584	0		
420.27	3.137	0	420.29	-6.576	0		
425.27	3.179	0	425.29	-6.563	0		
430.27	3.229	0	430.29	-6.524	0		
435.27	3.272	0	435.29	-6.424	0		
440.27	3.309	0	440.3	-6.309	0		
445.27	3.358	0	445.31	-6.267	30		1.69E-10
450.27	3.41	0	450.32	-6.267	0		
455.27	3.43	0	455.32	-6.276	0		
460.26	3.468	0	460.32	-6.233	0		
465.26	3.512	0	465.32	-6.13	0		
470.25	3.559	0	470.32	-6.033	0		
475.25	3.609	0	475.32	-5.977	0		
480.24	3.652	0	480.31	-5.951	0		
485.24	3.685	0	485.31	-5.939	0		
490.23	3.736	0	490.31	-5.924	0		
495.23	3.797	0	495.31	-5.875	0		
500.22	3.838	0	500.31	-5.76	0		
505.22	3.87	0	505.31	-5.661	0		
510.22	3.903	0	510.31	-5.613	0		
515.23	3.938	0	515.31	-5.583	0		
520.23	3.978	0	520.31	-5.563	0		
525.23	4.016	0	525.31	-5.542	0		

Results of the sequential logging

Depth1(m)	Borehole Head1(masl)	Flow1(ml/h)	Depth2(m)	Borehole Head2(masl)	Flow2(ml/h)	Formation Head(masl)	K(m/s)
530.24	4.057	0	530.3	-5.477	0		
535.24	4.09	0	535.3	-5.366	0		
540.24	4.129	0	540.3	-5.272	297		1.74E-09
545.25	4.175	0	545.3	-5.218	692		4.05E-09
550.25	4.21	0	550.3	-5.207	99		5.80E-10
555.26	4.237	0	555.31	-5.216	1201		6.98E-09
560.27	4.293	176	560.32	-5.178	10347	4.46	5.90E-08
565.28	4.336	0	565.33	-5.071	0		
570.28	4.37	0	570.32	-4.962	0		
575.28	4.4	0	575.32	-4.905	0		
580.28	4.449	0	580.32	-4.886	0		
585.28	4.498	0	585.31	-4.882	0		
590.28	4.538	691	590.31	-4.859	22421	4.84	1.27E-07
595.28	4.562	0	595.31	-4.77	0		
600.28	4.599	0	600.3	-4.67	37		2.18E-10
605.28	4.647	0	605.3	-4.624	0		
610.28	4.683	0	610.31	-4.591	36		2.11E-10
615.28	4.71	0	615.32	-4.584	0		
620.28	4.741	0	620.33	-4.588	0		
625.28	4.781	0	625.33	-4.57	0		
630.28	4.805	0	630.34	-4.49	0		
635.28	4.831	0	635.35	-4.414	0		
640.28	4.862	0	640.35	-4.398	0		
645.28	4.889	0	645.36	-4.41	0		
650.28	4.914	0	650.37	-4.427	0		
655.28	4.927	0	655.37	-4.435	0		
660.29	4.964	0	660.38	-4.324	0		
665.3	4.994	0	665.38	-4.221	0		
670.31	5.028	0	670.38	-4.188	0		

Results of the sequential logging

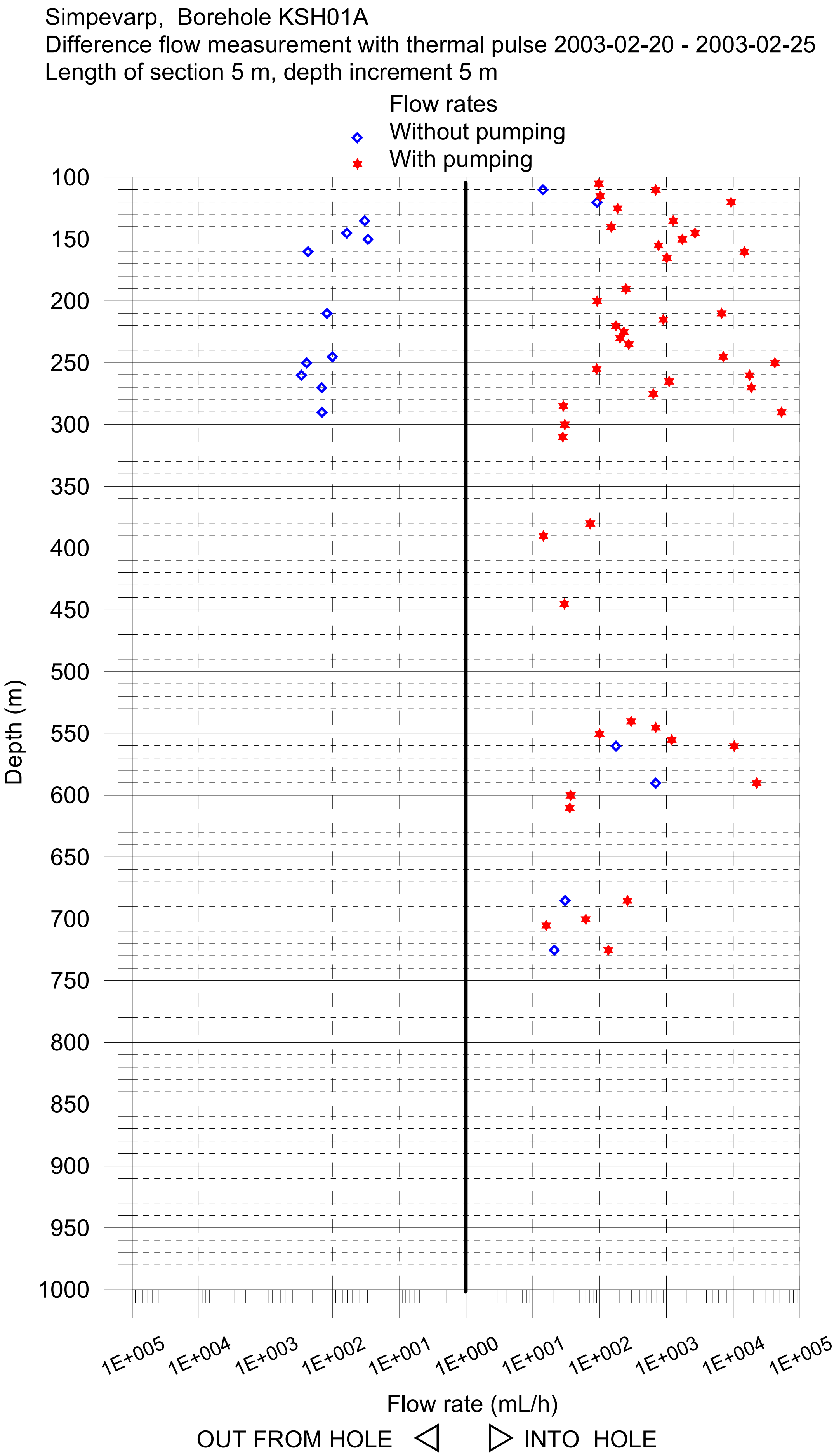
Depth1(m)	Borehole Head1(masl)	Flow1(ml/h)	Depth2(m)	Borehole Head2(masl)	Flow2(ml/h)	Formation Head(masl)	K(m/s)
675.31	5.059	0	675.39	-4.18	0		
680.32	5.089	0	680.39	-4.189	0		
685.33	5.119	30	685.4	-4.188	261	6.35	1.36E-09
690.33	5.15	0	690.4	-4.13	0		
695.34	5.174	0	695.41	-4.051	0		
700.35	5.204	0	700.42	-3.983	62		3.71E-10
705.35	5.228	0	705.42	-3.942	16		9.50E-11
710.36	5.259	0	710.42	-3.934	0		
715.36	5.3	0	715.42	-3.947	0		
720.36	5.329	0	720.43	-3.947	0		
725.37	5.345	21	725.43	-3.909	135	7.05	6.77E-10
730.37	5.366	0	730.43	-3.825	0		
735.37	5.4	0	735.43	-3.748	0		
740.37	5.424	0	740.43	-3.722	0		
745.37	5.45	0	745.43	-3.735	0		
750.37	5.485	0	750.43	-3.761	0		
755.37	5.505	0	755.43	-3.772	0		
760.37	5.519	0	760.43	-3.738	0		
765.36	5.538	0	765.44	-3.641	0		
770.36	5.583	0	770.44	-3.563	0		
775.36	5.621	0	775.44	-3.529	0		
780.36	5.642	0	780.44	-3.517	0		
785.36	5.66	0	785.44	-3.552	0		
790.35	5.664	0	790.45	-3.569	0		
795.35	5.694	0	795.45	-3.553	0		
800.35	5.725	0	800.45	-3.526	0		
805.35	5.733	0	805.45	-3.45	0		
810.36	5.759	0	810.45	-3.39	0		
815.36	5.768	0	815.46	-3.375	0		

