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Oskarshamn site investigation

Difference flow measurements in borehole KAV01 at Ävrö

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PRG-Tec Oy

September 2004

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Key words: Simpevarp, Hydrogeology, Bedrock, Borehole, Groundwater, Flow, Hydraulic tests, Flow log, Hydraulic parameters, Transmissivity, Posiva Flow Log.

Abstract

Posiva Flow Log/Difference Flow method can be used for relatively fast determination of hydraulic conductivity and hydraulic head in fractures or fractured zones in cored boreholes. This report presents the principles of the method as well as the results of the measurements carried out in borehole KAV01 at Ävrö in February 2004.

The main aim of the measurements presented in this report was to determine the depth and flow rate of flowing fractures in borehole KAV01.

The measurements were carried out between the depths of 70 m and 734 m; the flow rate into or out from a 5 m long test section was measured. This was done both without pumping the borehole and with pumping it. Flow logging was repeated at the location of the detected flow anomalies using 1 m section length and 0.1 m point intervals.

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

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

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

Sammanfattning

Föreliggande rapport presenterar resultat ifrån genomförda mätningar med Posiva Flow Log/Difference Flow i borrhål KAV01. Mätningarna utfördes med syftet att identifiera inflöden längs borrhålet. Dessa utfördes dels utan att pumpa i borrhålet i 5 m sektioner och 5 m steglängd (sekventiell mätning) och dels med pumpning i borrhålet med 5 m sektion och 0,5 steglängd samt 1m sektion och 0,1m steglängd (överlappande mätning). Både termisk puls och termisk utspädning användes som mätprinciper i den sekventiella mätningen. I den överlappande mätningen användes endast termisk utspädning.

Dessutom gjordes mätningar av absoluttryck, elektrisk konduktivitet och temperatur av borrhålsvattnet.

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

Slutligen beräknades transmissivitet (T) och naturlig trycknivå (h_i) för 5 m sektionerna.

Contents

1 Introduction

A general program for site investigations presenting survey methods has been prepared /SKB 2001/, as well as a site-specific program for the investigations in the Simpevarp area /SKB 2002b/. The difference flow logging form part of the site characterization program in the work breakdown structure number 1.1.5.7 of the execution programme /SKB 2002b/. Data and results were delivered to the SKB site characterization database SICADA with field note number Simpevarp 287.

The measurements were carried out in borehole KAV01 at the Ävrö site near Oskarshamn in February 17–27, 2004. The borehole is sub-vertical c 89.2° from the horizontal, drilled to a depth of c 757 m and cased to c 70 m depth. The borehole diameter is 56 mm in the interval 70–757 m. The location is shown in Figure 1-1.

The work carried out in borehole KAV01 was in accordance with the activity plan AP PS 400-03-85 (SKB internal controlling document) whose measurement campaigns are listed in Table 5-1. The purpose of the difference flow logging is

- to identify water-conductive sections/fractures along the hole and
- a hydrogeological characterisation of the borehole, including the actual water flow balance in the hole and the hydraulic properties (transmissivity 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.

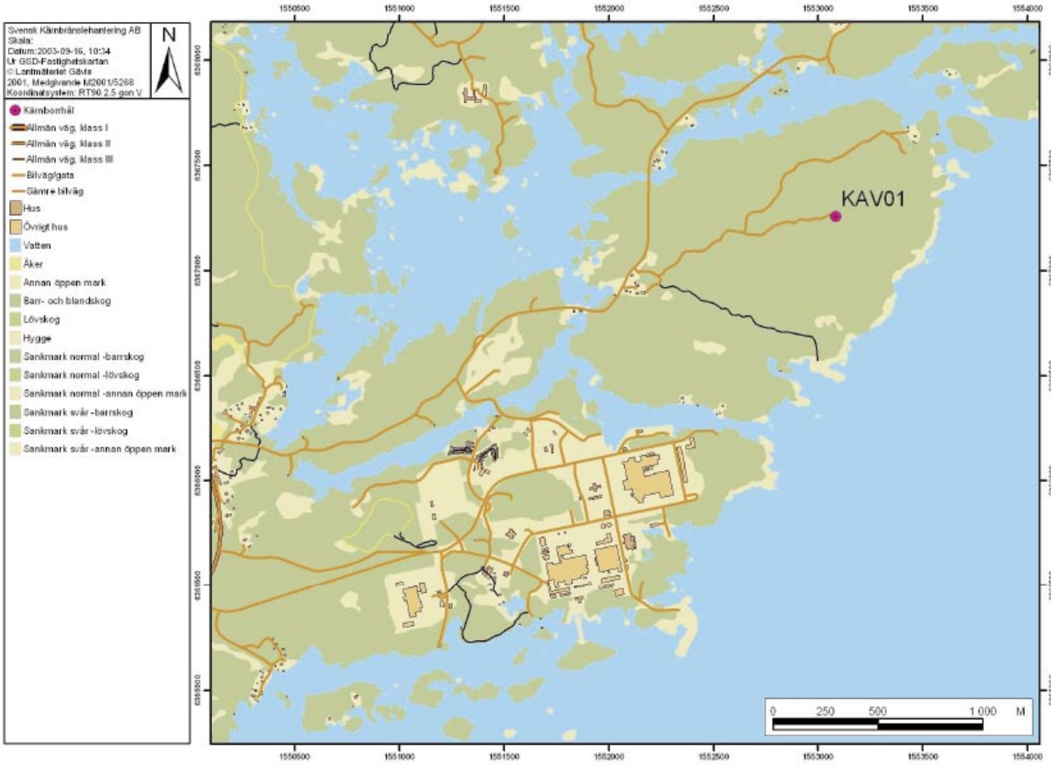

__Figure 1-1.__ Site map showing the location of borehole KAV01 which is situated on the island of Ävrö.

2 Principles of measurement and operation

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

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

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

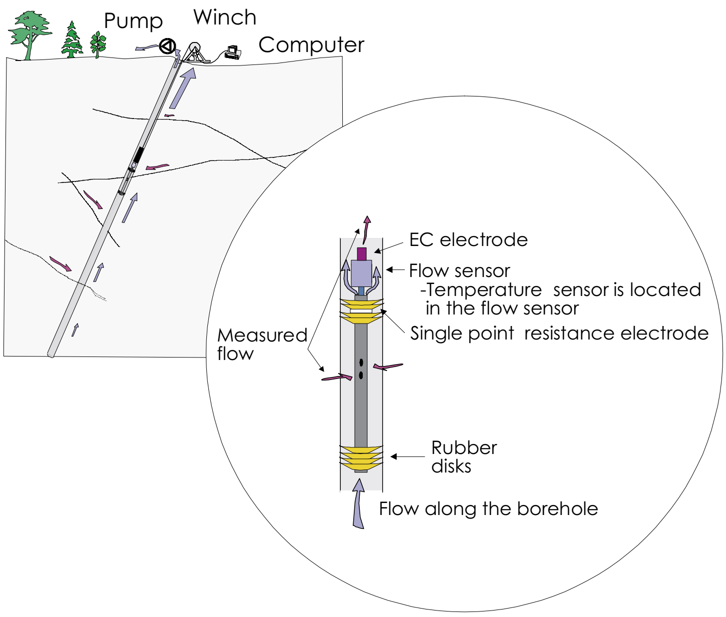

Figure 2-1. *Schematic of the downhole equipment used in the Difference flowmeter.*

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.

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

Flow rate is measured during the constant power heating (Figure 2-3 b). If it is larger than 600 mL/h, a larger constant power heating is applied, Figure 2-4 a). It is used for thermal dilution method for flow rates larger than 600 mL/h.

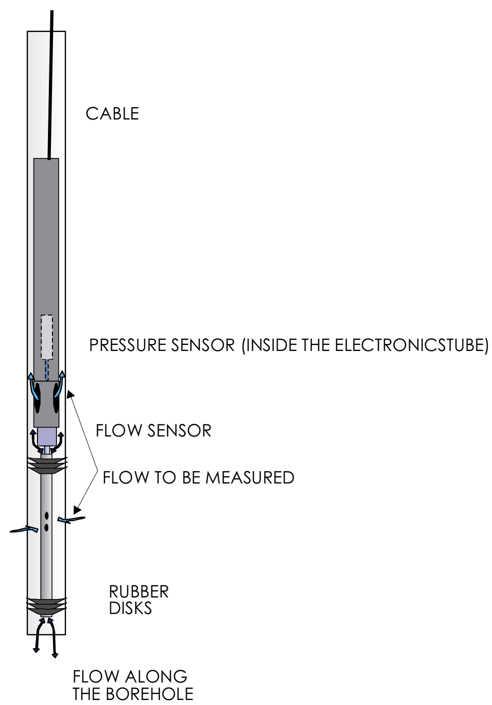

Figure 2-2. *The absolute pressure sensor is located inside the electronics tube and connected through a tube to the borehole water.*

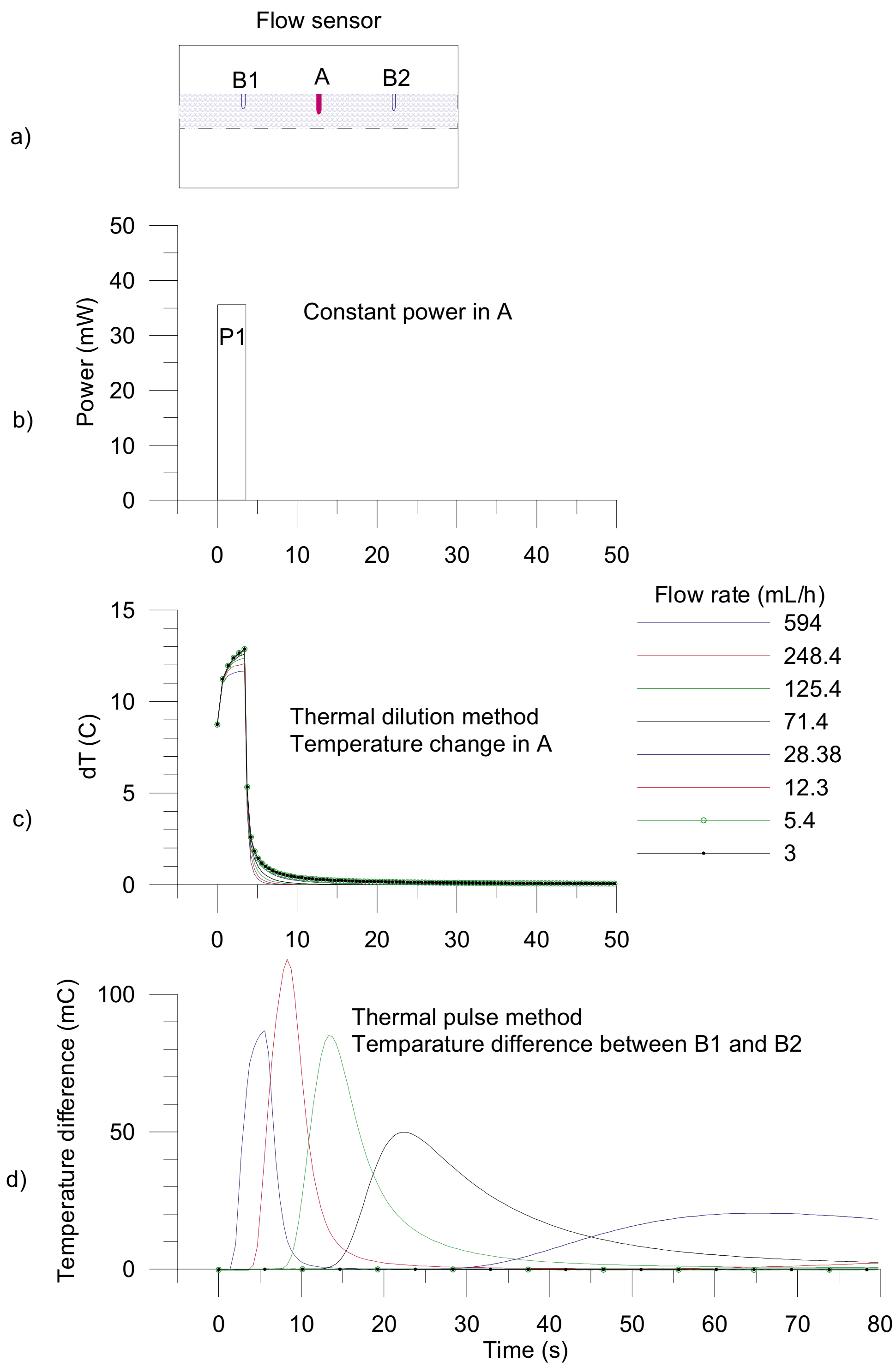

Figure 2-3. *Flow measurement, flow rate <600 mL/h.*

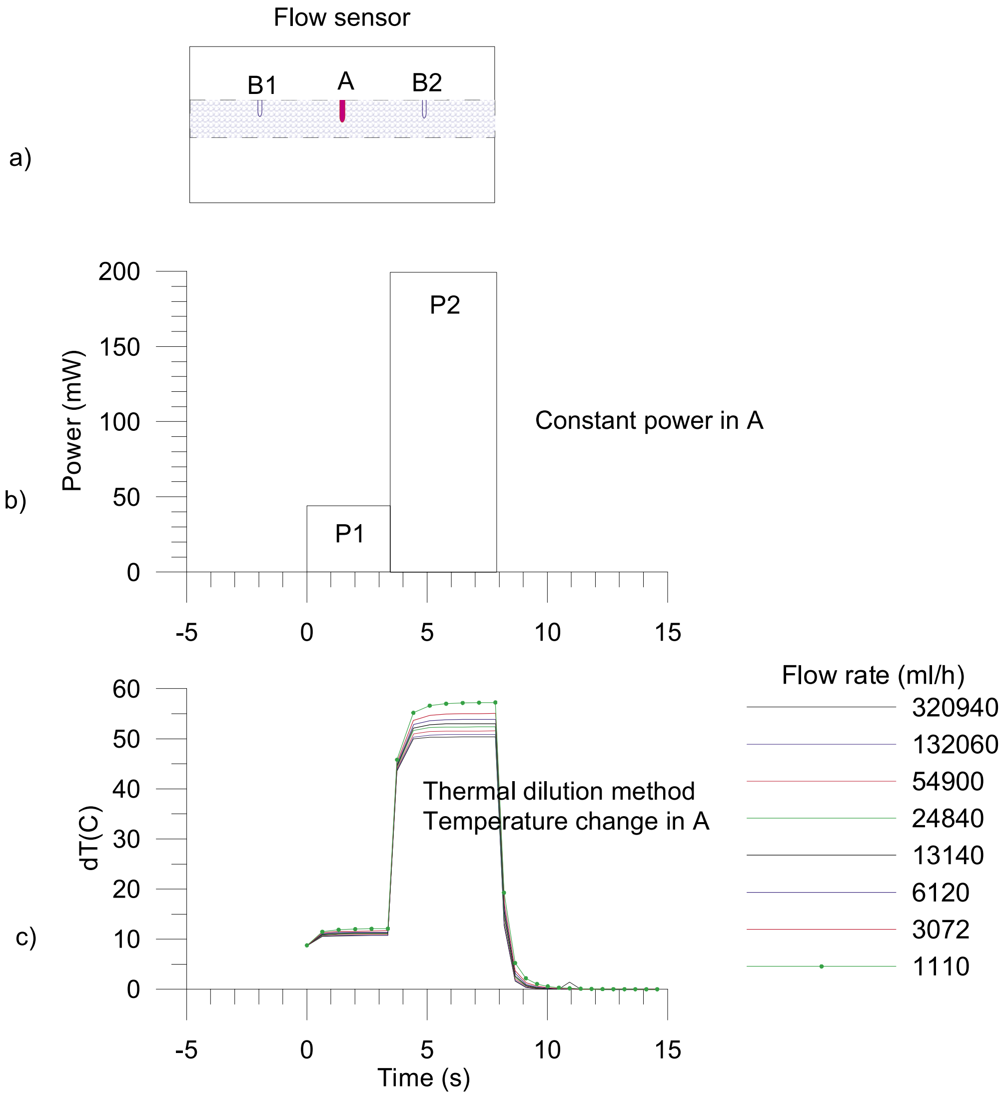

Figure 2-4. *Flow measurement, flow rate > 600 mL/h.*

If the flow rate during the constant power heating (Figure 2-3 b) is less than 600 mL/h, the measurement continues with monitoring of thermal dilution transient and thermal pulse response (Figure 2-3 d). 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 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/h)
Thermal dilution P1	30–6,000
Thermal dilution P2	600–300,000
Thermal pulse	6–600

3 Interpretation

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

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

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

where

h_1 and h_2 are the hydraulic heads in the borehole,

a is a constant depending on the assumed flow geometry,

Q_{n1} and Q_{n2} are the measured flows rates in the test section,

K_n is hydraulic conductivity of the test section, and

h_i is the undisturbed hydraulic head zone far from the test section.

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

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

where

L is the length of the test section,

R is the radial distance to the undisturbed hydraulic head hi, and

r_0 is the nominal radius of the borehole.

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

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

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

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

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

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

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

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

where Q_{n1} and Q_{n2} are flow rates at fracture n

h_i and T_n are the hydraulic head and the transmissivity of fracture n

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

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

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

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:

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

where L is length of test section (m).

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

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

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:

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

4 Equipment specifications

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

The flowmeter was calibrated in December 2003

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

Table 4-1. Range and accuracy of sensors.

Sensor	Range	Accuracy
Flow	6–300,000 mL/h	+/–10% curr. value
Temperature (middle thermistor)	0–50°C	0.1°C
Temperature difference (between outer thermistors)	–2–+2°C	0.0001°C
Electric conductuvtivty of water (EC)	0.02–11 S/m	+/– 5% curr. value
Single point resistance	5–500,000 Ω	+/– 10% curr. value
Groundwater level sensor	0–0.1 MPa	+/– 1% full scale
Absolute pressure sensor	0–20 MPa	+/– 0.01% full scale

5 Results

5.1 Field work

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

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

The combined sequential/overlapping flow logging (Item 7) was carried out between the depths of 70–734 m. Section length was 5 m. Step length was 0.5 m for thermal dilution method and 5 m for thermal pulse method (thermal pulse was measured at every 10th point).

Pumping was started on February 21. After 24 hours waiting time, the overlapping flow logging (Item 9) was carried out between the depths of 70–734 m. Section length was 5 m. Step length was 0.5 m.

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 10).

Table 5-1. Flow logging and testing in KAV01. Activity schedule. (The item numbers from actual work as defined in the activity plan AP PS 400-03-85 (SKB internal controlling document) are retained in this table.)

Item	Activity	Explanation	Date
6	Length calibration of the down-hole tool	Dummy logging (SKB Caliper and SPR) Logging without the lower rubber discs upwards, no pumping. Problems with caliper tool.	2004-02-17 2004-02-18
8	EC- and temp-logging of the borehole fluid, absolute pressure	Logging without the lower rubber discs, no pumping	2004-02-18 2004-02-18
7	Combined sequential and overlapping flow logging	Section length L_w=5 m, Step length dL=5 m, no pumping	2004-02-19 2004-02-20
9	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)	2004-02-22 2004-02-23
10	Overlapping flow logging	Section length L_w=1 m, Step length dL=0.1 m, at pumping (only in conductive borehole intervals)	2004-02-23 2004-02-25
11	EC- and temp- logging of the borehole fluid	Logging without the lower rubber discs, at pumping	2004-02-25
12	Recovery transient	Measurement of water level in the borehole after stopping of pumping	2004-02-25 2004-02-26
6 extra	Length calibration of the down-hole tool	Dummy logging (SKB Caliper and SPR) Logging without the lower rubber discs downwards, no pumping	2004-02-26 2004-02-27

Thereafter EC of borehole water (Item 11) was measured, still at pumping. After this, the pump was stopped and groundwater recovery was monitored (Item 12).

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

5.2 Depth calibration and SPR measurement

Caliper (borehole diameter) measurement was carried out together with Single point resistance measurement (SPR). The Caliper tool, provided by SKB, was attached to the flowmeter in such a way that Caliper and SPR could be measured simultaneously. The Caliper tool is on/off type showing an anomaly if the borehole diameter is larger than 57 mm. Measurements were performed before and after flow logging. At the first time caliper tool was out of order.

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. All SPR curves are plotted together with Caliper. They were measured in Items 6, 7, 9 and 10, see Table 5-1.

The zoomed results of Caliper and SPR are presented in Appendices 1.2–1.28. The depth marks were detected at 100 m (only lower one), 200 m, 300 m (only lower one), 350 m, 400 m (only lower one), 451 m, 500 m, 550 m, 650 and at 700 m. Each mark can be seen in SPR results but the anomaly is complicated because there are four rubber disks used at the upper end of the section, two rubber disks at the both sides of the resistance electrode.

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

The aim of the plots in Appendices 1.2–1.28 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 6) 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 6 was then compared with the SPR curves of Items 7, 9 and 10 to obtain relative depth errors of Items 7, 9 and 10.
- All SPR curves could then be synchronized, as can be seen in Appendices 1.2–1.28.

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 measurement was repeated during pumping (after about four days pumping period), see Appendix 2.1 red curve.

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

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

5.4 Flow logging

The flow logging was started with combined sequential/overlapping flow logging with a 5 m section length and with 0.5 m depth increments, see Appendices 3.1–3.33. The method gives the depth and the thickness of conductive zones with a depth resolution of 0.5 m. Thermal pulse method is slower but it makes it possible to measure smaller flow rates and flow directions (into the borehole or out from it). 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 held almost constant at about 10 m. The flow logging was performed in overlapping flow logging mode using 0.5 m depth increments. The method gives the depth and the thickness of conductive zones with a depth resolution of 0.5 m.

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 6) measurements. The depth corrections of Items 7 and 9–10 were carried out synchronizing the SPR curves of Items 7 and 9–10 with the depth corrected first SPR measurement (Item 6).

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

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

5.5 Pressure measurements

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

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

where

h is the hydraulic head (masl) according to the RHB 70 reference system,

p_{abs} is absolute pressure (Pa),

p_b is barometric (air) pressure (Pa),

ρ_{fw} is unit density 1,000 kg/m^3

g is standard gravity 9.80065 m/s^2 and

z is the elevation of measurement (masl) according to the RHB 70 reference system.

A sensor specific offset, given by the sensor manufacturer, of 2.46 kPa is subtracted from all absolute pressure results.

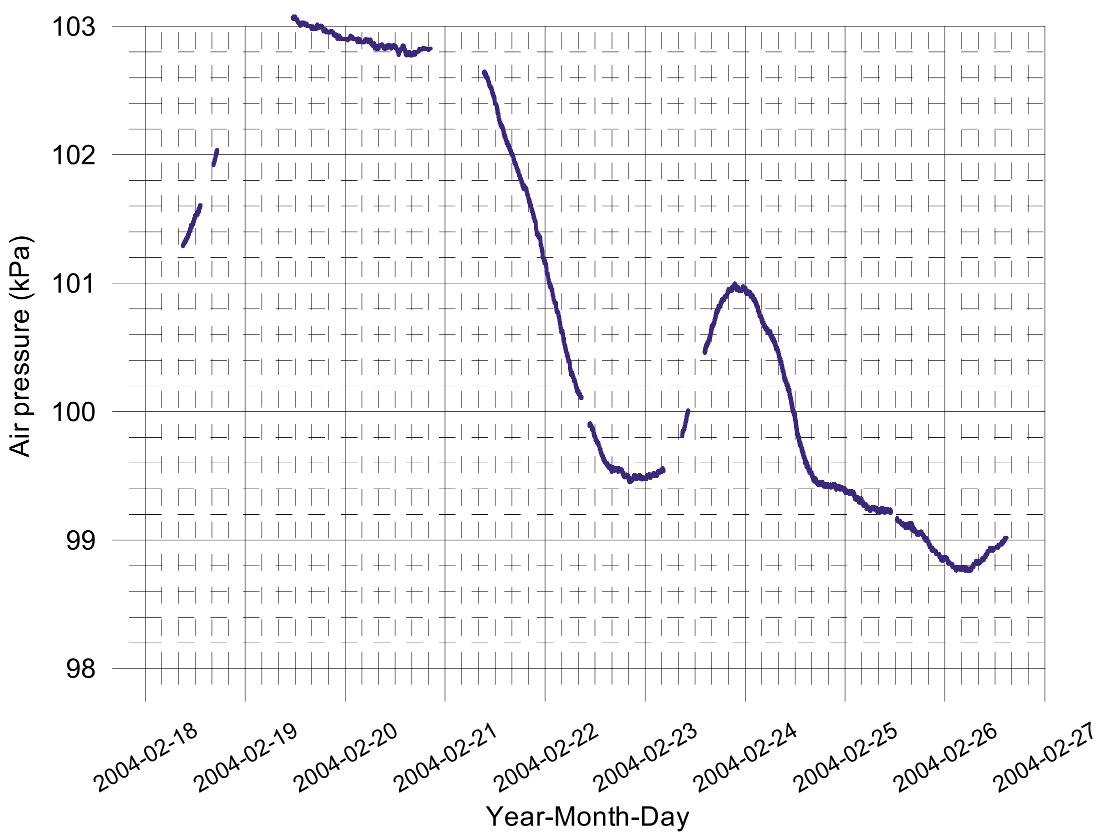

Figure 5-1. *Air pressure measured at the borehole.*

The calculated head results are presented in Appendix 5. Exact depth information is important in head calculation, 10 cm error in level means 10 cm error in head. The depth correction of borehole EC measurement is not as accurate as depth correction of flow measurement because SPR was not measured during borehole EC. Therefore, the head values during the borehole EC measurements are not as accurate as the other head values. The depth correction of Caliper measurement was applied to borehole EC measurements, black curve in Appendix 1.29. In spite of the different depth corrections of flow and EC measurements, there are no detectable deviations in head, see Appendix 5.

5.6 Hydraulic head and transmissivity of formations

Hydraulic head and transmissivity of formations were calculated from the results of sequential flow logging. The borehole was measured with 5 m depth increments. Section length was also 5 m.

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

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

The flow results are presented in Appendices 4.1 and 4.2. The depths represent the distance from the reference depth (top of the casing tube) to the upper end of the test section.

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

The flow results (Flow1 and Flow2) are similarly given without and with pumping the borehole. Flow rates are positive if the flow direction is from the bedrock into the borehole. The sum of detected flows without pumping was 9036 mL/h (about 0.15 L/min). This is about 3.2% of all measured flows without pumping. This sum should be should be zero if all the flows in the borehole are correctly measured, borehole is not pumped, water level is constant, salinity distribution in the borehole is stabilized and the fractures are at steady state pressure. More flows were measured into the borehole than away from it. The reason is unknown.

Flow values in the flow rate plots are shown using a logarithmic scale, see Appendix 5.1. The flows are shown in both directions, the left hand side of each diagram represents flow out from the borehole within a test section and the right hand side represents flow into the borehole within a test section. If the measured flow was zero, it is not visible in the logarithmic scale of the appendices. All the sections between 72 m and 732 m were measured.

Fresh water head of fractures and transmissivities 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. Transmissivity is presented if both or either of the flows are not equal to zero, Appendix 5.2.

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 18 and 21 when the first Caliper, EC and flow measurements were carried out.

Later the borehole was pumped with a drawdown of about 10 m. The groundwater recovery was measured after pumping period, February 25–26, 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.

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 28 L/min to 18 L/min. This can be compared with the summed up flow result from of flow measurements from the entire borehole. The sum is about 21.9 L/min.