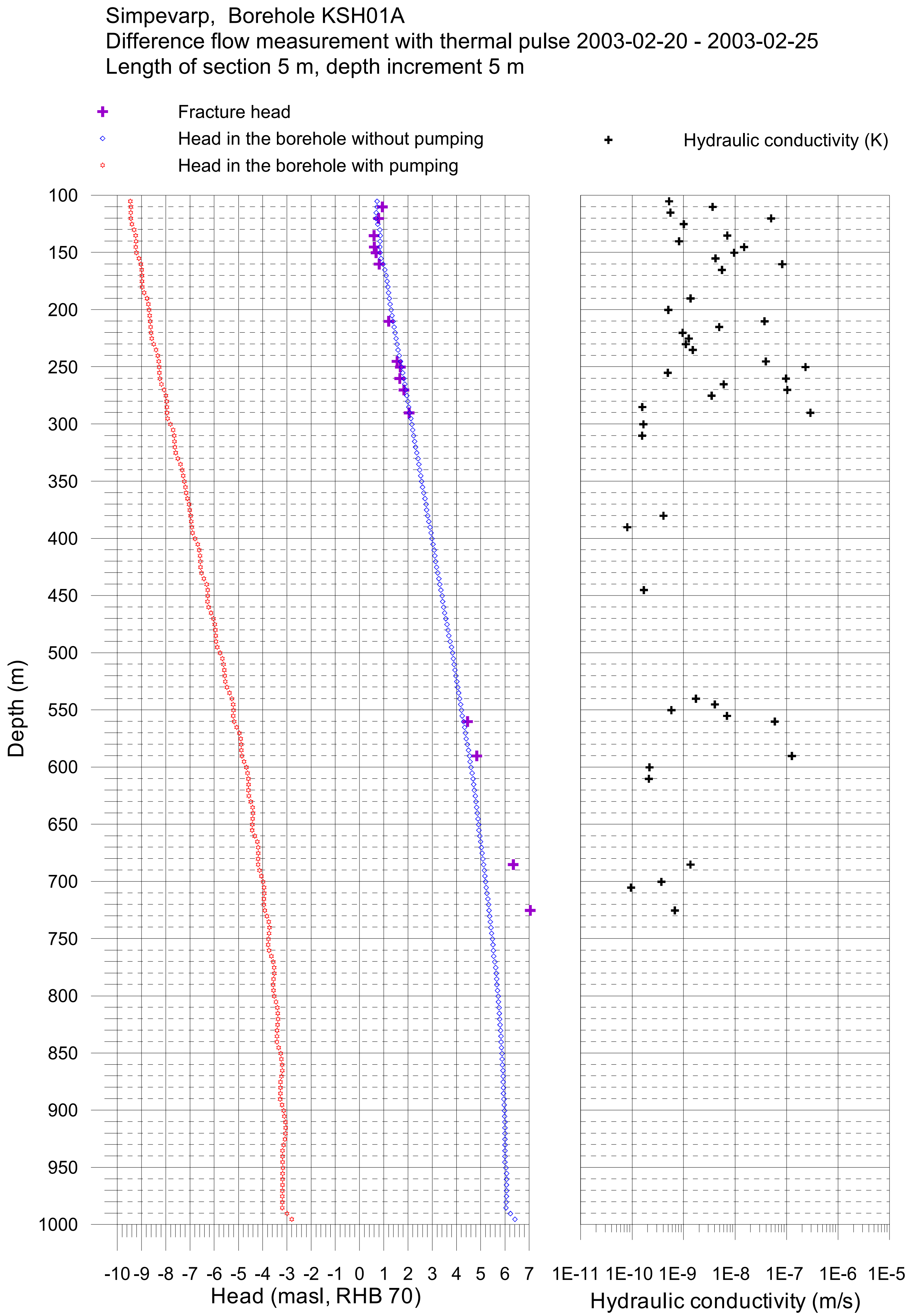
Results of the sequential logging

Depth1(m)	Borehole Head1(masl)	Flow1(ml/h)	Depth2(m)	Borehole Head2(masl)	Flow2(ml/h)	Formation Head(masl)	K(m/s)
820.36	5.783	0	820.46	-3.367	0		
825.37	5.801	0	825.46	-3.384	0		
830.37	5.823	0	830.46	-3.404	0		
835.38	5.839	0	835.46	-3.409	0		
840.38	5.842	0	840.47	-3.411	0		
845.38	5.857	0	845.47	-3.34	0		
850.39	5.881	0	850.47	-3.255	0		
855.39	5.883	0	855.47	-3.23	0		
860.39	5.896	0	860.47	-3.2	0		
865.4	5.919	0	865.48	-3.187	0		
870.4	5.928	0	870.48	-3.224	0		
875.4	5.931	0	875.48	-3.264	0		
880.41	5.934	0	880.48	-3.264	0		
885.41	5.94	0	885.48	-3.269	0		
890.41	5.958	0	890.49	-3.277	0		
895.42	5.972	0	895.49	-3.201	0		
900.42	5.984	0	900.49	-3.13	0		
905.42	5.99	0	905.49	-3.105	0		
910.43	5.998	0	910.5	-3.062	0		
915.43	6	0	915.5	-3.051	0		
920.43	6.002	0	920.51	-3.061	0		
925.44	6	0	925.51	-3.081	0		
930.44	6.005	0	930.52	-3.136	0		
935.45	6.005	0	935.52	-3.18	0		
940.45	6.002	0	940.53	-3.181	0		
945.45	5.997	0	945.53	-3.177	0		
950.46	6.04	0	950.54	-3.167	0		
955.44	6.071	0	955.54	-3.176	0		
960.42	6.069	0	960.54	-3.18	0		

Results of the sequential logging

Depth1(m)	Borehole Head1(masl)	Flow1(ml/h)	Depth2(m)	Borehole Head2(masl)	Flow2(ml/h)	Formation Head(masl)	K(m/s)
965.42	6.062	0	965.54	-3.18	0		
970.42	6.066	0	970.54	-3.186	0		
975.42	6.063	0	975.54	-3.187	0		
980.42	6.05	0	980.54	-3.19	0		
985.42	6.041	0	985.54	-3.192	0		
990.42	6.228	0	990.54	-2.994	0		
995.42	6.414	0	995.54	-2.797	0		


Simpevarp, Borehole KSH01A
Difference flow measurement with thermal pulse 2003-02-20 - 2003-02-25
Length of section 5 m, depth increment 5 m
Flow rates
Without pumping
With pumping
Depth (m)
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1E+005
1E+004
1E+003
1E+002
1E+001
1E+000
1E+001
1E+002
1E+003
1E+004
1E+005
Flow rate (mL/h)
OUT FROM HOLE
INTO HOLE


Simpevarp, Borehole KSH01A
Difference flow measurement with thermal pulse 2003-02-20 - 2003-02-25
Length of section 5 m, depth increment 5 m
Fracture head
Head in the borehole without pumping
Head in the borehole with pumping
Hydraulic conductivity (K)
Depth (m)
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7
Head (masl, RHB 70)
1E-11 1E-10 1E-9 1E-8 1E-7 1E-6 1E-5
Hydraulic conductivity (m/s)

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)
KSH01A	102.79	997.92	5A	**20030222**	**12:18**	20030223	13:00	**20030301**	**15:48**	5	5	5.40E-05	

5. PFL-DIFFERENCE	FLOW LOGGING -	Basic test data									
t_{p1}	**t_{p2}**	**t_{F1}**	**t_{F2}**	**h_0**	**h_1**	**h_2**	**s_1**	**s_2**	**T**	Reference	Comments
									Entire hole		
(s)	(s)	(s)	(s)	(m)	(m)	(m)	(m)	(m)	(m2/s)	(-)	(-)
617400		83160		0.12	-10.25		-10.37		5.1 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
KSH01A	102.80	107.80	5	5A	0	2.69E-08	-	0.726	-9.465	-	2.61E-09	-	-	1.138	1.542	8.61	9.38	
KSH01A	107.79	112.79	5	5A	3.89E-09	1.92E-07	-	0.729	-9.436	-	1.84E-08	-	0.94	1.133	1.598	8.64	9.44	
KSH01A	112.79	117.79	5	5A	0	2.83E-08	-	0.691	-9.444	-	2.77E-09	-	-	1.142	1.289	8.71	9.34	
KSH01A	117.79	122.79	5	5A	2.53E-08	2.59E-06	-	0.683	-9.439	-	2.51E-07	-	0.78	1.152	1.655	8.74	9.56	
KSH01A	122.79	127.79	5	5A	0	5.17E-08	-	0.753	-9.399	-	5.05E-09	-	-	1.162	1.566	8.80	9.59	
KSH01A	127.79	132.79	5	5A	0	0	-	0.836	-9.305	-	-	1.59E-10	-	1.174	1.345	8.89	9.63	
KSH01A	132.79	137.79	5	5A	-9.17E-09	3.51E-07	-	0.858	-9.242	-	3.53E-08	-	0.6	1.185	1.602	8.94	9.73	
KSH01A	137.79	142.79	5	5A	0	4.14E-08	-	0.847	-9.228	-	4.08E-09	-	-	1.192	1.359	9.02	9.73	
KSH01A	142.79	147.79	5	5A	-1.69E-08	7.44E-07	-	0.835	-9.238	-	7.5E-08	-	0.61	1.205	1.392	9.07	9.80	
KSH01A	147.79	152.79	5	5A	-8.06E-09	4.81E-07	-	0.848	-9.212	-	4.81E-08	-	0.68	1.219	1.506	9.13	9.94	
KSH01A	152.79	157.79	5	5A	0	2.11E-07	-	0.885	-9.107	-	2.09E-08	-	-	1.237	1.438	9.23	9.82	
KSH01A	157.79	162.79	5	5A	-6.5E-08	4.09E-06	-	0.966	-9.028	-	4.11E-07	-	0.81	1.254	1.452	9.27	10.04	
KSH01A	162.79	167.79	5	5A	0	2.82E-07	-	1.042	-8.991	-	2.78E-08	-	-	1.249	1.658	9.30	10.09	
KSH01A	167.79	172.79	5	5A	0	0	-	1.1	-8.981	-	-	1.59E-10	-	1.273	1.684	9.39	10.14	
KSH01A	172.79	177.79	5	5A	0	0	-	1.136	-8.982	-	-	1.59E-10	-	1.300	1.720	9.45	10.18	
KSH01A	177.78	182.78	5	5A	0	0	-	1.167	-8.971	-	-	1.59E-10	-	1.310	1.663	9.51	10.24	
KSH01A	182.78	187.78	5	5A	0	0	-	1.194	-8.889	-	-	1.59E-10	-	1.321	1.564	9.59	10.27	
KSH01A	187.78	192.78	5	5A	0	6.89E-08	-	1.229	-8.771	-	6.8E-09	-	-	1.337	1.591	9.64	10.33	
KSH01A	192.78	197.78	5	5A	0	0	-	1.26	-8.717	-	-	1.59E-10	-	1.350	1.677	9.71	10.38	
KSH01A	197.78	202.78	5	5A	0	2.56E-08	-	1.302	-8.691	-	2.52E-09	-	-	1.370	1.391	9.80	10.34	
KSH01A	202.78	207.78	5	5A	0	0	-	1.341	-8.666	-	-	1.59E-10	-	1.382	1.419	9.87	10.38	
KSH01A	207.78	212.78	5	5A	-3.36E-08	1.86E-06	-	1.384	-8.641	-	1.87E-07	-	1.21	1.390	1.621	9.91	10.54	
KSH01A	212.78	217.78	5	5A	0	2.50E-07	-	1.427	-8.625	-	2.46E-08	-	-	1.405	1.699	9.98	10.58	
KSH01A	217.78	222.78	5	5A	0	4.89E-08	-	1.467	-8.603	-	4.79E-09	-	-	1.422	1.696	10.03	10.63	
KSH01A	222.78	227.78	5	5A	0	6.42E-08	-	1.507	-8.578	-	6.3E-09	-	-	1.439	1.700	10.09	10.66	
KSH01A	227.79	232.79	5	5A	0	5.61E-08	-	1.547	-8.498	-	5.5E-09	-	-	1.456	1.592	10.15	10.69	
KSH01A	232.79	237.79	5	5A	0	7.61E-08	-	1.586	-8.399	-	7.55E-09	-	-	1.474	1.635	10.23	10.72	
KSH01A	237.79	242.79	5	5A	0	0	-	1.64	-8.33	-	-	1.59E-10	-	1.491	1.449	10.29	10.69	
KSH01A	242.79	247.79	5	5A	-2.81E-08	1.97E-06	-	1.688	-8.29	-	1.99E-07	-	1.55	1.513	1.485	10.39	10.73	
KSH01A	247.79	252.79	5	5A	-6.81E-08	1.17E-05	-	1.737	-8.271	-	1.17E-06	-	1.68	1.486	1.774	10.43	10.88	

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
KSH01A	252.79	257.79	5	5A	0	2.5E-08	-	1.781	-8.264	-	2.47E-09	-	100	1.510	1.651	10.52	10.88	
KSH01A	257.78	262.78	5	5A	-8.14E-08	4.89E-06	-	1.825	-8.245	-	4.89E-07	-	1.66	1.505	1.680	10.55	11.02	
KSH01A	262.77	267.77	5	5A	0	3.05E-07	-	1.868	-8.178	-	3.01E-08	-	-	1.511	1.700	10.66	11.00	
KSH01A	267.76	272.76	5	5A	-4.03E-08	5.19E-06	-	1.909	-8.069	-	5.2E-07	-	1.83	1.507	1.726	10.70	11.14	
KSH01A	272.76	277.76	5	5A	0	1.76E-07	-	1.952	-7.995	-	1.76E-08	-	-	1.511	1.776	10.77	11.16	
KSH01A	277.76	282.76	5	5A	0	0	-	1.992	-7.965	-	-	1.59E-10	-	1.511	1.769	10.82	11.19	
KSH01A	282.76	287.76	5	5A	0	8.06E-09	-	2.029	-7.954	-	7.85E-10	-	-	1.513	1.730	10.92	11.22	
KSH01A	287.77	292.77	5	5A	-4E-08	1.47E-05	-	2.071	-7.95	-	1.46E-06	-	2.04	1.509	1.736	10.96	11.30	
KSH01A	292.77	297.77	5	5A	0	0	-	2.117	-7.926	-	-	1.59E-10	-	1.509	1.719	11.01	11.37	
KSH01A	297.77	302.77	5	5A	0	8.33E-09	-	2.16	-7.804	-	8.25E-10	-	-	1.505	1.775	11.08	11.43	
KSH01A	302.77	307.77	5	5A	0	0	-	2.192	-7.695	-	-	1.59E-10	-	1.506	1.771	11.14	11.50	
KSH01A	307.77	312.77	5	5A	0	7.78E-09	-	2.232	-7.647	-	7.8E-10	-	-	1.503	1.776	11.20	11.57	
KSH01A	312.77	317.77	5	5A	0	0	-	2.274	-7.638	-	-	1.59E-10	-	1.500	1.783	11.26	11.63	
KSH01A	317.77	322.77	5	5A	0	0	-	2.314	-7.621	-	-	1.59E-10	-	1.498	1.784	11.33	11.70	
KSH01A	322.77	327.77	5	5A	0	0	-	2.363	-7.59	-	-	1.59E-10	-	1.494	1.801	11.40	11.77	
KSH01A	327.78	332.78	5	5A	0	0	-	2.412	-7.502	-	-	1.59E-10	-	1.492	1.809	11.46	11.85	
KSH01A	332.78	337.78	5	5A	0	0	-	2.446	-7.39	-	-	1.59E-10	-	1.487	1.820	11.53	11.90	
KSH01A	337.78	342.78	5	5A	0	0	-	2.482	-7.322	-	-	1.59E-10	-	1.484	1.823	11.59	11.98	
KSH01A	342.78	347.78	5	5A	0	0	-	2.524	-7.282	-	-	1.59E-10	-	1.479	1.829	11.66	12.04	
KSH01A	347.78	352.78	5	5A	0	0	-	2.562	-7.234	-	-	1.59E-10	-	1.476	1.835	11.74	12.12	
KSH01A	352.78	357.78	5	5A	0	0	-	2.6	-7.191	-	-	1.59E-10	-	1.472	1.840	11.81	12.18	
KSH01A	357.78	362.78	5	5A	0	0	-	2.646	-7.158	-	-	1.59E-10	-	1.469	1.844	11.88	12.26	
KSH01A	362.78	367.78	5	5A	0	0	-	2.702	-7.105	-	-	1.59E-10	-	1.466	1.850	11.94	12.32	
KSH01A	367.78	372.78	5	5A	0	0	-	2.746	-7.042	-	-	1.59E-10	-	1.461	1.853	12.01	12.40	
KSH01A	372.78	377.78	5	5A	0	0	-	2.769	-7.005	-	-	1.59E-10	-	1.457	1.854	12.07	12.48	
KSH01A	377.78	382.78	5	5A	0	2E-08	-	2.81	-6.976	-	2.03E-09	-	-	1.453	1.861	12.15	12.53	
KSH01A	382.79	387.79	5	5A	0	0	-	2.859	-6.949	-	-	1.59E-10	-	1.451	1.863	12.20	12.61	
KSH01A	387.79	392.79	5	5A	0	3.89E-09	-	2.91	-6.923	-	4.02E-10	-	-	1.446	1.869	12.28	12.67	
KSH01A	392.79	397.79	5	5A	0	0	-	2.953	-6.894	-	-	1.59E-10	-	1.443	1.872	12.34	12.74	
KSH01A	397.79	402.79	5	5A	0	0	-	2.99	-6.792	-	-	1.59E-10	-	1.440	1.869	12.41	12.82	