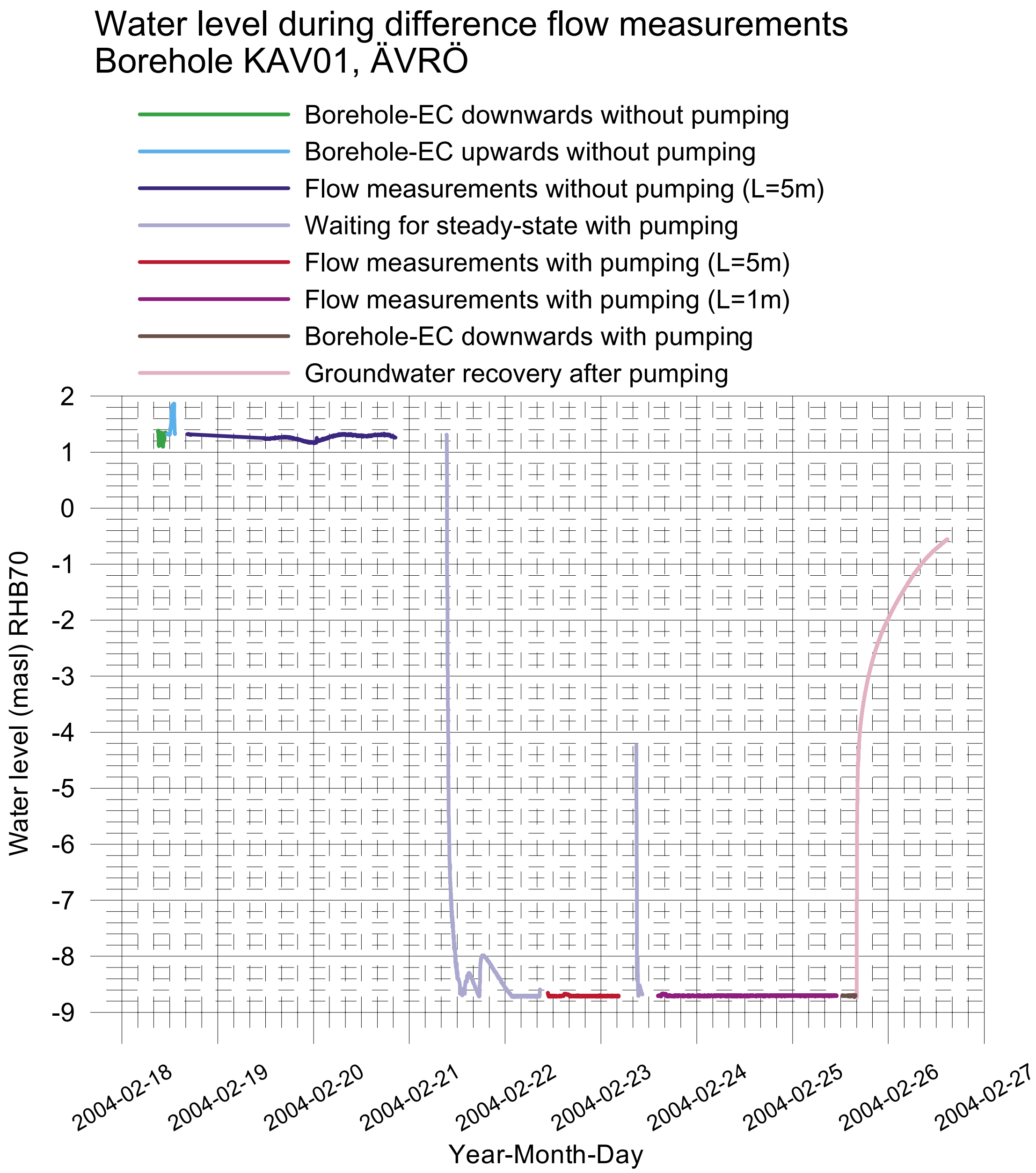

Figure 5-2. *Groundwater level in borehole KAV01.*

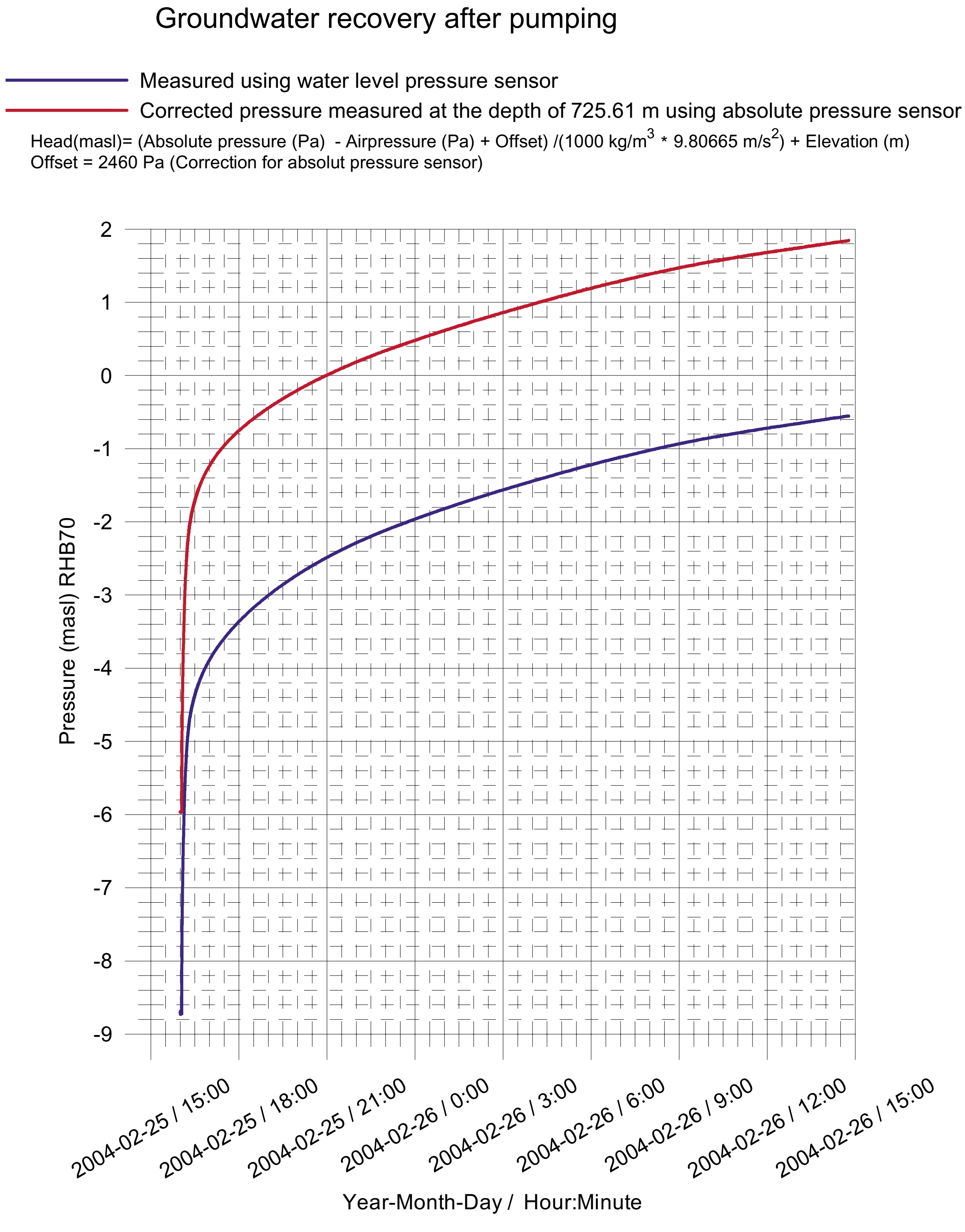

Figure 5-3. *Groundwater recovery in borehole KAV01.*

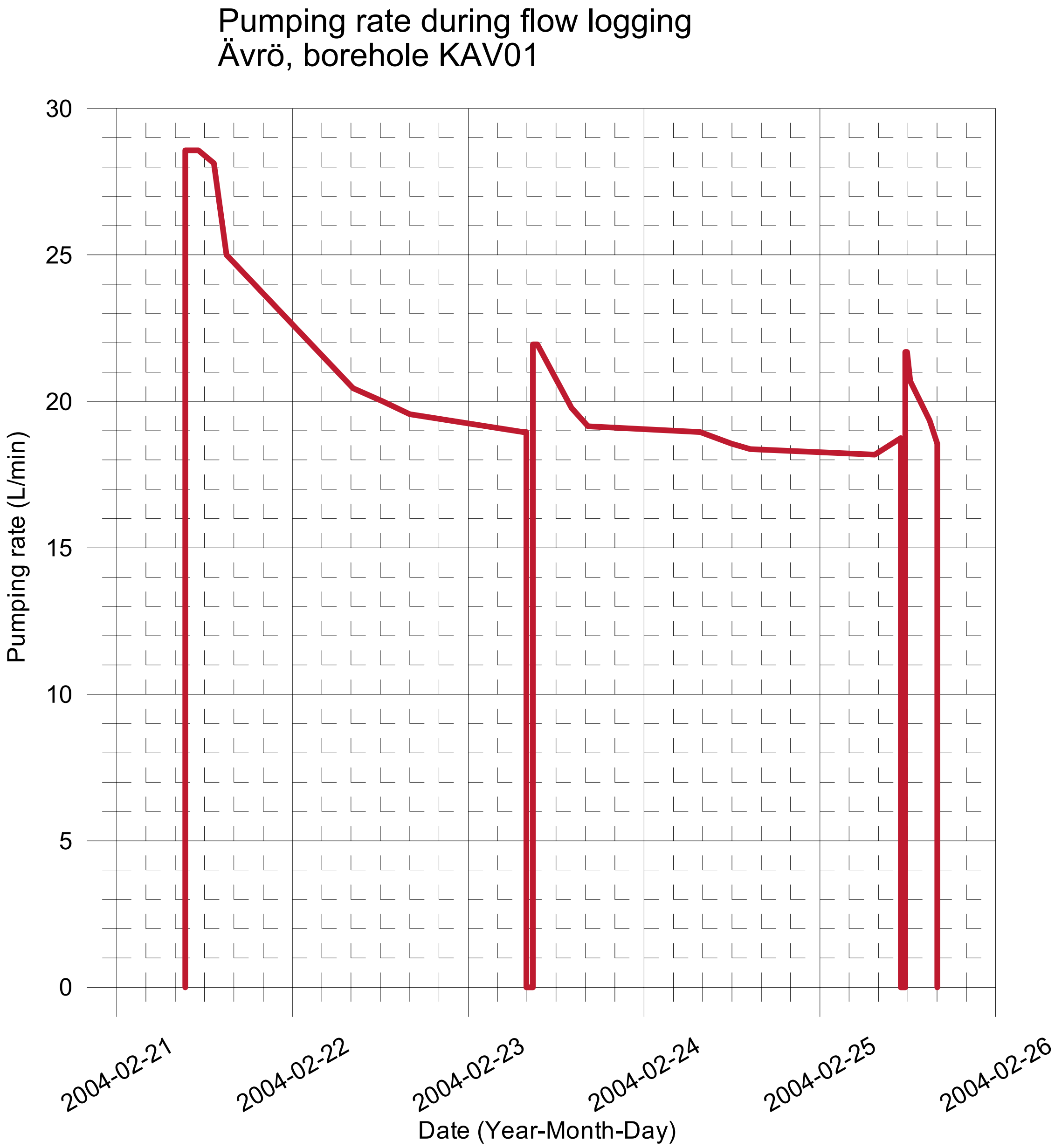

***Figure 5-4.** Pumping rate during the flow logging.*

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 664 m and borehole diameter $2r_0$ is 0.056 m.

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

The results of the three methods are given in Table 5-2 where the flow was set to Q=19.2 L/min and drawdown s=9.98 m. Moye's approximation gives the highest and Jacob/Horner method the lowest transmissivity. Basic test data is gathered in Appendix 6.

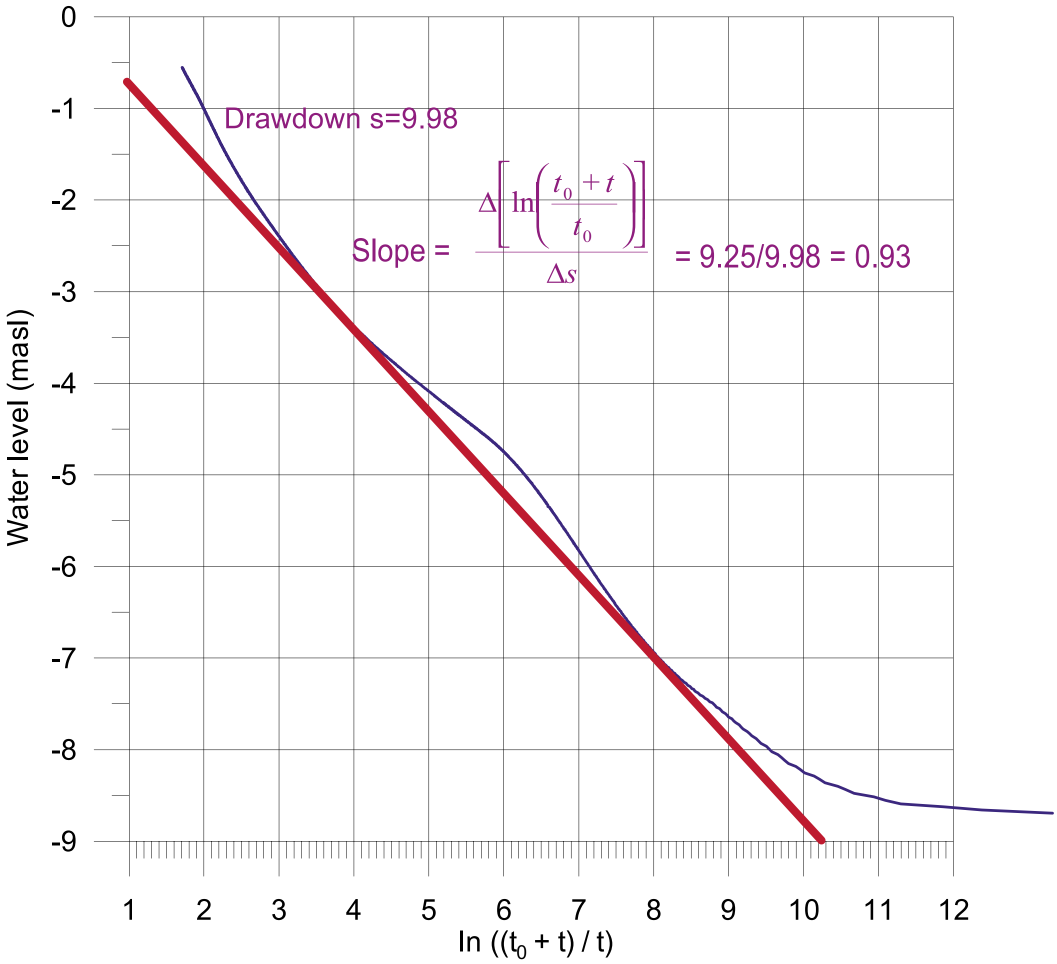

Figure 5-5. *Horner's diagram for the recovery phase.*

Table 5-2. Transmissivity of the entire borehole.

Method	Transmissivity (m^2/s)
Dupuit	3.17 E–6
Moye	5.31 E–6
Jacob/Horner	3.848E–5

5.9 Tables of sequential and overlapping logging

The results of sequential flow logging are presented in Appendices 7.1–7.5. Explanations of the columns are given Appendix 9. The lowest possible limit of transmissivity is presented in column Td-measl. It is calculated assuming the lowest measurable flow rate (it depends on noise level) at the used drawdown.

The results of overlapping flow logging are presented in Appendices 8.1–8.6. Overlapping measurements were used in inferring these fracture specific values. The lowest possible limit of transmissivity is similar as described above except that it is about five times higher (lowest measurable flow rate 30 mL/h). Many of the fracture specific results are marked as uncertain. In these cases the measured flow rate is below 30 mL/h or the fractures are very close each other making the flow evaluation difficult.

The tables in Appendices 10.1–10.3 was used to calculate conductive fracture frequency (CFF), Appendices 10.1–10.3. The number of conductive fractures were counted on the same 5 m sections as in Appendices 7 and 8 before. The number of conductive fractures were sorted in six columns depending on their flow rate. The total conductive fracture frequency is presented graphically, see Appendix 11.

5.10 Noise in flow

The flow rates of the overlapping measurements are shown in Appendices 3.1–3.33. Noise level or minimum measurable flow rate in the overlapping results varies as a function of depth. Theoretical minimum is about 30 mL/h. Noise level of the overlapping measurements was higher than 30 ml/h below 600 m, see Appendices 3.27–3.33.

There are several known reasons for increased noise in flow:

1) Rough borehole wall

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

3) Gas bubbles in water

Rough borehole wall always causes high noise not only in flow but also in Single point resistance results. Drilling mud usually causes increased noise level for the results obtained without pumping and with pumping. Pumping causes pressure drop in borehole water and in fracture water near the borehole. This may lead to transformation of gas from dissolved form to gas bubbles.

6 Summary and discussion

In this study Posiva Flow Log/Difference Flow method has been used in combined sequential/overlapping logging mode to determine the depth and flow rate of flowing fractures. Measurements were carried out when the borehole was at rest with 5 m section length and with 0.5 m depth increments. Both thermal pulse and thermal dilution methods were applied. The same was repeated when the borehole was pumped except that thermal pulse method was not used.. 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.

Transmissivity and hydraulic head of were calculated for formations. The highest transmissivity $7.09 \cdot 10^{-6}$ m^2/s was detected in the fracture at the depth of 431.8 m.