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
KSH01A	402.79	407.79	5	5A	0	0	-	3.036	-6.679	-	-	1.59E-10	-	1.437	1.877	12.47	12.87	
KSH01A	407.79	412.79	5	5A	0	0	-	3.081	-6.619	-	-	1.59E-10	-	1.435	1.887	12.53	12.94	
KSH01A	412.79	417.79	5	5A	0	0	-	3.105	-6.584	-	-	1.59E-10	-	1.433	1.889	12.61	13.02	
KSH01A	417.78	422.78	5	5A	0	0	-	3.137	-6.576	-	-	1.59E-10	-	1.431	1.895	12.68	13.09	
KSH01A	422.78	427.78	5	5A	0	0	-	3.179	-6.563	-	-	1.59E-10	-	1.427	1.898	12.74	13.16	
KSH01A	427.78	432.78	5	5A	0	0	-	3.229	-6.524	-	-	1.59E-10	-	1.426	1.900	12.82	13.24	
KSH01A	432.78	437.78	5	5A	0	0	-	3.272	-6.424	-	-	1.59E-10	-	1.424	1.891	12.89	13.31	
KSH01A	437.79	442.79	5	5A	0	0	-	3.309	-6.309	-	-	1.59E-10	-	1.423	1.903	12.95	13.36	
KSH01A	442.79	447.79	5	5A	0	8.33E-09	-	3.358	-6.267	-	8.45E-10	-	-	1.421	1.908	13.07	13.44	
KSH01A	447.80	452.80	5	5A	0	0	-	3.41	-6.267	-	-	1.59E-10	-	1.422	1.921	13.10	13.50	
KSH01A	452.80	457.80	5	5A	0	0	-	3.43	-6.276	-	-	1.59E-10	-	1.422	1.922	13.18	13.59	
KSH01A	457.79	462.79	5	5A	0	0	-	3.468	-6.233	-	-	1.59E-10	-	1.421	1.924	13.25	13.65	
KSH01A	462.79	467.79	5	5A	0	0	-	3.512	-6.13	-	-	1.59E-10	-	1.422	1.912	13.30	13.71	
KSH01A	467.79	472.79	5	5A	0	0	-	3.559	-6.033	-	-	1.59E-10	-	1.421	1.929	13.37	13.79	
KSH01A	472.79	477.79	5	5A	0	0	-	3.609	-5.977	-	-	1.59E-10	-	1.420	1.933	13.44	13.86	
KSH01A	477.77	482.77	5	5A	0	0	-	3.652	-5.951	-	-	1.59E-10	-	1.420	1.937	13.51	13.93	
KSH01A	482.77	487.77	5	5A	0	0	-	3.685	-5.939	-	-	1.59E-10	-	1.421	1.945	13.57	14.01	
KSH01A	487.77	492.77	5	5A	0	0	-	3.736	-5.924	-	-	1.59E-10	-	1.419	1.944	13.66	14.07	
KSH01A	492.77	497.77	5	5A	0	0	-	3.797	-5.875	-	-	1.59E-10	-	1.419	1.946	13.73	14.14	
KSH01A	497.76	502.76	5	5A	0	0	-	3.838	-5.76	-	-	1.59E-10	-	1.419	1.931	13.79	14.20	
KSH01A	502.76	507.76	5	5A	0	0	-	3.87	-5.661	-	-	1.59E-10	-	1.419	1.947	13.85	14.28	
KSH01A	507.76	512.76	5	5A	0	0	-	3.903	-5.613	-	-	1.59E-10	-	1.419	1.952	13.90	14.33	
KSH01A	512.77	517.77	5	5A	0	0	-	3.938	-5.583	-	-	1.58E-10	-	1.431	1.958	13.96	14.40	
KSH01A	517.77	522.77	5	5A	0	0	-	3.978	-5.563	-	-	1.59E-10	-	1.437	1.968	14.06	14.48	
KSH01A	522.77	527.77	5	5A	0	0	-	4.016	-5.542	-	-	1.59E-10	-	1.438	1.963	14.11	14.56	
KSH01A	527.77	532.77	5	5A	0	0	-	4.057	-5.477	-	-	1.58E-10	-	1.441	1.961	14.20	14.62	
KSH01A	532.77	537.77	5	5A	0	0	-	4.09	-5.366	-	-	1.58E-10	-	1.452	1.914	14.27	14.72	
KSH01A	537.77	542.77	5	5A	0	8.25E-08	-	4.129	-5.272	-	8.7E-09	-	-	1.469	1.897	14.35	14.79	
KSH01A	542.77	547.77	5	5A	0	1.92E-07	-	4.175	-5.218	-	2.03E-08	-	-	1.475	1.958	14.43	14.82	
KSH01A	547.77	552.77	5	5A	0	2.75E-08	-	4.21	-5.207	-	2.9E-09	-	-	1.478	1.866	14.50	14.88	