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

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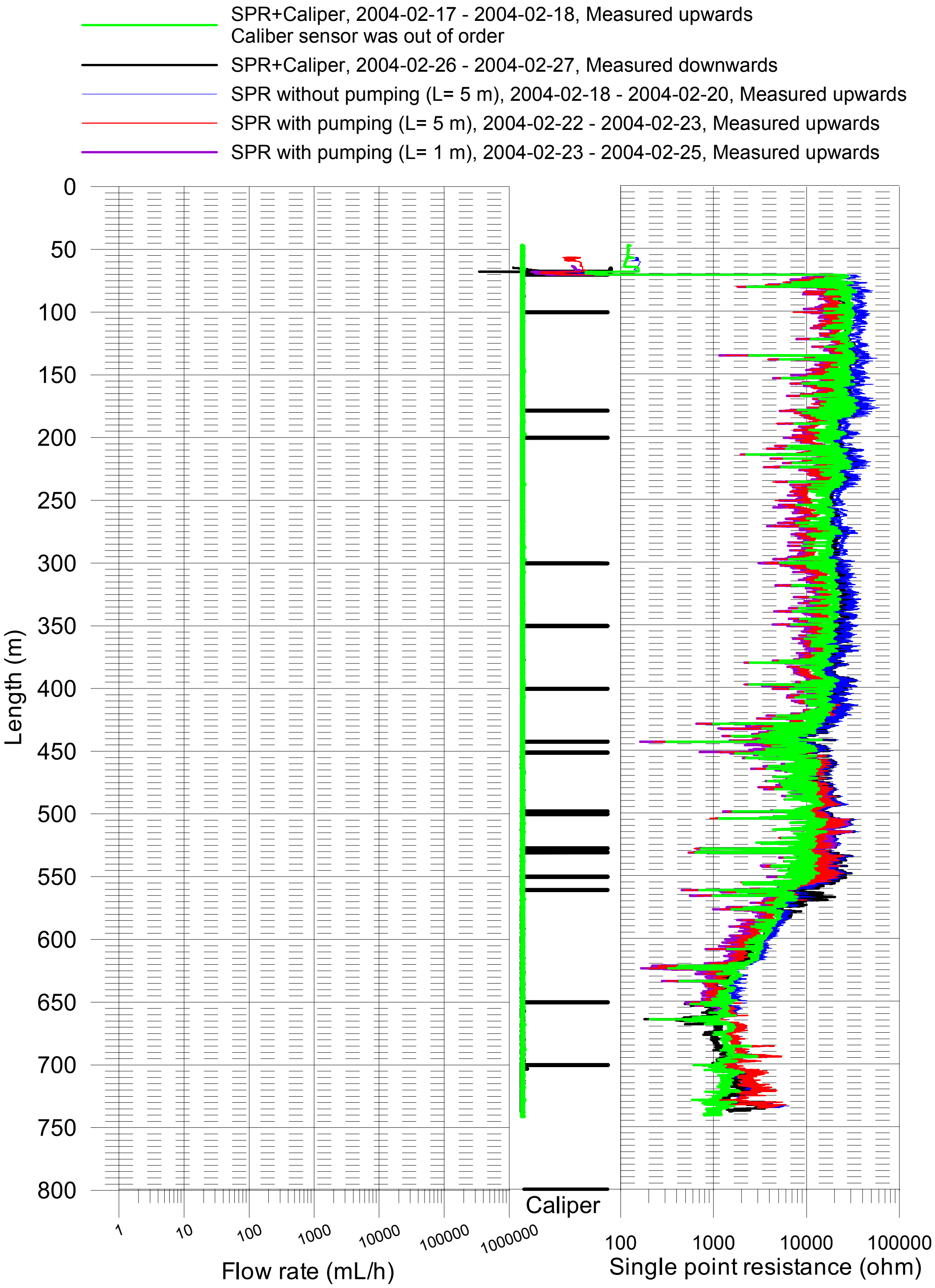
Appendices

Appendices	1.1–1.28	Depth calibration
Appendix	1.29	Depth corrections
Appendices	2.1	EC of borehole water
Appendices	2.2	Temperature of borehole water
Appendices	3.1–3.33	Measured flow rates, Caliper and Single point resistance
Appendix	4.1	Plotted flow rates of 5 m sections
Appendix	4.2	Plotted head and conductivity of formations
Appendix	5	Borehole heads
Appendix	6	Basic test data
Appendices	7.1–7.5	Results of sequential flow logging
Appendices	8.1–8.6	Inferred flow anomalies from overlapping flow logging
Appendix	9	Explanations for the tables in Appendices 6–8
Appendices	10.1–10.3	Conductive fracture frequency
Appendix	11	Plotted conductive fracture frequency

Ävrö, KAV01
SPR and Caliper results after depth correction



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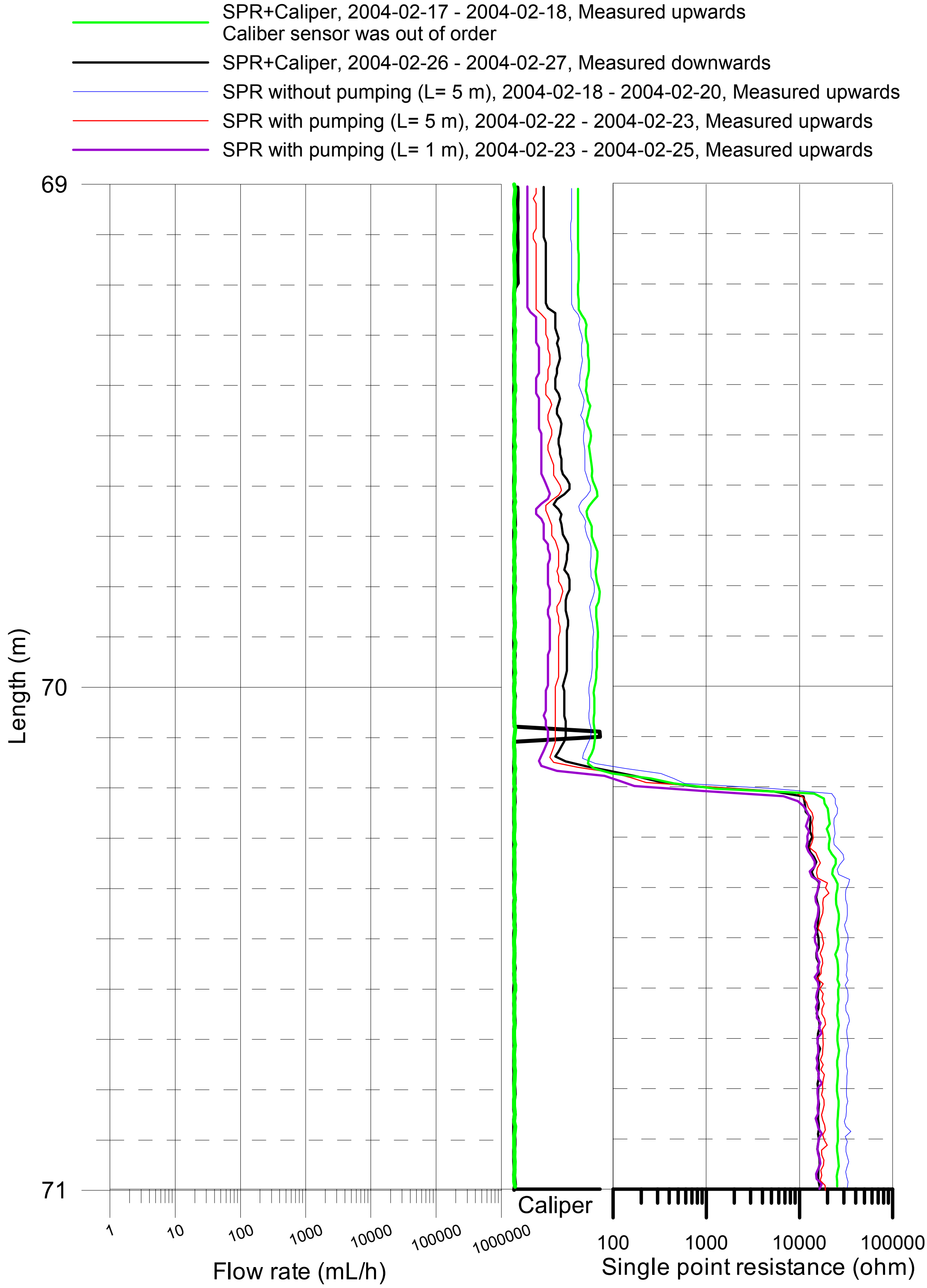
SPR and Caliper results after depth correction



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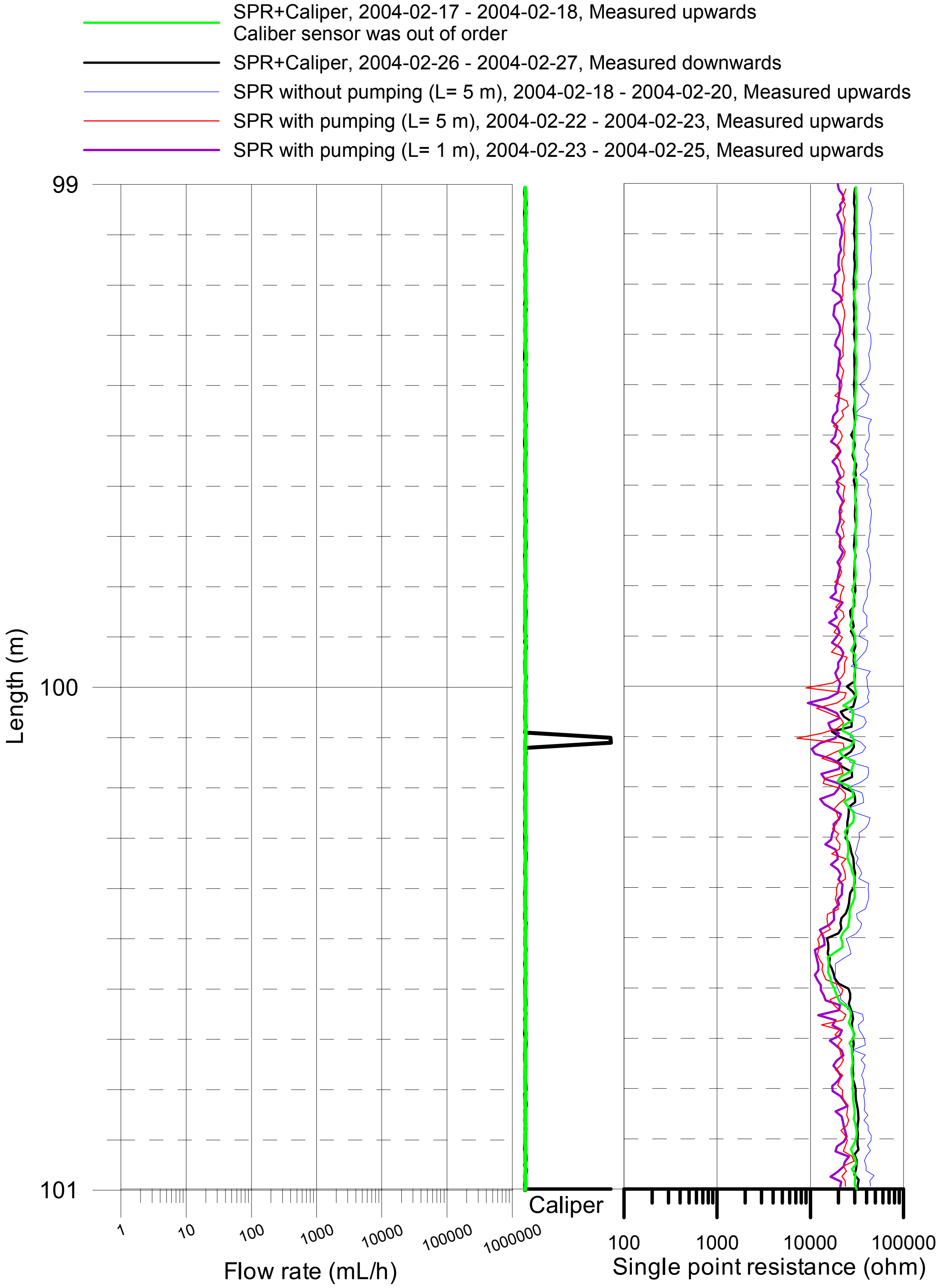

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SPR and Caliper results after depth correction

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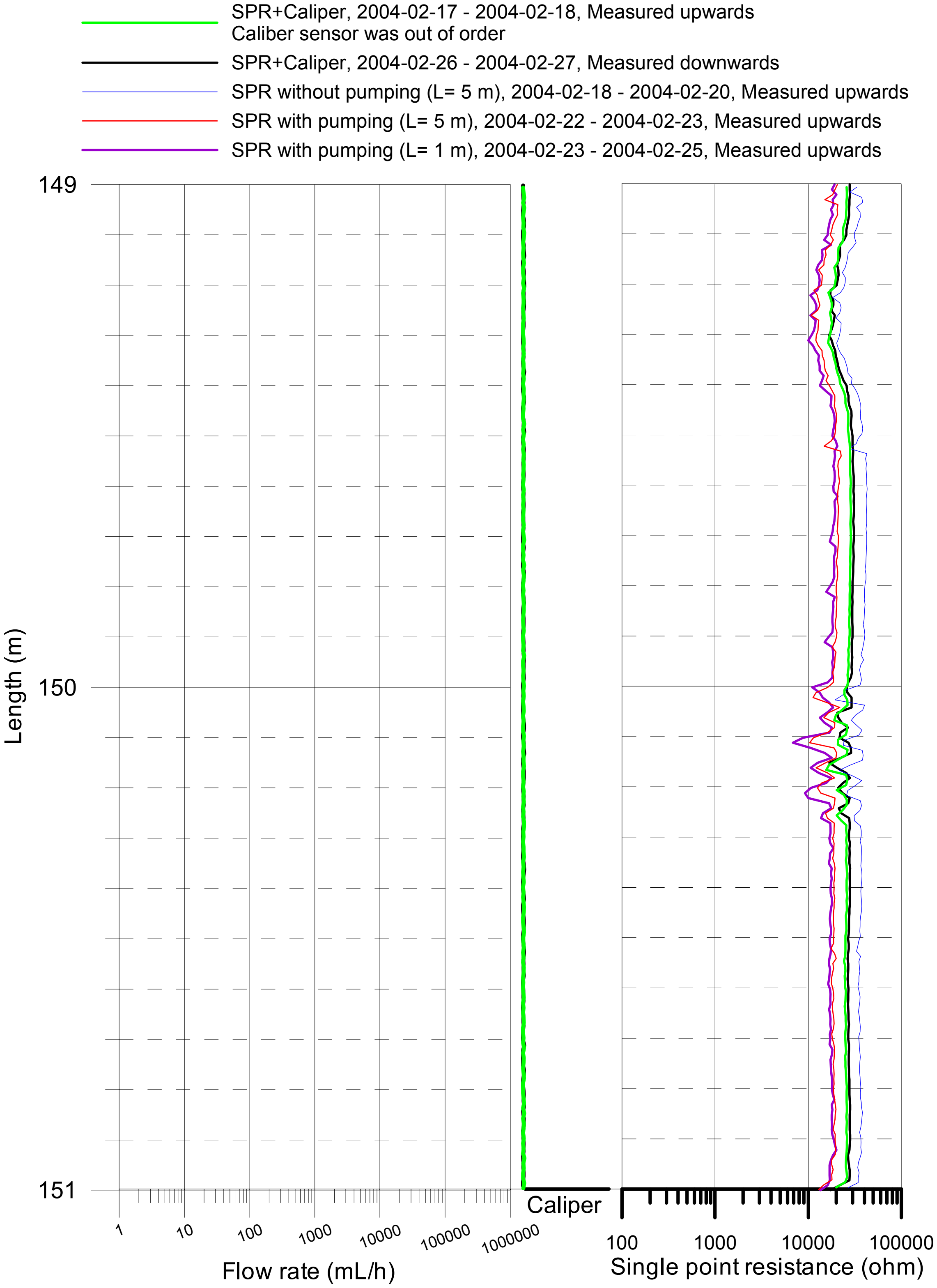
SPR and Caliper results after depth correction