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
KSH01A	552.78	557.78	5	5A	0	3.34E-07	-	4.237	-5.216	-	3.49E-08	-	-	1.452	1.837	14.61	14.91	
KSH01A	557.79	562.79	5	5A	4.89E-08	2.87E-06	-	4.293	-5.178	-	2.95E-07	-	4.46	1.437	1.815	14.63	15.01	
KSH01A	562.80	567.80	5	5A	0	0	-	4.336	-5.071	-	-	1.59E-10	-	1.421	1.784	14.70	15.09	
KSH01A	567.80	572.80	5	5A	0	0	-	4.37	-4.962	-	-	1.59E-10	-	1.411	1.782	14.77	15.17	
KSH01A	572.80	577.80	5	5A	0	0	-	4.4	-4.905	-	-	1.59E-10	-	1.403	1.787	14.84	15.23	
KSH01A	577.80	582.80	5	5A	0	0	-	4.449	-4.886	-	-	1.59E-10	-	1.400	1.827	14.94	15.31	
KSH01A	582.79	587.79	5	5A	0	0	-	4.498	-4.882	-	-	1.59E-10	-	1.400	1.904	15.04	15.35	
KSH01A	587.79	592.79	5	5A	1.92E-07	6.23E-06	-	4.538	-4.859	-	6.35E-07	-	4.84	1.375	1.699	15.09	15.41	
KSH01A	592.79	597.79	5	5A	0	0	-	4.562	-4.77	-	-	1.59E-10	-	1.335	1.522	15.15	15.48	
KSH01A	597.79	602.79	5	5A	0	1.03E-08	-	4.599	-4.67	-	1.09E-09	-	-	1.305	1.405	15.21	15.53	
KSH01A	602.79	607.79	5	5A	0	0	-	4.647	-4.624	-	-	1.59E-10	-	1.284	1.344	15.26	15.59	
KSH01A	607.79	612.79	5	5A	0	1E-08	-	4.683	-4.591	-	1.06E-09	-	-	1.258	1.296	15.33	15.66	
KSH01A	612.80	617.80	5	5A	0	0	-	4.71	-4.584	-	-	1.59E-10	-	1.240	1.252	15.40	15.72	
KSH01A	617.80	622.80	5	5A	0	0	-	4.741	-4.588	-	-	1.59E-10	-	1.215	1.227	15.46	15.79	
KSH01A	622.80	627.80	5	5A	0	0	-	4.781	-4.57	-	-	1.59E-10	-	1.196	1.211	15.53	15.86	
KSH01A	627.81	632.81	5	5A	0	0	-	4.805	-4.49	-	-	1.59E-10	-	1.181	1.192	15.59	15.92	
KSH01A	632.82	637.82	5	5A	0	0	-	4.831	-4.414	-	-	1.59E-10	-	1.165	1.183	15.67	16.01	
KSH01A	637.82	642.82	5	5A	0	0	-	4.862	-4.398	-	-	1.59E-10	-	1.150	1.171	15.76	16.08	
KSH01A	642.82	647.82	5	5A	0	0	-	4.889	-4.41	-	-	1.59E-10	-	1.138	1.167	15.81	16.14	
KSH01A	647.83	652.83	5	5A	0	0	-	4.914	-4.427	-	-	1.59E-10	-	1.130	1.167	15.90	16.23	
KSH01A	652.83	657.83	5	5A	0	0	-	4.927	-4.435	-	-	1.59E-10	-	1.118	1.163	15.95	16.30	
KSH01A	657.84	662.84	5	5A	0	0	-	4.964	-4.324	-	-	1.59E-10	-	1.110	1.164	16.03	16.36	
KSH01A	662.84	667.84	5	5A	0	0	-	4.994	-4.221	-	-	1.59E-10	-	1.103	1.168	16.11	16.42	
KSH01A	667.85	672.85	5	5A	0	0	-	5.028	-4.188	-	-	1.59E-10	-	1.098	1.247	16.17	16.50	
KSH01A	672.85	677.85	5	5A	0	0	-	5.059	-4.18	-	-	1.6E-10	-	1.089	1.393	16.32	16.62	
KSH01A	677.86	682.86	5	5A	0	0	-	5.089	-4.189	-	-	1.6E-10	-	1.088	1.398	16.35	16.71	
KSH01A	682.87	687.87	5	5A	8.33E-09	7.25E-08	-	5.119	-4.188	-	6.8E-09	-	6.35	1.074	1.334	16.41	16.75	
KSH01A	687.87	692.87	5	5A	0	0	-	5.15	-4.13	-	-	1.59E-10	-	1.063	1.272	16.50	16.83	
KSH01A	692.88	697.88	5	5A	0	0	-	5.174	-4.051	-	-	1.59E-10	-	1.053	1.231	16.55	16.92	
KSH01A	697.88	702.88	5	5A	0	1.72E-08	-	5.204	-3.983	-	1.86E-09	-	-	1.040	1.195	16.63	16.98	

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
KSH01A	702.88	707.88	5	5A	0	4.44E-09	-	5.228	-3.942	-	4.75E-10	-	-	1.025	1.156	16.71	17.06	
KSH01A	707.89	712.89	5	5A	0	0	-	5.259	-3.934	-	-	1.59E-10	-	1.011	1.130	16.79	17.13	
KSH01A	712.89	717.89	5	5A	0	0	-	5.3	-3.947	-	-	1.59E-10	-	1.001	1.125	16.86	17.21	
KSH01A	717.89	722.89	5	5A	0	0	-	5.329	-3.947	-	-	1.59E-10	-	0.987	1.111	16.94	17.32	
KSH01A	722.90	727.90	5	5A	5.83E-09	3.75E-08	-	5.345	-3.909	-	3.39E-09	-	7.05	0.973	1.111	17.00	17.32	
KSH01A	727.90	732.90	5	5A	0	0	-	5.366	-3.825	-	-	1.59E-10	-	0.953	1.023	17.07	17.43	
KSH01A	732.90	737.90	5	5A	0	0	-	5.4	-3.748	-	-	1.59E-10	-	0.936	0.991	17.15	17.51	
KSH01A	737.90	742.90	5	5A	0	0	-	5.424	-3.722	-	-	1.59E-10	-	0.918	0.964	17.23	17.59	
KSH01A	742.90	747.90	5	5A	0	0	-	5.45	-3.735	-	-	1.59E-10	-	0.897	0.946	17.30	17.66	
KSH01A	747.90	752.90	5	5A	0	0	-	5.485	-3.761	-	-	1.59E-10	-	0.884	0.938	17.38	17.75	
KSH01A	752.90	757.90	5	5A	0	0	-	5.505	-3.772	-	-	1.59E-10	-	0.868	0.928	17.45	17.80	
KSH01A	757.90	762.90	5	5A	0	0	-	5.519	-3.738	-	-	1.59E-10	-	0.849	0.904	17.53	17.89	
KSH01A	762.90	767.90	5	5A	0	0	-	5.538	-3.641	-	-	1.59E-10	-	0.830	0.869	17.60	17.96	
KSH01A	767.90	772.90	5	5A	0	0	-	5.583	-3.563	-	-	1.59E-10	-	0.811	0.840	17.67	18.03	
KSH01A	772.90	777.90	5	5A	0	0	-	5.621	-3.529	-	-	1.59E-10	-	0.789	0.815	17.76	18.12	
KSH01A	777.90	782.90	5	5A	0	0	-	5.642	-3.517	-	-	1.59E-10	-	0.771	0.797	17.83	18.19	
KSH01A	782.90	787.90	5	5A	0	0	-	5.66	-3.552	-	-	1.59E-10	-	0.751	0.768	17.91	18.28	
KSH01A	787.90	792.90	5	5A	0	0	-	5.664	-3.569	-	-	1.59E-10	-	0.732	0.748	18.00	18.37	
KSH01A	792.90	797.90	5	5A	0	0	-	5.694	-3.553	-	-	1.59E-10	-	0.715	0.737	18.07	18.44	
KSH01A	797.90	802.90	5	5A	0	0	-	5.725	-3.526	-	-	1.59E-10	-	0.697	0.717	18.16	18.52	
KSH01A	802.90	807.90	5	5A	0	0	-	5.733	-3.45	-	-	1.59E-10	-	0.674	0.693	18.25	18.62	
KSH01A	807.90	812.90	5	5A	0	0	-	5.759	-3.39	-	-	1.59E-10	-	0.660	0.677	18.32	18.68	
KSH01A	812.91	817.91	5	5A	0	0	-	5.768	-3.375	-	-	1.59E-10	-	0.641	0.660	18.37	18.76	
KSH01A	817.91	822.91	5	5A	0	0	-	5.783	-3.367	-	-	1.59E-10	-	0.626	0.643	18.47	18.83	
KSH01A	822.91	827.91	5	5A	0	0	-	5.801	-3.384	-	-	1.59E-10	-	0.609	0.626	18.55	18.91	
KSH01A	827.91	832.91	5	5A	0	0	-	5.823	-3.404	-	-	1.59E-10	-	0.591	0.611	18.62	18.99	
KSH01A	832.92	837.92	5	5A	0	0	-	5.839	-3.409	-	-	1.59E-10	-	0.583	0.606	18.71	19.08	
KSH01A	837.92	842.92	5	5A	0	0	-	5.842	-3.411	-	-	1.59E-10	-	0.562	0.582	18.79	19.15	
KSH01A	842.92	847.92	5	5A	0	0	-	5.857	-3.34	-	-	1.59E-10	-	0.549	0.571	18.85	19.23	
KSH01A	847.93	852.93	5	5A	0	0	-	5.881	-3.255	-	-	1.59E-10	-	0.540	0.559	18.91	19.31	

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
KSH01A	852.93	857.93	5	5A	0	0	-	5.883	-3.23	-	-	1.59E-10	-	0.527	0.556	19.01	19.39	
KSH01A	857.93	862.93	5	5A	0	0	-	5.896	-3.2	-	-	1.59E-10	-	0.513	0.534	19.07	19.45	
KSH01A	862.94	867.94	5	5A	0	0	-	5.919	-3.187	-	-	1.59E-10	-	0.501	0.525	19.14	19.53	
KSH01A	867.94	872.94	5	5A	0	0	-	5.928	-3.224	-	-	1.59E-10	-	0.491	0.514	19.22	19.60	
KSH01A	872.94	877.94	5	5A	0	0	-	5.931	-3.264	-	-	1.59E-10	-	0.481	0.505	19.31	19.67	
KSH01A	877.95	882.95	5	5A	0	0	-	5.934	-3.264	-	-	1.59E-10	-	0.472	0.495	19.39	19.80	
KSH01A	882.95	887.95	5	5A	0	0	-	5.94	-3.269	-	-	1.59E-10	-	0.464	0.488	19.44	19.85	
KSH01A	887.95	892.95	5	5A	0	0	-	5.958	-3.277	-	-	1.59E-10	-	0.456	0.481	19.52	19.92	
KSH01A	892.96	897.96	5	5A	0	0	-	5.972	-3.201	-	-	1.59E-10	-	0.456	0.475	19.52	20.00	
KSH01A	897.96	902.96	5	5A	0	0	-	5.984	-3.13	-	-	1.59E-10	-	0.446	0.471	19.70	20.08	
KSH01A	902.96	907.96	5	5A	0	0	-	5.99	-3.105	-	-	1.59E-10	-	0.436	0.467	19.79	20.15	
KSH01A	907.97	912.97	5	5A	0	0	-	5.998	-3.062	-	-	1.59E-10	-	0.433	0.463	19.87	20.25	
KSH01A	912.97	917.97	5	5A	0	0	-	6	-3.051	-	-	1.59E-10	-	0.429	0.459	19.94	20.32	
KSH01A	917.97	922.97	5	5A	0	0	-	6.002	-3.061	-	-	1.59E-10	-	0.426	0.457	20.01	20.39	
KSH01A	922.98	927.98	5	5A	0	0	-	6	-3.081	-	-	1.59E-10	-	0.423	0.457	20.09	20.39	
KSH01A	927.98	932.98	5	5A	0	0	-	6.005	-3.136	-	-	1.59E-10	-	0.420	0.451	20.16	20.54	
KSH01A	932.99	937.99	5	5A	0	0	-	6.005	-3.18	-	-	1.59E-10	-	0.419	0.449	20.22	20.61	
KSH01A	937.99	942.99	5	5A	0	0	-	6.002	-3.181	-	-	1.59E-10	-	0.417	0.448	20.30	20.68	
KSH01A	942.99	947.99	5	5A	0	0	-	5.997	-3.177	-	-	1.59E-10	-	0.415	0.446	20.38	20.75	
KSH01A	948.00	953.00	5	5A	0	0	-	6.04	-3.167	-	-	1.59E-10	-	0.417	0.445	20.47	20.85	
KSH01A	952.99	957.99	5	5A	0	0	-	6.071	-3.176	-	-	1.59E-10	-	0.416	0.446	20.54	20.92	
KSH01A	957.98	962.98	5	5A	0	0	-	6.069	-3.18	-	-	1.59E-10	-	0.412	0.443	20.60	20.99	
KSH01A	962.98	967.98	5	5A	0	0	-	6.062	-3.18	-	-	1.59E-10	-	0.411	0.443	20.70	21.08	
KSH01A	967.98	972.98	5	5A	0	0	-	6.066	-3.186	-	-	1.59E-10	-	0.411	0.444	20.77	21.15	
KSH01A	972.98	977.98	5	5A	0	0	-	6.063	-3.187	-	-	1.59E-10	-	0.412	0.441	20.83	21.23	
KSH01A	977.98	982.98	5	5A	0	0	-	6.05	-3.19	-	-	1.59E-10	-	0.411	0.442	20.91	21.31	
KSH01A	982.98	987.98	5	5A	0	0	-	6.041	-3.192	-	-	1.59E-10	-	0.411	0.442	21.00	21.38	
KSH01A	987.98	992.98	5	5A	0	0	-	6.228	-2.994	-	-	1.59E-10	-	0.411	0.441	21.05	21.44	
KSH01A	992.98	997.98	5	5A	0	0	-	6.414	-2.797	-	-	1.59E-10	-	0.411	0.441	21.05	21.44	