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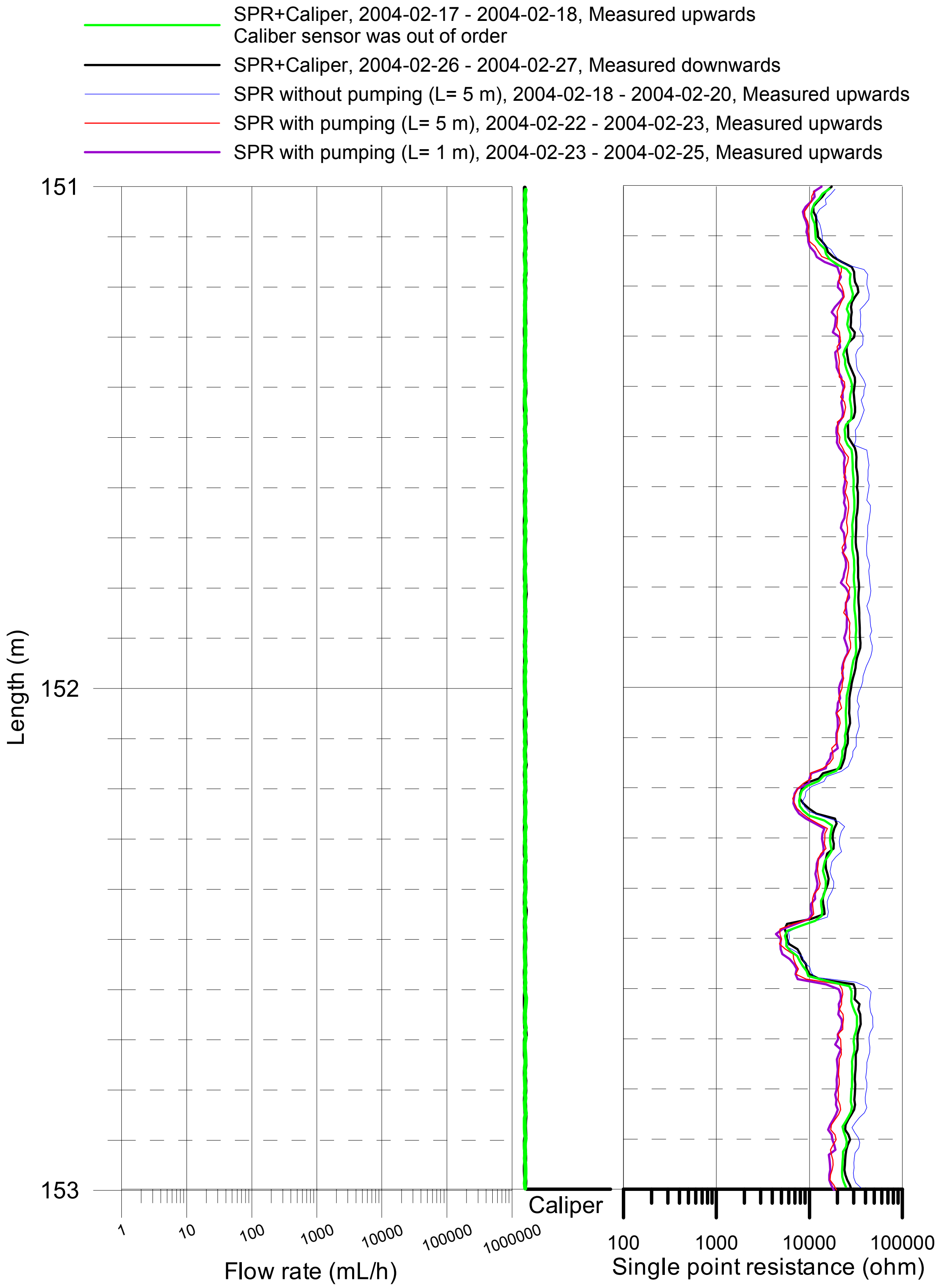

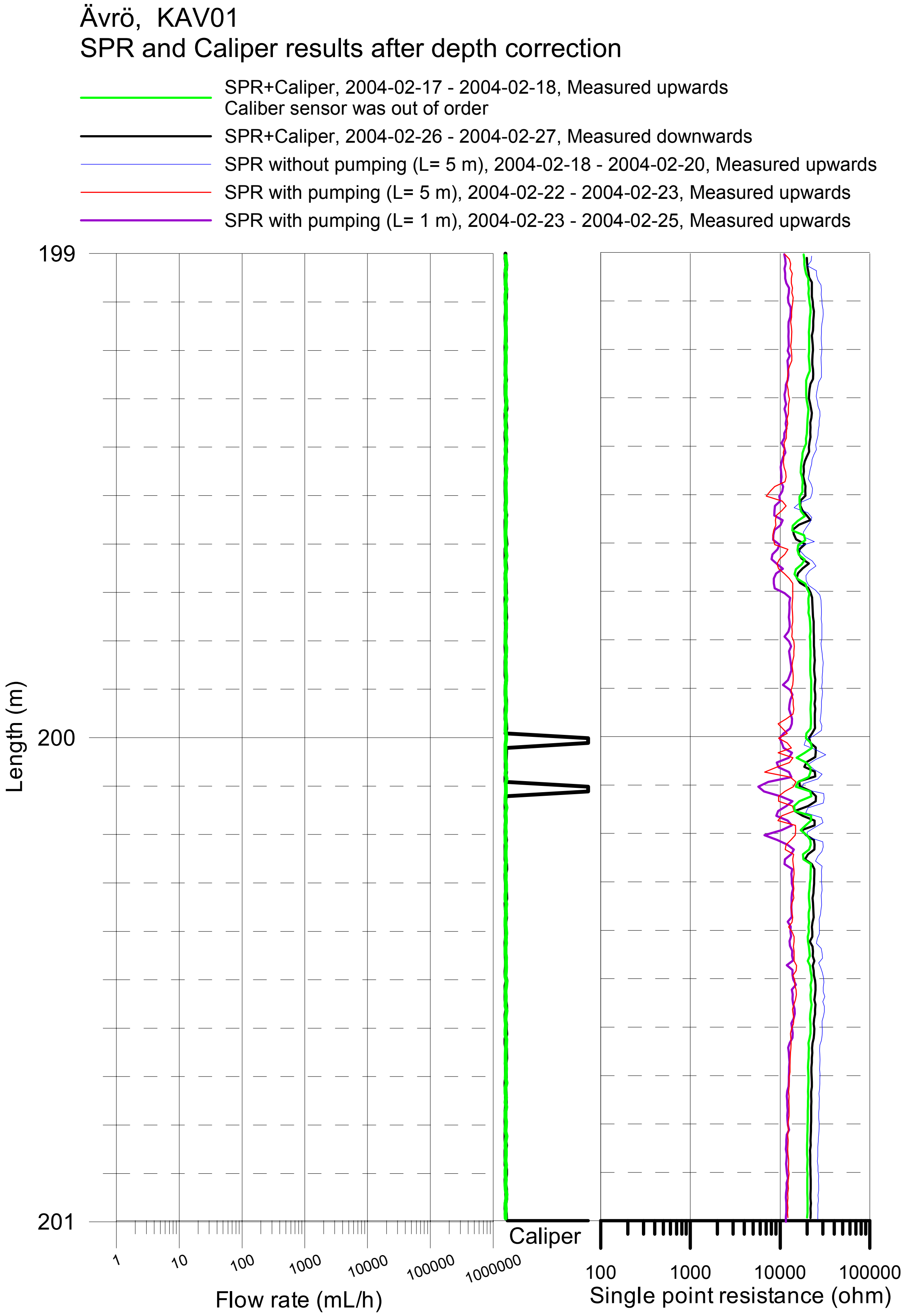
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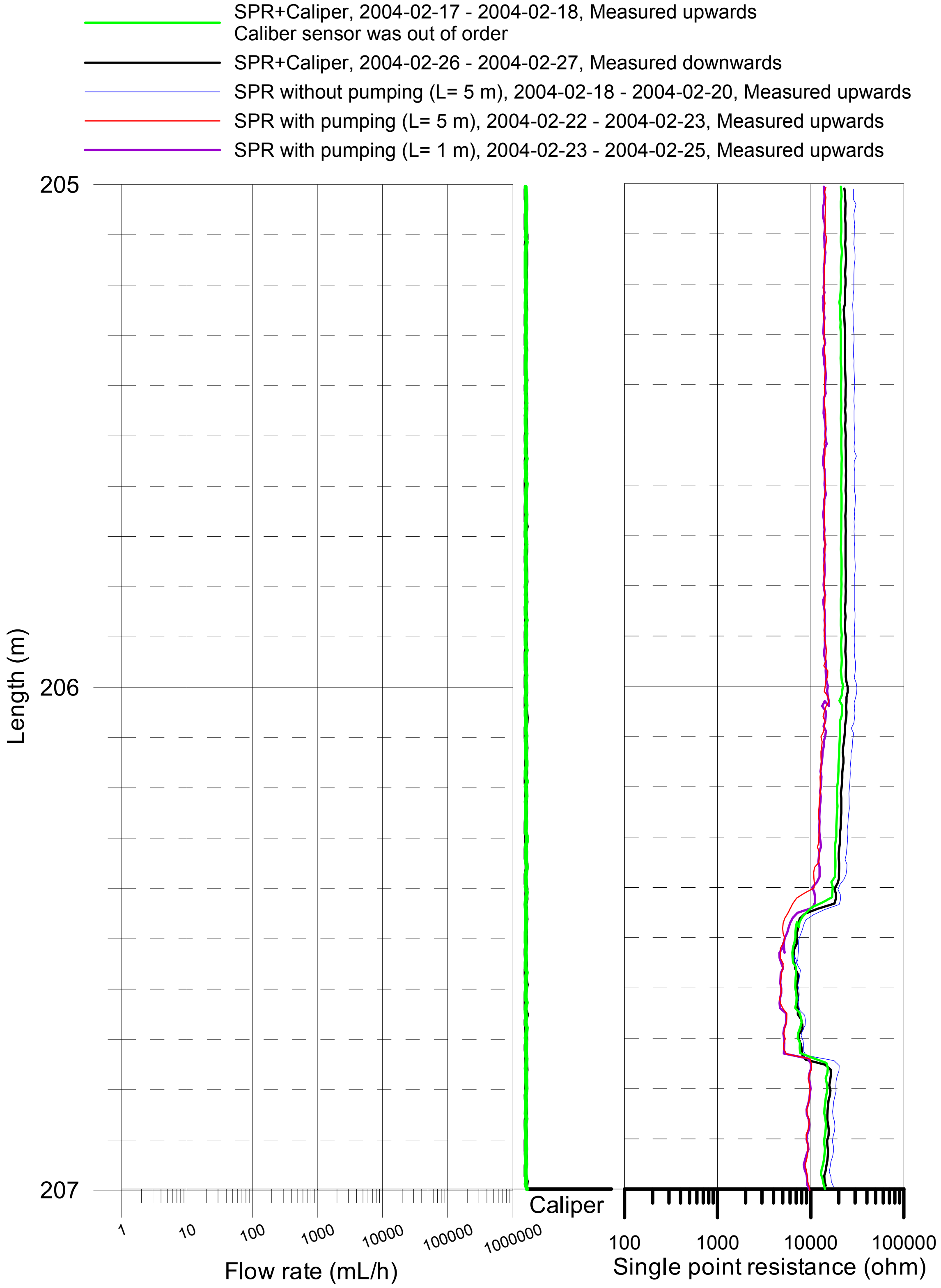
SPR and Caliper results after depth correction
SPR+Caliper, 2004-02-17 - 2004-02-18, Measured upwards
Caliber sensor was out of order
SPR+Caliper, 2004-02-26 - 2004-02-27, Measured downwards
SPR without pumping (L= 5 m), 2004-02-18 - 2004-02-20, Measured upwards
SPR with pumping (L= 5 m), 2004-02-22 - 2004-02-23, Measured upwards
SPR with pumping (L= 1 m), 2004-02-23 - 2004-02-25, Measured upwards
Length (m)
199
200
201
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
Caliper
100
1000
10000
100000
Single point resistance (ohm)

Ävrö, KAV01
SPR and Caliper results after depth correction



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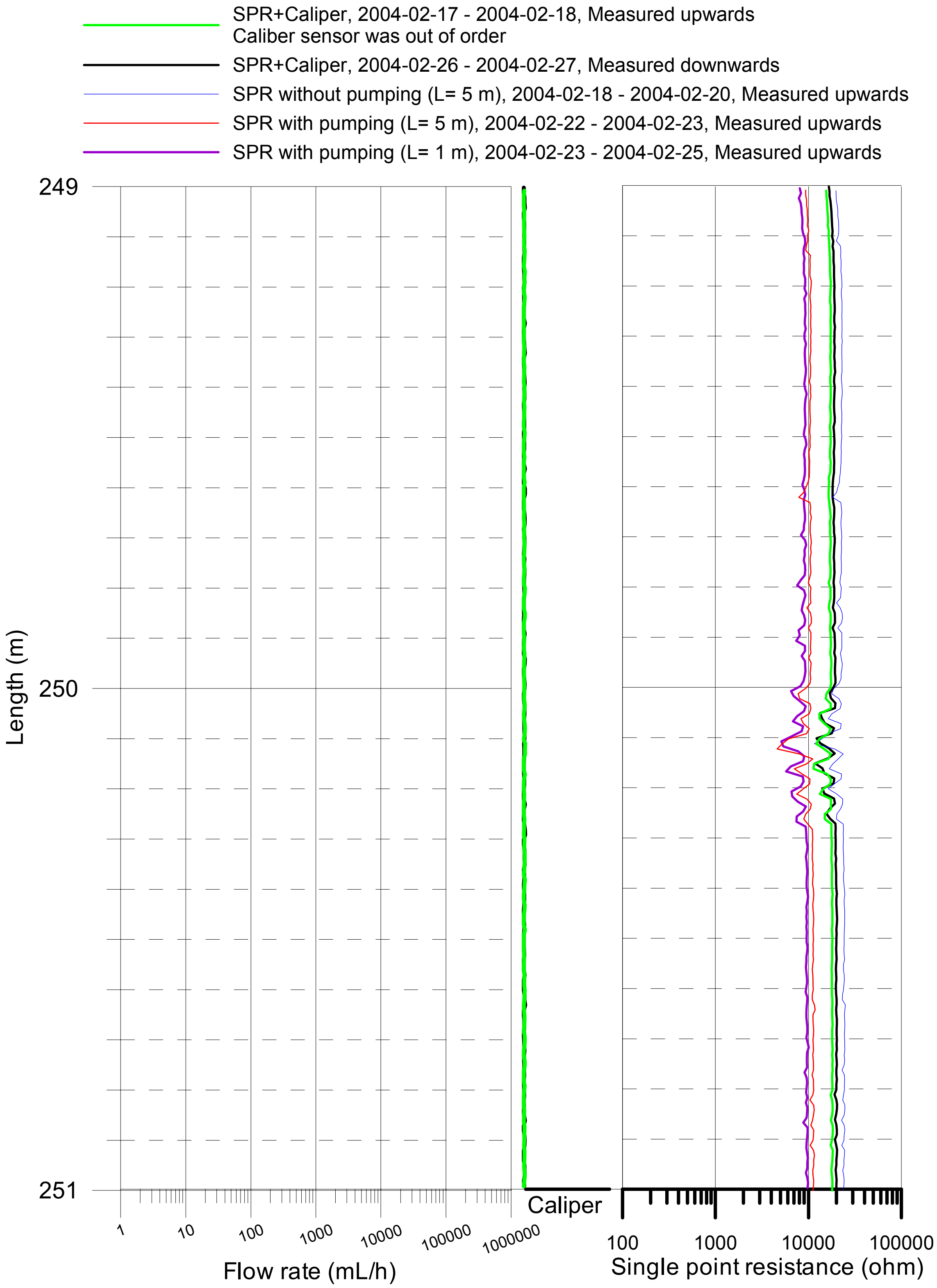

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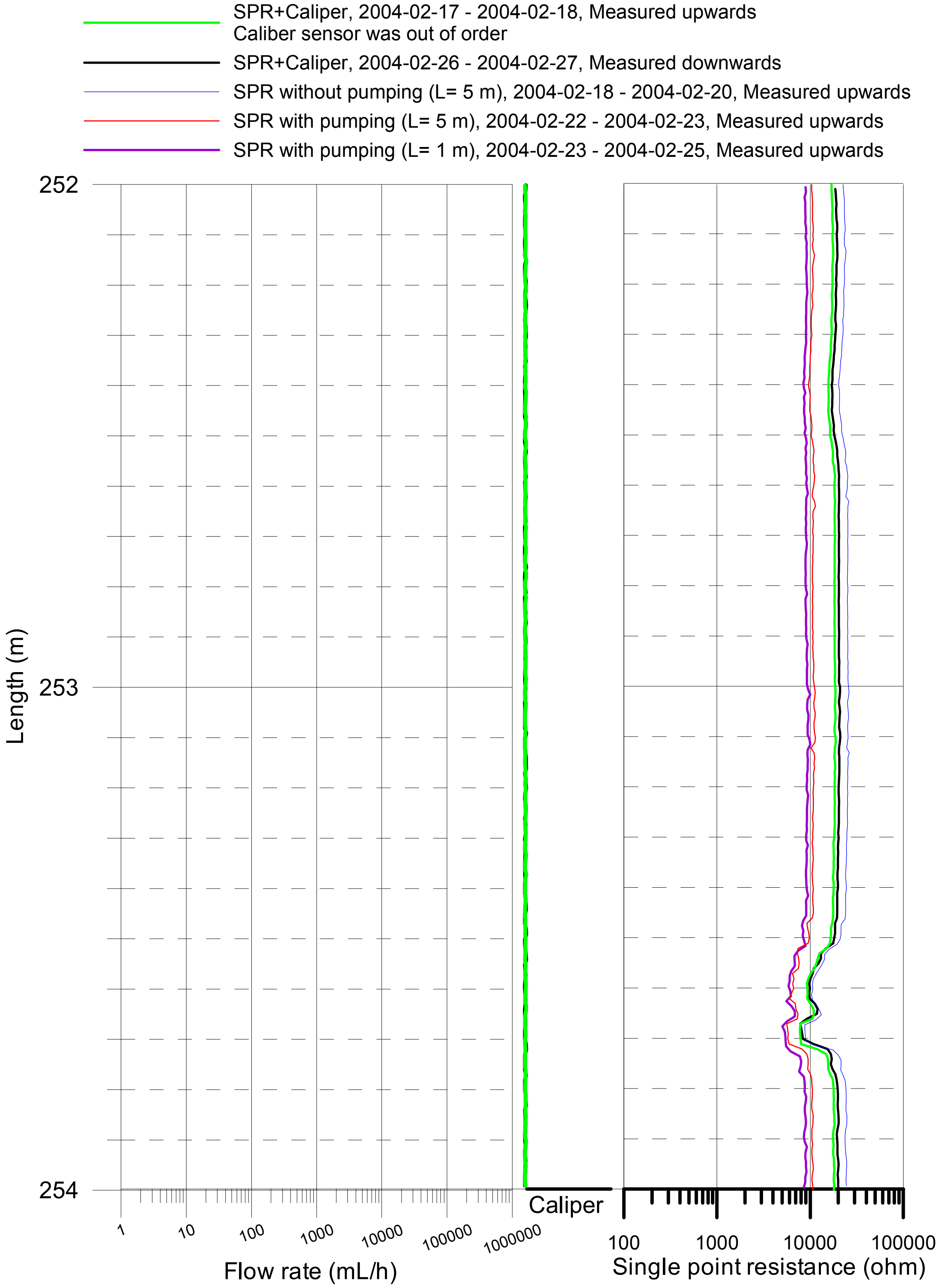

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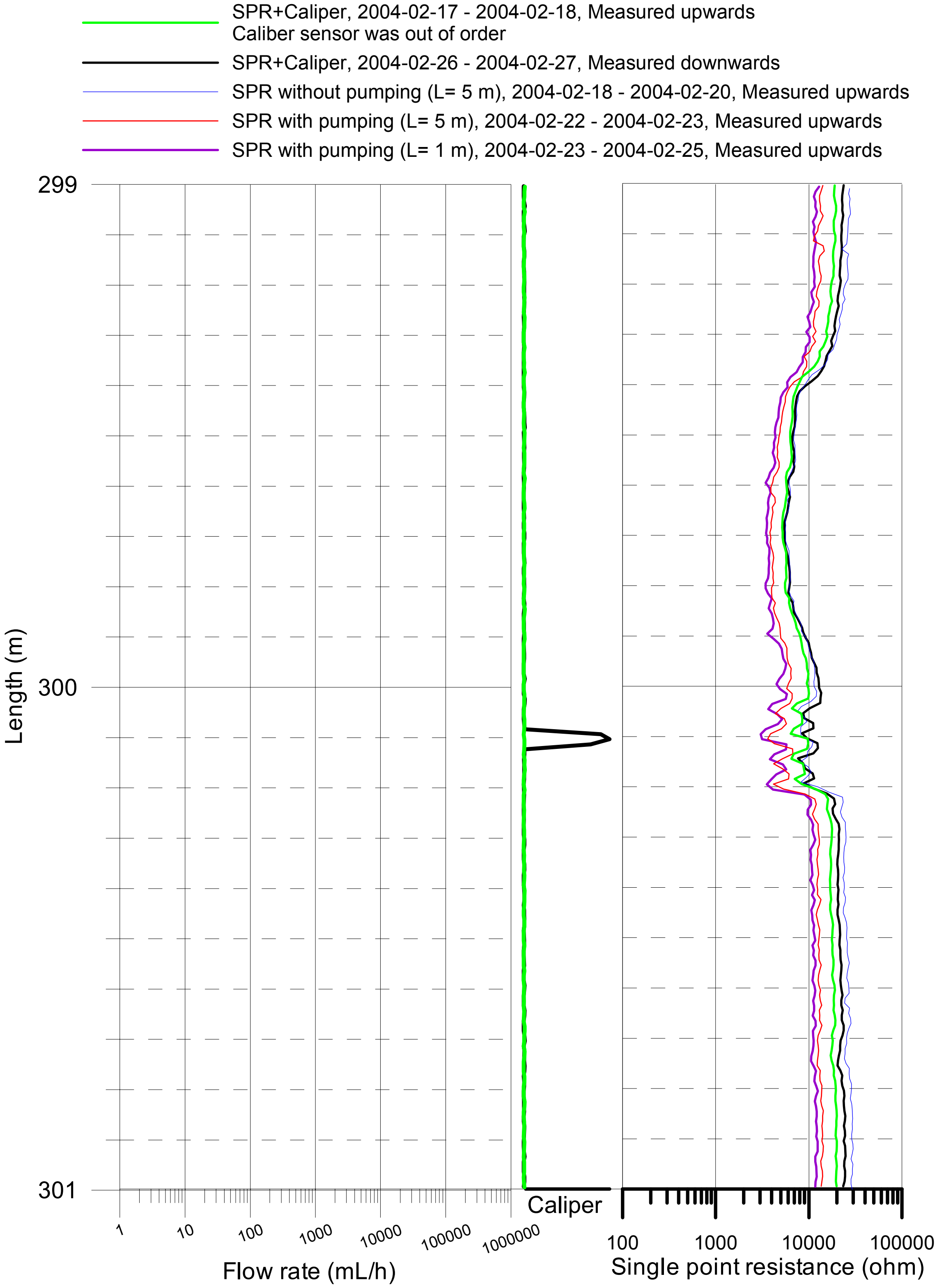

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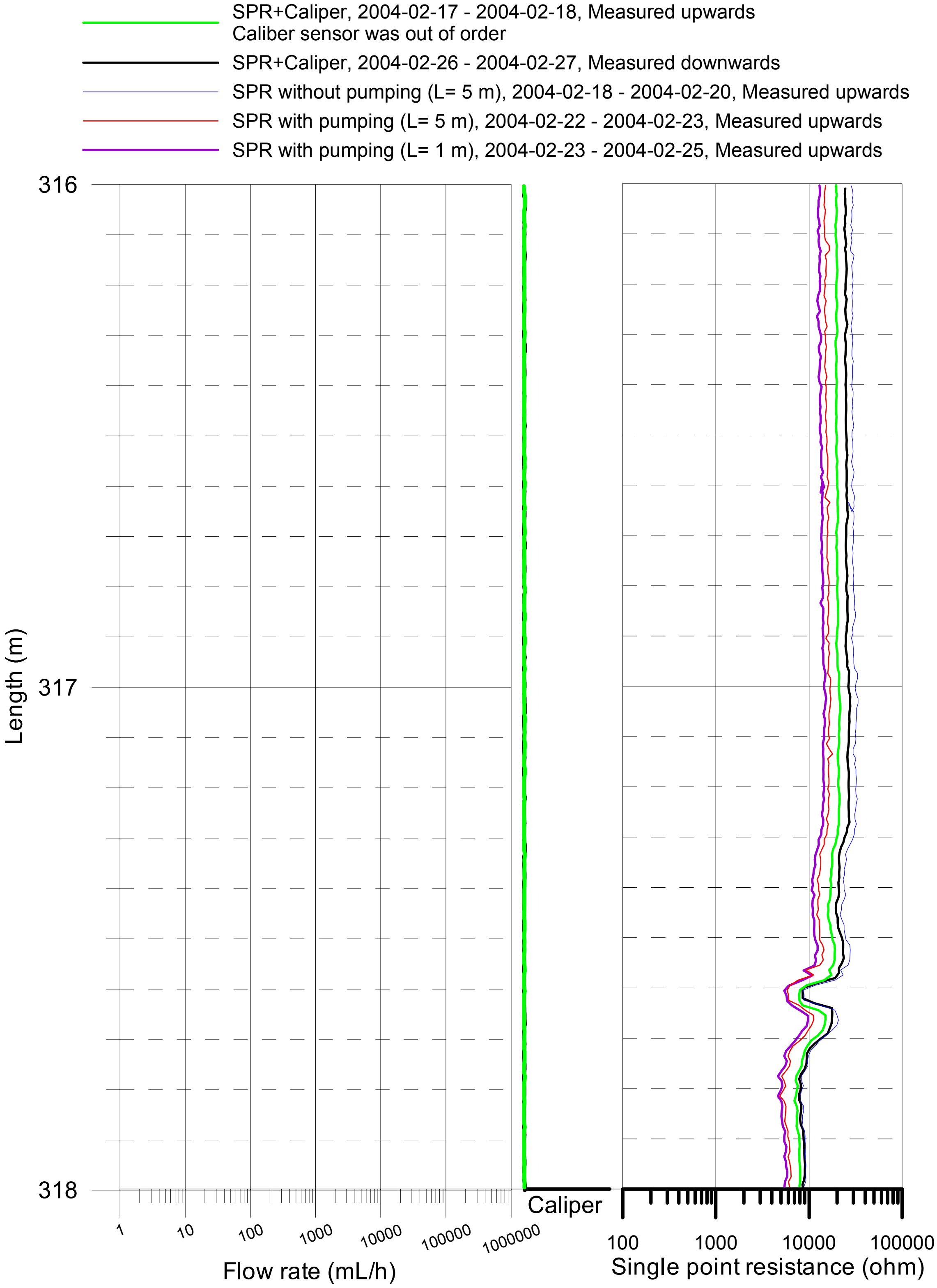

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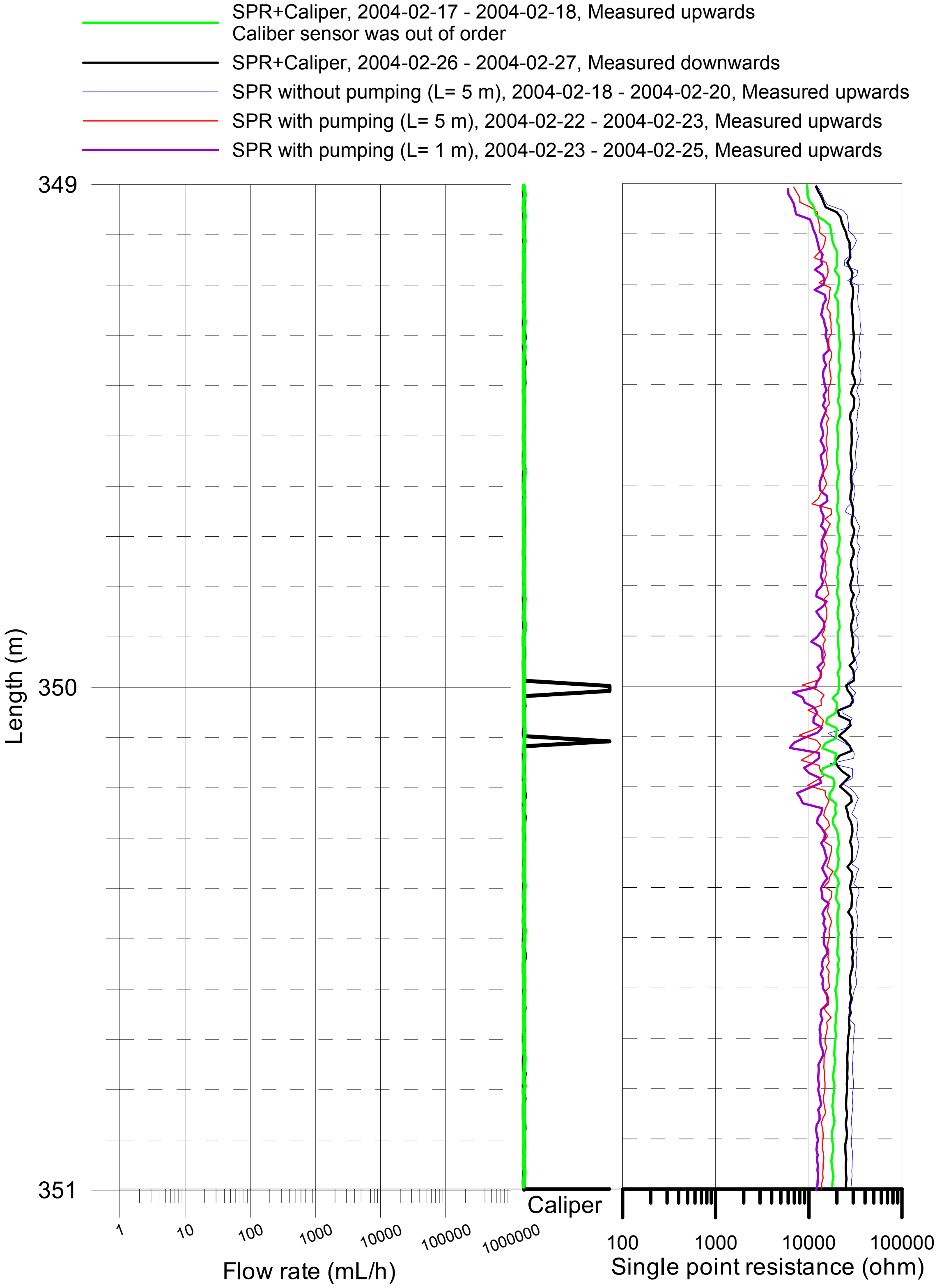