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	T_{ef}	Comments
KSH01A	102.9	1.0	0.1	5B	-	1.33E-08	-	0.71	-9.62	-	1.28E-09	7.98E-10	-	-	-	
KSH01A	104.9	1.0	0.1	5B	-	5.00E-09	-	0.72	-9.56	-	4.81E-10	8.01E-10	-	-	-	Uncertain
KSH01A	107.8	1.0	0.1	5B	-	6.39E-09	-	0.74	-9.47	-	6.19E-10	8.08E-10	-	-	-	Uncertain
KSH01A	108.4	1.0	0.1	5B	-	1.39E-08	-	0.74	-9.45	-	1.35E-09	8.09E-10	-	-	-	Uncertain
KSH01A	108.9	1.0	0.1	5B	-	1.67E-08	-	0.73	-9.45	-	1.62E-09	8.09E-10	-	-	-	
KSH01A	109.2	1.0	0.1	5B	-	9.44E-09	-	0.73	-9.45	-	9.17E-10	8.09E-10	-	-	-	Uncertain
KSH01A	111.3	1.0	0.1	5B	-	1.43E-07	-	0.73	-9.47	-	1.39E-08	8.08E-10	-	-	-	
KSH01A	116.3	1.0	0.1	5B	-	1.72E-08	-	0.68	-9.50	-	1.67E-09	8.10E-10	-	-	-	
KSH01A	118.2	1.0	0.1	5B	-	2.22E-07	-	0.67	-9.50	-	2.16E-08	8.11E-10	-	-	-	Uncertain
KSH01A	118.5	1.0	0.1	5B	-	1.75E-06	-	0.68	-9.49	-	1.70E-07	8.11E-10	-	-	-	
KSH01A	118.7	1.0	0.1	5B	-	5.56E-07	-	0.68	-9.49	-	5.41E-08	8.11E-10	-	-	-	Uncertain
KSH01A	119.2	1.0	0.1	5B	-	2.92E-07	-	0.68	-9.48	-	2.84E-08	8.12E-10	-	-	-	
KSH01A	119.7	1.0	0.1	5B	-	9.72E-08	-	0.68	-9.48	-	9.46E-09	8.11E-10	-	-	-	Uncertain
KSH01A	122.3	1.0	0.1	5B	-	5.14E-08	-	0.69	-9.46	-	5.01E-09	8.12E-10	-	-	-	
KSH01A	127.1	1.0	0.1	5B	-	3.28E-08	-	0.79	-9.36	-	3.19E-09	8.12E-10	-	-	-	
KSH01A	137.5	1.0	0.1	5B	-	3.19E-07	-	0.85	-9.29	-	3.11E-08	8.12E-10	-	-	-	
KSH01A	139	1.0	0.1	5B	-	1.67E-08	-	0.85	-9.30	-	1.62E-09	8.12E-10	-	-	-	Uncertain
KSH01A	144.8	1.0	0.1	5B	-	6.00E-07	-	0.84	-9.26	-	5.88E-08	8.16E-10	-	-	-	
KSH01A	146.6	1.0	0.1	5B	-	1.14E-07	-	0.83	-9.22	-	1.12E-08	8.20E-10	-	-	-	
KSH01A	147.6	1.0	0.1	5B	-	4.17E-08	-	0.83	-9.19	-	4.11E-09	8.23E-10	-	-	-	Uncertain
KSH01A	149.8	1.0	0.1	5B	-	1.39E-07	-	0.85	-9.13	-	1.38E-08	8.26E-10	-	-	-	
KSH01A	150.2	1.0	0.1	5B	-	2.78E-07	-	0.85	-9.12	-	2.76E-08	8.27E-10	-	-	-	
KSH01A	152.2	1.0	0.1	5B	-	4.72E-08	-	0.86	-9.07	-	4.71E-09	8.30E-10	-	-	-	
KSH01A	153.6	1.0	0.1	5B	-	1.81E-08	-	0.87	-9.08	-	1.79E-09	8.28E-10	-	-	-	Uncertain
KSH01A	156.9	1.0	0.1	5B	-	6.39E-08	-	0.90	-9.09	-	6.33E-09	8.25E-10	-	-	-	
KSH01A	157.6	1.0	0.1	5B	-	8.33E-08	-	0.91	-9.10	-	8.23E-09	8.23E-10	-	-	-	
KSH01A	158.1	1.0	0.1	5B	-	1.81E-07	-	0.92	-9.10	-	1.78E-08	8.23E-10	-	-	-	
KSH01A	159.6	1.0	0.1	5B	-	3.24E-06	-	0.95	-9.10	-	3.19E-07	8.20E-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
KSH01A	161.4	1.0	0.1	5B	-	4.67E-07	-	0.99	-9.09	-	4.58E-08	8.17E-10	-	-	-	
KSH01A	163.2	1.0	0.1	5B	-	3.89E-08	-	1.02	-9.10	-	3.80E-09	8.14E-10	-	-	-	
KSH01A	165.4	1.0	0.1	5B	-	2.31E-07	-	1.04	-9.08	-	2.25E-08	8.14E-10	-	-	-	
KSH01A	192.5	1.0	0.1	5B	-	1.53E-08	-	1.25	-8.81	-	1.50E-09	8.19E-10	-	-	-	Uncertain
KSH01A	198.6	1.0	0.1	5B	-	2.64E-08	-	1.28	-8.77	-	2.60E-09	8.20E-10	-	-	-	
KSH01A	207.9	1.0	0.1	5B	-	1.73E-06	-	1.36	-8.57	-	1.72E-07	8.31E-10	-	-	-	
KSH01A	212.3	1.0	0.1	5B	-	4.86E-08	-	1.41	-8.57	-	4.82E-09	8.26E-10	-	-	-	
KSH01A	213.8	1.0	0.1	5B	-	2.11E-07	-	1.42	-8.55	-	2.09E-08	8.27E-10	-	-	-	
KSH01A	221.5	1.0	0.1	5B	-	1.25E-08	-	1.48	-8.55	-	1.23E-09	8.22E-10	-	-	-	Uncertain
KSH01A	223	1.0	0.1	5B	-	5.56E-08	-	1.49	-8.53	-	5.48E-09	8.22E-10	-	-	-	
KSH01A	231.8	1.0	0.1	5B	-	6.11E-08	-	1.56	-8.49	-	6.01E-09	8.20E-10	-	-	-	
KSH01A	234	1.0	0.1	5B	-	2.22E-08	-	1.58	-8.47	-	2.19E-09	8.20E-10	-	-	-	
KSH01A	235.5	1.0	0.1	5B	-	1.11E-08	-	1.59	-8.44	-	1.10E-09	8.22E-10	-	-	-	Uncertain
KSH01A	237.3	1.0	0.1	5B	-	4.03E-08	-	1.60	-8.41	-	3.98E-09	8.23E-10	-	-	-	
KSH01A	247.8	1.0	0.1	5B	-	1.94E-06	-	1.71	-8.22	-	1.94E-07	8.30E-10	-	-	-	
KSH01A	249	1.0	0.1	5B	-	4.17E-08	-	1.72	-8.23	-	4.14E-09	8.28E-10	-	-	-	
KSH01A	250.4	1.0	0.1	5B	-	5.14E-07	-	1.74	-8.23	-	5.10E-08	8.27E-10	-	-	-	
KSH01A	251	1.0	0.1	5B	-	3.39E-06	-	1.75	-8.24	-	3.36E-07	8.26E-10	-	-	-	
KSH01A	255.7	1.0	0.1	5B	-	2.36E-08	-	1.78	-8.23	-	2.33E-09	8.23E-10	-	-	-	
KSH01A	259.3	1.0	0.1	5B	-	1.53E-08	-	1.81	-8.21	-	1.51E-09	8.22E-10	-	-	-	Uncertain
KSH01A	259.7	1.0	0.1	5B	-	4.69E-06	-	1.82	-8.22	-	4.62E-07	8.21E-10	-	-	-	
KSH01A	266.6	1.0	0.1	5B	-	2.92E-07	-	1.88	-8.13	-	2.88E-08	8.23E-10	-	-	-	
KSH01A	269.4	1.0	0.1	5B	-	2.46E-06	-	1.90	-8.02	-	2.45E-07	8.31E-10	-	-	-	
KSH01A	271.1	1.0	0.1	5B	-	2.13E-06	-	1.92	-7.98	-	2.13E-07	8.33E-10	-	-	-	
KSH01A	272.9	1.0	0.1	5B	-	2.36E-08	-	1.93	-7.93	-	2.37E-09	8.35E-10	-	-	-	
KSH01A	274	1.0	0.1	5B	-	1.40E-07	-	1.94	-7.92	-	1.41E-08	8.36E-10	-	-	-	
KSH01A	286.9	1.0	0.1	5B	-	4.17E-09	-	2.04	-7.93	-	4.14E-10	8.27E-10	-	-	-	Uncertain
KSH01A	290.2	1.0	0.1	5B	-	1.33E-06	-	2.07	-7.89	-	1.32E-07	8.28E-10	-	-	-	
KSH01A	290.8	1.0	0.1	5B	-	1.19E-05	-	2.08	-7.88	-	1.19E-06	8.28E-10	-	-	-	
KSH01A	299.8	1.0	0.1	5B	-	8.33E-09	-	2.16	-7.73	-	8.34E-10	8.34E-10	-	-	-	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
KSH01A	311.8	1.0	0.1	5B	-	3.89E-09	-	2.25	-7.42	-	3.98E-10	8.53E-10	-	-	-	Uncertain
KSH01A	312	1.0	0.1	5B	-	3.89E-09	-	2.25	-7.42	-	3.98E-10	8.53E-10	-	-	-	Uncertain
KSH01A	379.5	1.0	0.1	5B	-	1.11E-08	-	2.80	-6.90	-	1.13E-09	8.50E-10	-	-	-	Uncertain
KSH01A	382.7	1.0	0.1	5B	-	8.33E-09	-	2.84	-6.86	-	8.50E-10	8.50E-10	-	-	-	Uncertain
KSH01A	392.4	1.0	0.1	5B	-	3.89E-09	-	2.93	-6.65	-	4.01E-10	8.60E-10	-	-	-	Uncertain
KSH01A	445.3	1.0	0.1	5B	-	8.33E-09	-	3.36	-6.19	-	8.63E-10	8.63E-10	-	-	-	Uncertain
KSH01A	542	1.0	0.1	5B	-	6.94E-09	-	4.15	-5.13	-	7.40E-10	8.88E-10	-	-	-	Uncertain
KSH01A	542.3	1.0	0.1	5B	-	2.08E-08	-	4.15	-5.12	-	2.22E-09	8.89E-10	-	-	-	
KSH01A	543.2	1.0	0.1	5B	-	8.61E-08	-	4.16	-5.12	-	9.18E-09	8.89E-10	-	-	-	Uncertain
KSH01A	544	1.0	0.1	5B	-	9.44E-08	-	4.16	-5.11	-	1.01E-08	8.89E-10	-	-	-	
KSH01A	544.3	1.0	0.1	5B	-	9.72E-09	-	4.17	-5.10	-	1.04E-09	8.89E-10	-	-	-	
KSH01A	552	1.0	0.1	5B	-	1.39E-08	-	4.22	-4.91	-	1.51E-09	9.03E-10	-	-	-	
KSH01A	556.2	1.0	0.1	5B	-	9.72E-09	-	4.24	-4.88	-	1.05E-09	9.03E-10	-	-	-	Uncertain
KSH01A	557.5	1.0	0.1	5B	-	2.96E-07	-	4.25	-4.83	-	3.22E-08	9.08E-10	-	-	-	
KSH01A	558.4	1.0	0.1	5B	-	2.22E-06	-	4.26	-4.84	-	2.41E-07	9.05E-10	-	-	-	
KSH01A	560.2	1.0	0.1	5B	-	3.89E-07	-	4.29	-4.85	-	4.21E-08	9.02E-10	-	-	-	Uncertain
KSH01A	590.4	1.0	0.1	5B	-	5.97E-06	-	4.54	-4.38	-	6.63E-07	9.25E-10	-	-	-	
KSH01A	601.8	1.0	0.1	5B	-	1.00E-08	-	4.62	-4.27	-	1.11E-09	9.28E-10	-	-	-	Uncertain
KSH01A	611.4	1.0	0.1	5B	-	1.00E-08	-	4.69	-4.20	-	1.11E-09	9.28E-10	-	-	-	Uncertain
KSH01A	685	1.0	0.1	5B	-	7.50E-08	-	5.12	-3.67	-	8.45E-09	9.38E-10	-	-	-	
KSH01A	701.4	1.0	0.1	5B	-	1.53E-08	-	5.21	-3.55	-	1.72E-09	9.40E-10	-	-	-	Uncertain
KSH01A	702.6	1.0	0.1	5B	-	3.89E-09	-	5.22	-3.51	-	4.41E-10	9.44E-10	-	-	-	Uncertain
KSH01A	704.3	1.0	0.1	5B	-	4.17E-09	-	5.23	-3.55	-	4.70E-10	9.40E-10	-	-	-	Uncertain
KSH01A	727.1	1.0	0.1	5B	-	3.61E-08	-	5.35	-3.24	-	4.16E-09	9.59E-10	-	-	-	Uncertain