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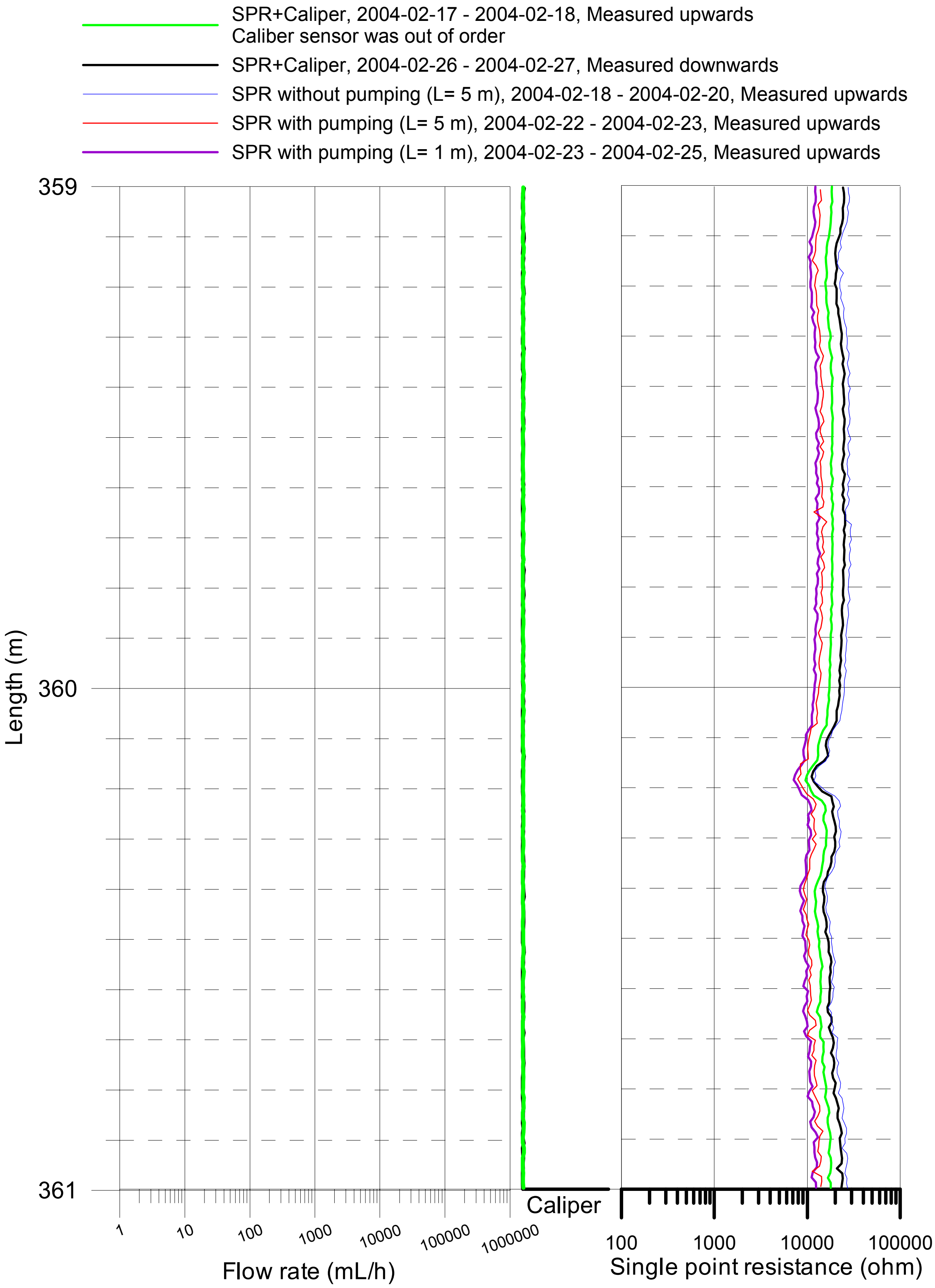

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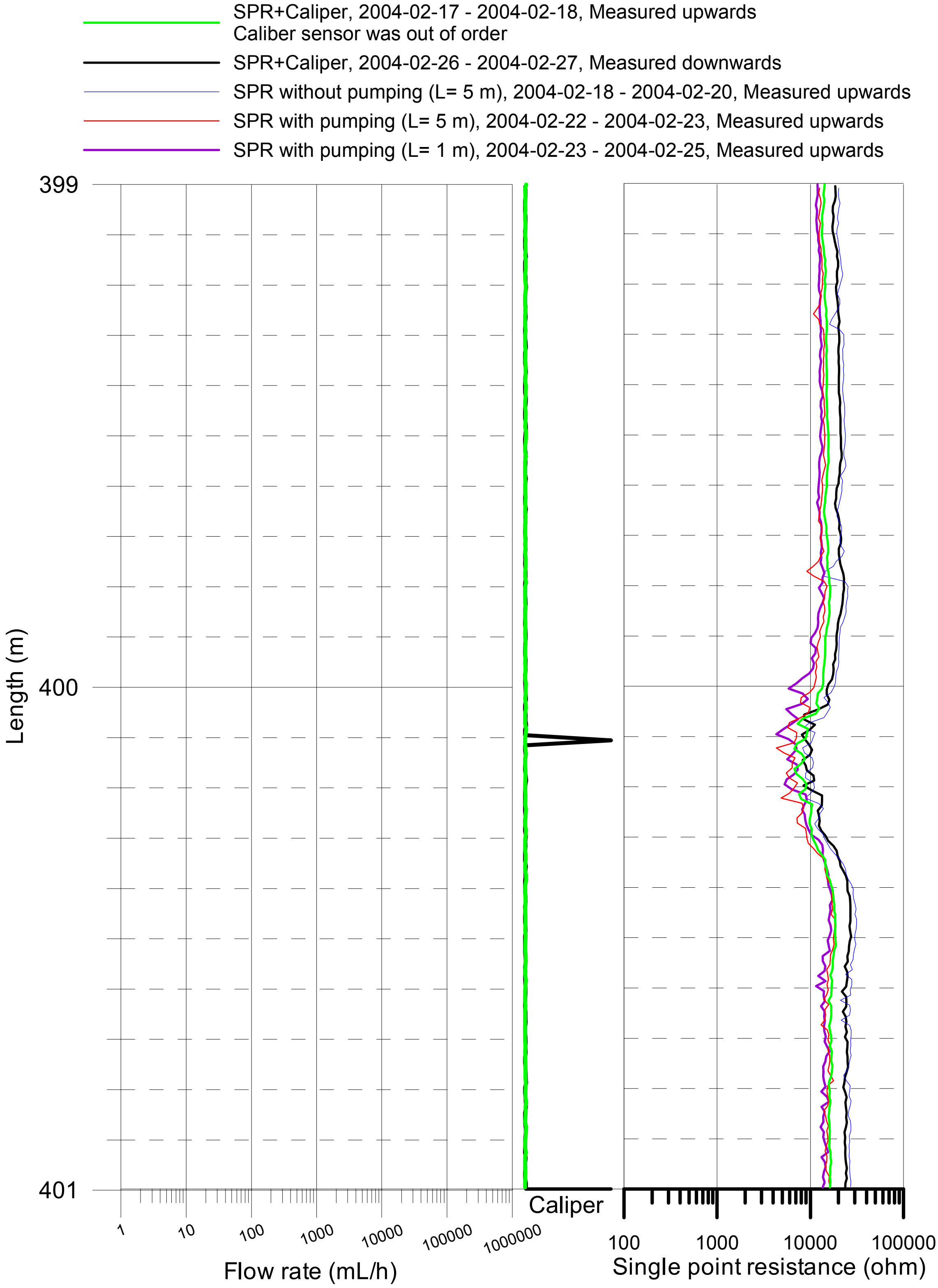

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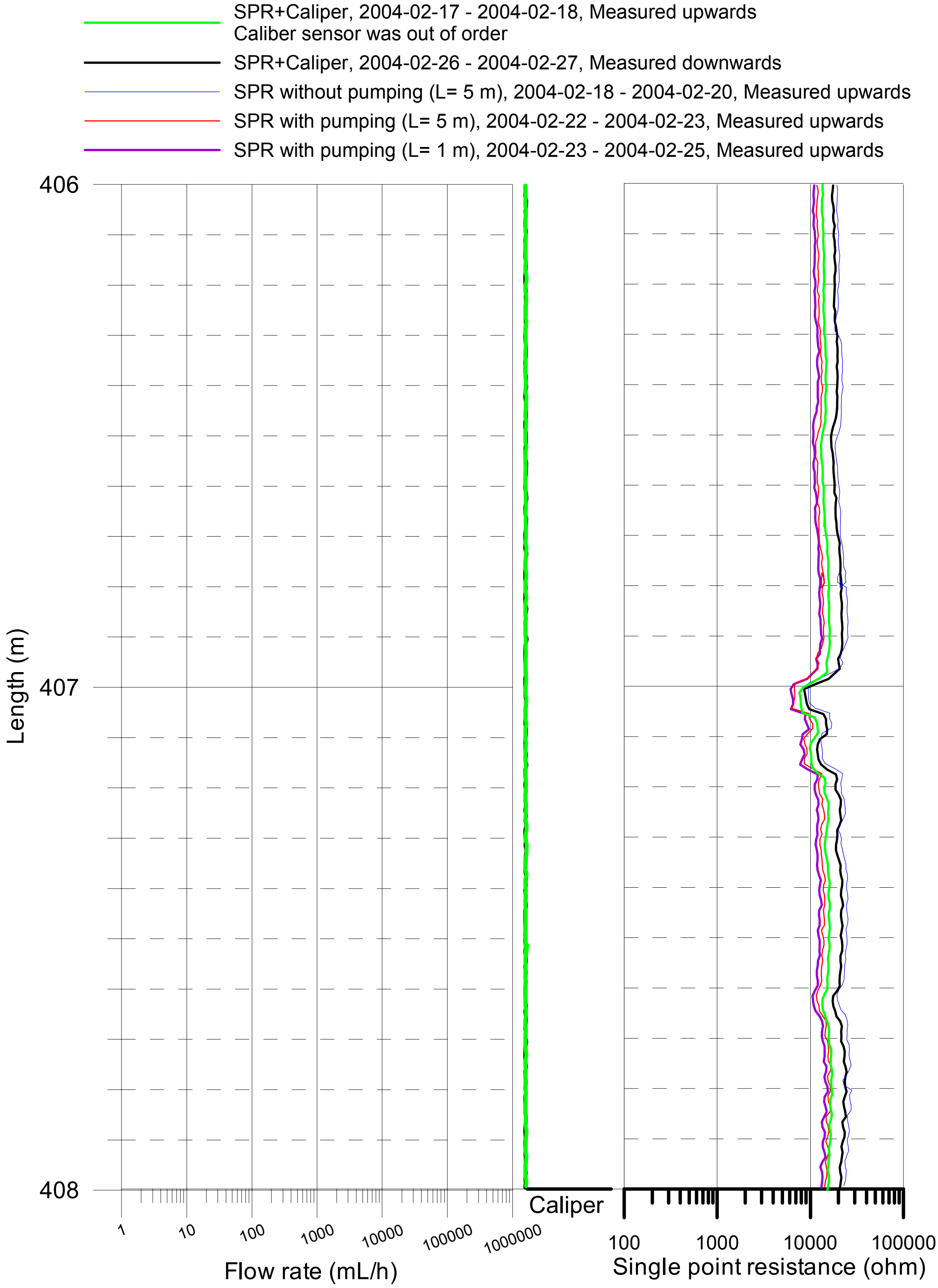

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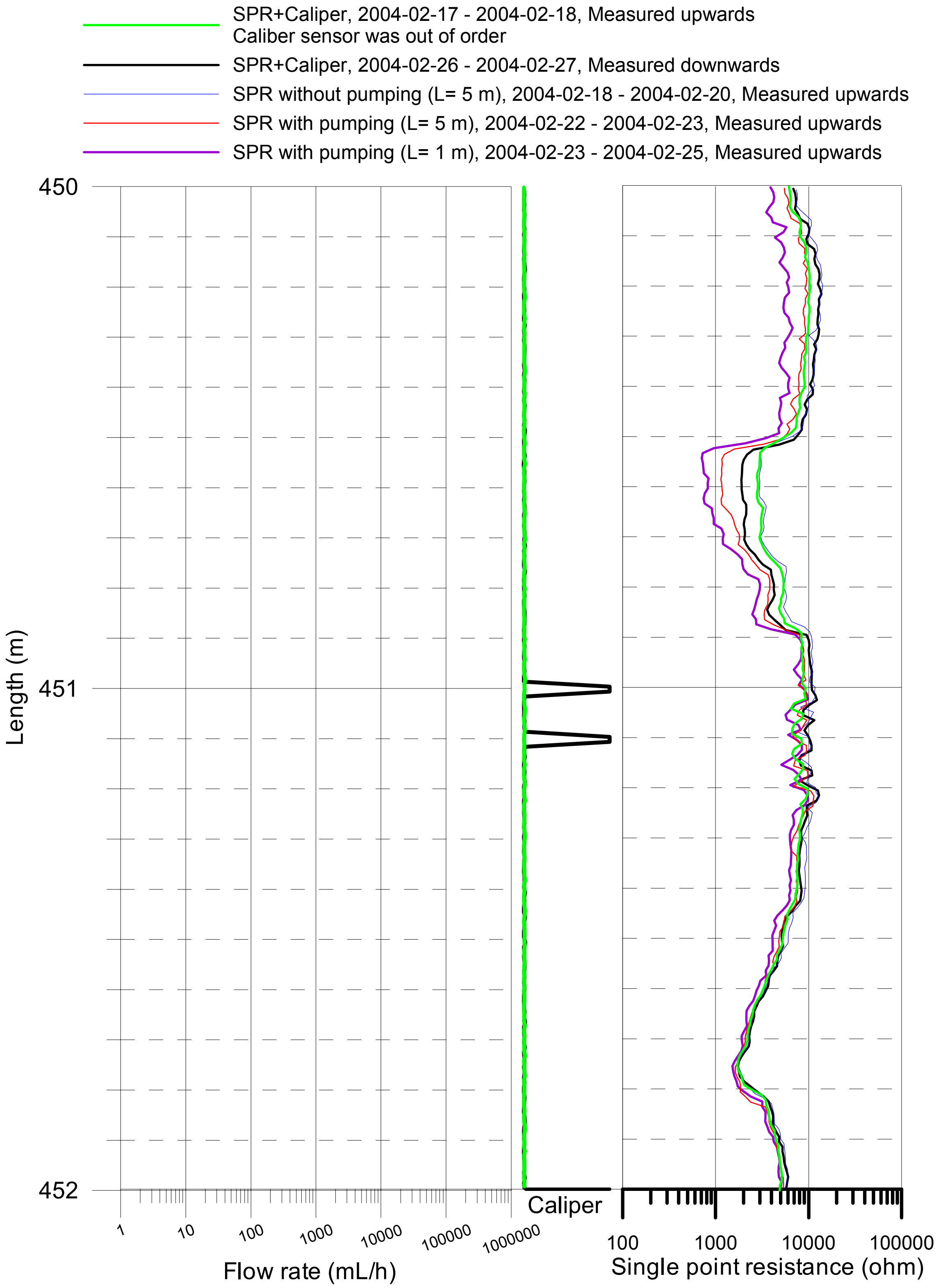