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)
102.795	107.795	2	2	0	0	0	0
107.785	112.785	5	4	1	0	0	0
112.785	117.785	1	1	0	0	0	0
117.785	122.785	6	0	3	3	0	0
122.785	127.785	1	0	1	0	0	0
127.785	132.785	0	0	0	0	0	0
132.79	137.79	1	0	0	1	0	0
137.79	142.79	1	1	0	0	0	0
142.79	147.79	3	0	2	1	0	0
147.79	152.79	3	0	2	0	0	0
152.79	157.79	3	1	2	0	0	0
157.79	162.79	3	0	1	1	1	0
162.79	167.79	2	0	2	0	0	0
167.79	172.79	0	0	0	0	0	0
172.79	177.79	0	0	0	0	0	0
177.78	182.78	0	0	0	0	0	0
182.78	187.78	0	0	0	0	0	0
187.78	192.78	1	1	0	0	0	0
192.78	197.78	0	0	0	0	0	0
197.78	202.78	1	1	0	0	0	0
202.78	207.78	0	0	0	0	0	0
207.78	212.78	2	0	1	1	0	0
212.78	217.78	1	0	1	0	0	0
217.78	222.78	1	1	0	0	0	0
222.78	227.78	1	0	1	0	0	0
227.79	232.79	1	0	1	0	0	0
232.79	237.79	3	2	1	0	0	0
237.79	242.79	0	0	0	0	0	0
242.79	247.79	0	0	0	0	0	0
247.79	252.79	4	0	1	2	1	0
252.79	257.79	1	1	0	0	0	0
257.78	262.78	2	1	0	0	1	0
262.775	267.775	1	0	0	1	0	0
267.765	272.765	2	0	0	2	0	0
272.765	277.765	2	1	1	0	0	0
277.765	282.765	0	0	0	0	0	0
282.765	287.765	1	1	0	0	0	0
287.775	292.775	2	0	0	1	1	0
292.775	297.775	0	0	0	0	0	0
297.775	302.775	1	1	0	0	0	0
302.775	307.775	0	0	0	0	0	0
307.775	312.775	2	2	0	0	0	0
312.775	317.775	0	0	0	0	0	0
317.775	322.775	0	0	0	0	0	0
322.775	327.775	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)
327.78	332.78	0	0	0	0	0	0
332.78	337.78	0	0	0	0	0	0
337.78	342.78	0	0	0	0	0	0
342.78	347.78	0	0	0	0	0	0
347.78	352.78	0	0	0	0	0	0
352.78	357.78	0	0	0	0	0	0
357.78	362.78	0	0	0	0	0	0
362.78	367.78	0	0	0	0	0	0
367.78	372.78	0	0	0	0	0	0
372.78	377.78	0	0	0	0	0	0
377.78	382.78	2	2	0	0	0	0
382.785	387.785	0	0	0	0	0	0
387.785	392.785	1	1	0	0	0	0
392.785	397.785	0	0	0	0	0	0
397.785	402.785	0	0	0	0	0	0
402.785	407.785	0	0	0	0	0	0
407.785	412.785	0	0	0	0	0	0
412.785	417.785	0	0	0	0	0	0
417.78	422.78	0	0	0	0	0	0
422.78	427.78	0	0	0	0	0	0
427.78	432.78	0	0	0	0	0	0
432.78	437.78	0	0	0	0	0	0
437.785	442.785	0	0	0	0	0	0
442.79	447.79	1	1	0	0	0	0
447.795	452.795	0	0	0	0	0	0
452.795	457.795	0	0	0	0	0	0
457.79	462.79	0	0	0	0	0	0
462.79	467.79	0	0	0	0	0	0
467.785	472.785	0	0	0	0	0	0
472.785	477.785	0	0	0	0	0	0
477.775	482.775	0	0	0	0	0	0
482.775	487.775	0	0	0	0	0	0
487.77	492.77	0	0	0	0	0	0
492.77	497.77	0	0	0	0	0	0
497.765	502.765	0	0	0	0	0	0
502.765	507.765	0	0	0	0	0	0
507.765	512.765	0	0	0	0	0	0
512.77	517.77	0	0	0	0	0	0
517.77	522.77	0	0	0	0	0	0
522.77	527.77	0	0	0	0	0	0
527.77	532.77	0	0	0	0	0	0
532.77	537.77	0	0	0	0	0	0
537.77	542.77	2	2	0	0	0	0
542.775	547.775	3	1	2	0	0	0
547.775	552.775	1	1	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)
552.785	557.785	2	1	0	1	0	0
557.795	562.795	2	0	0	2	0	0
562.805	567.805	0	0	0	0	0	0
567.8	572.8	0	0	0	0	0	0
572.8	577.8	0	0	0	0	0	0
577.8	582.8	0	0	0	0	0	0
582.795	587.795	0	0	0	0	0	0
587.795	592.795	1	0	0	0	1	0
592.795	597.795	0	0	0	0	0	0
597.79	602.79	1	1	0	0	0	0
602.79	607.79	0	0	0	0	0	0
607.795	612.795	1	1	0	0	0	0
612.8	617.8	0	0	0	0	0	0
617.805	622.805	0	0	0	0	0	0
622.805	627.805	0	0	0	0	0	0
627.81	632.81	0	0	0	0	0	0
632.815	637.815	0	0	0	0	0	0
637.815	642.815	0	0	0	0	0	0
642.82	647.82	0	0	0	0	0	0
647.825	652.825	0	0	0	0	0	0
652.825	657.825	0	0	0	0	0	0
657.835	662.835	0	0	0	0	0	0
662.84	667.84	0	0	0	0	0	0
667.845	672.845	0	0	0	0	0	0
672.85	677.85	0	0	0	0	0	0
677.855	682.855	0	0	0	0	0	0
682.865	687.865	1	0	1	0	0	0
687.865	692.865	0	0	0	0	0	0
692.875	697.875	0	0	0	0	0	0
697.885	702.885	2	2	0	0	0	0
702.885	707.885	1	1	0	0	0	0
707.89	712.89	0	0	0	0	0	0
712.89	717.89	0	0	0	0	0	0
717.895	722.895	0	0	0	0	0	0
722.9	727.9	1	0	1	0	0	0
727.9	732.9	0	0	0	0	0	0
732.9	737.9	0	0	0	0	0	0
737.9	742.9	0	0	0	0	0	0
742.9	747.9	0	0	0	0	0	0
747.9	752.9	0	0	0	0	0	0
752.9	757.9	0	0	0	0	0	0
757.9	762.9	0	0	0	0	0	0
762.9	767.9	0	0	0	0	0	0
767.9	772.9	0	0	0	0	0	0
772.9	777.9	0	0	0	0	0	0
777.9	782.9	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)
842.925	847.925	0	0	0	0	0	0
847.93	852.93	0	0	0	0	0	0
852.93	857.93	0	0	0	0	0	0
857.93	862.93	0	0	0	0	0	0
862.94	867.94	0	0	0	0	0	0
867.94	872.94	0	0	0	0	0	0
872.94	877.94	0	0	0	0	0	0
877.945	882.945	0	0	0	0	0	0
882.945	887.945	0	0	0	0	0	0
887.95	892.95	0	0	0	0	0	0
892.955	897.955	0	0	0	0	0	0
897.955	902.955	0	0	0	0	0	0
902.955	907.955	0	0	0	0	0	0
907.965	912.965	0	0	0	0	0	0
912.965	917.965	0	0	0	0	0	0
917.97	922.97	0	0	0	0	0	0
922.975	927.975	0	0	0	0	0	0
927.98	932.98	0	0	0	0	0	0
932.985	937.985	0	0	0	0	0	0
937.99	942.99	0	0	0	0	0	0
942.99	947.99	0	0	0	0	0	0
948	953	0	0	0	0	0	0
952.99	957.99	0	0	0	0	0	0
957.98	962.98	0	0	0	0	0	0
962.98	967.98	0	0	0	0	0	0
967.98	972.98	0	0	0	0	0	0
972.98	977.98	0	0	0	0	0	0
977.98	982.98	0	0	0	0	0	0
982.98	987.98	0	0	0	0	0	0
987.98	992.98	0	0	0	0	0	0
992.98	997.98	0	0	0	0	0	0

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Calculation of conductive fracture frequency