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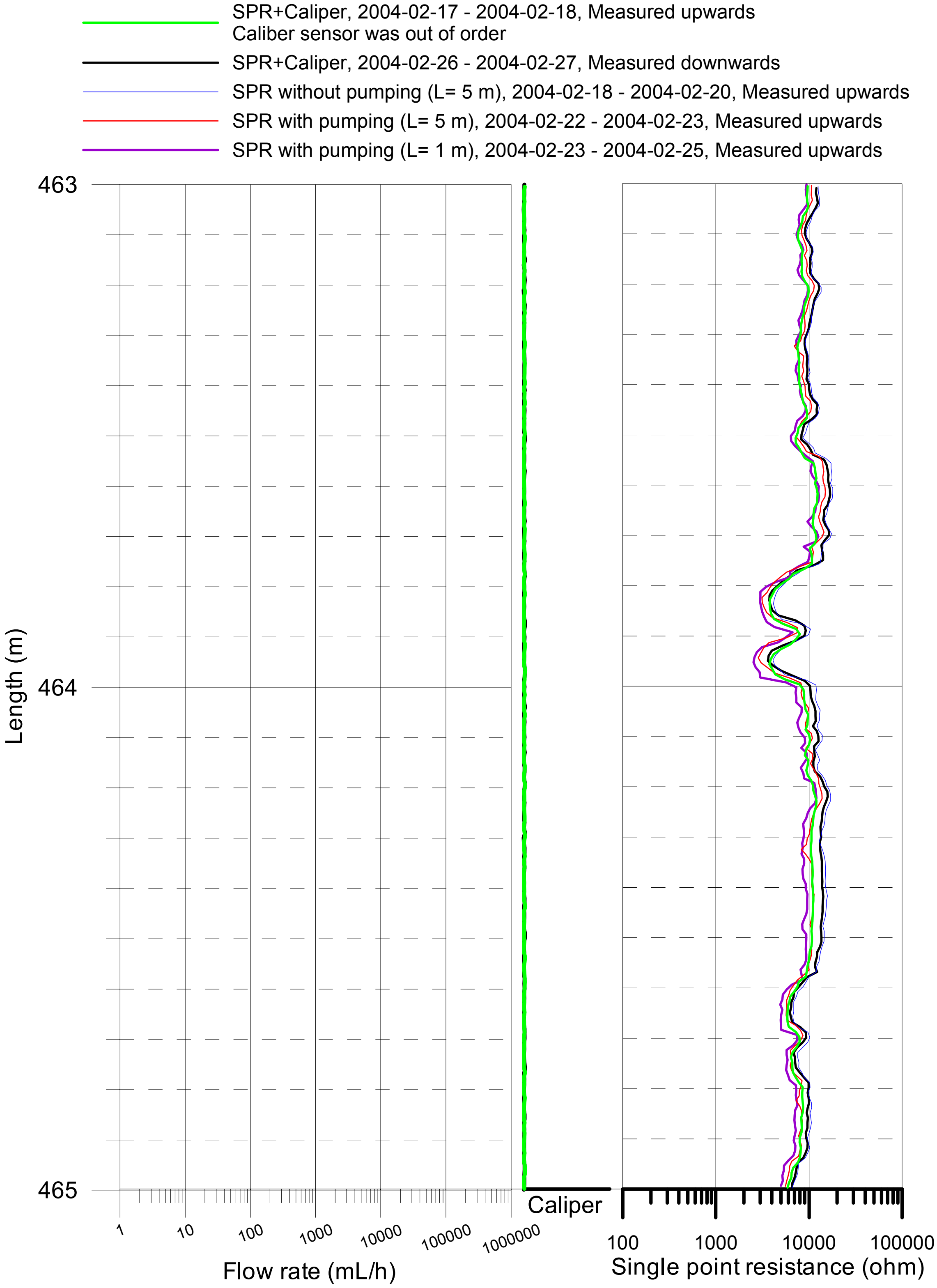

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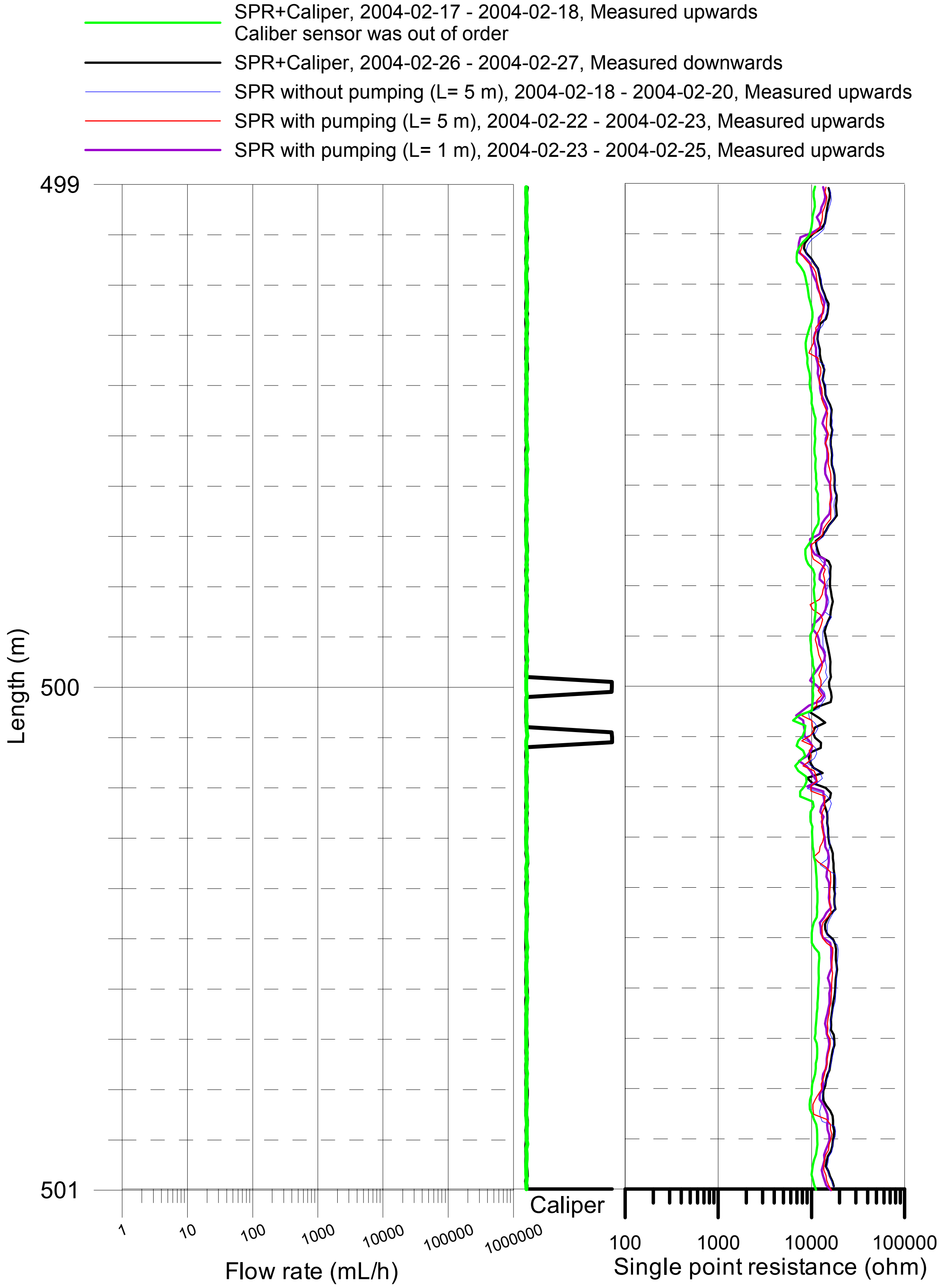

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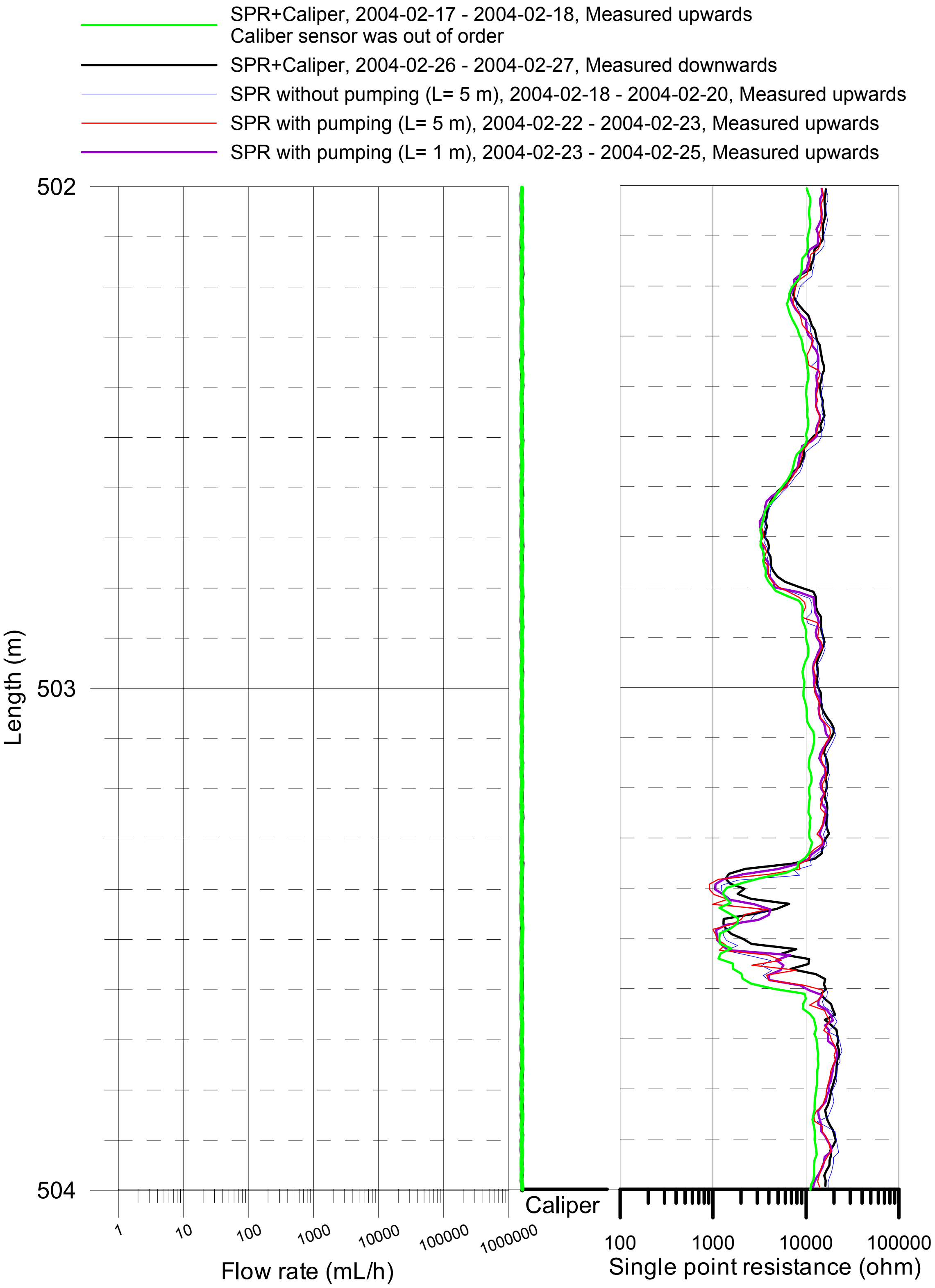

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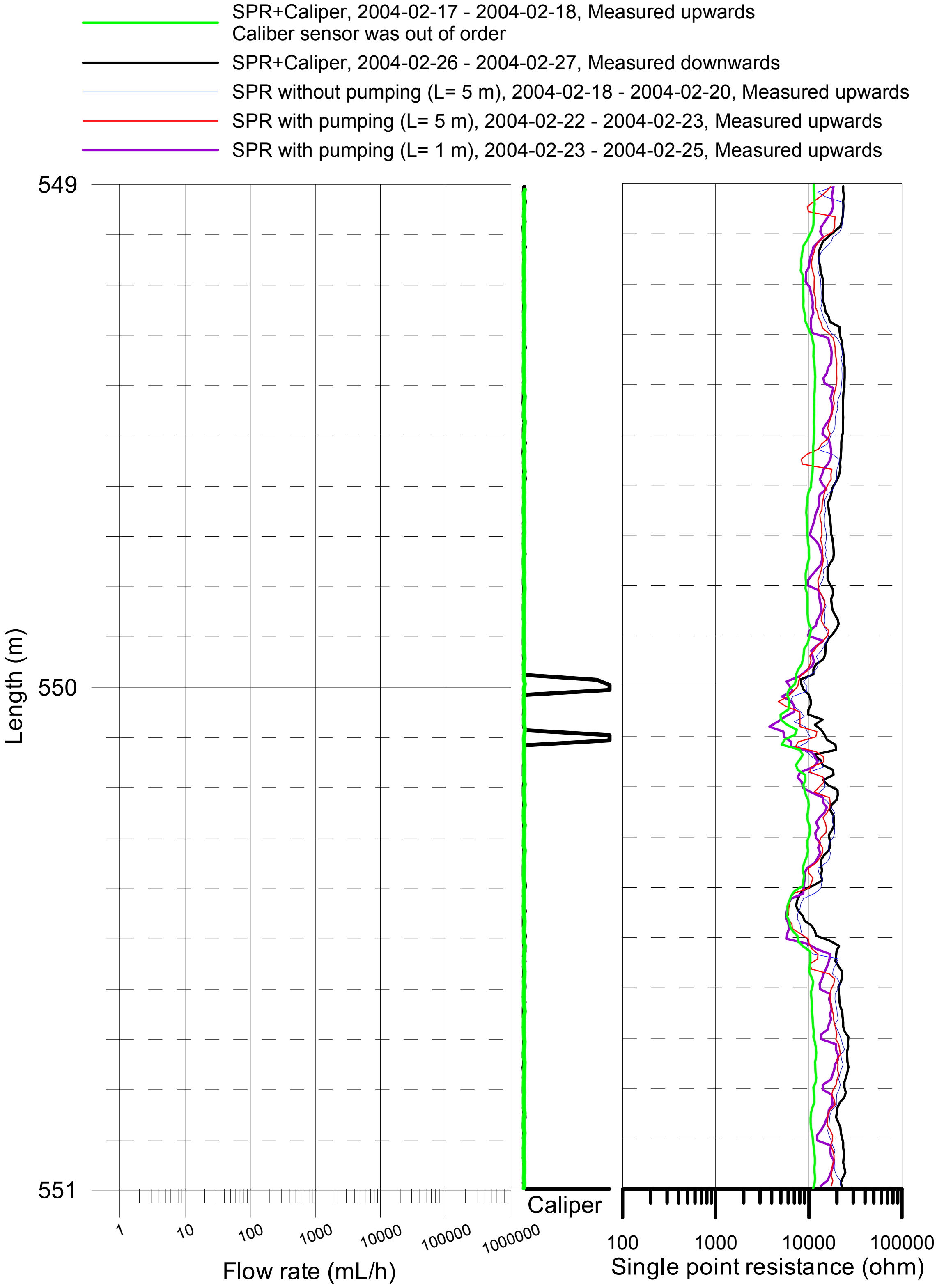

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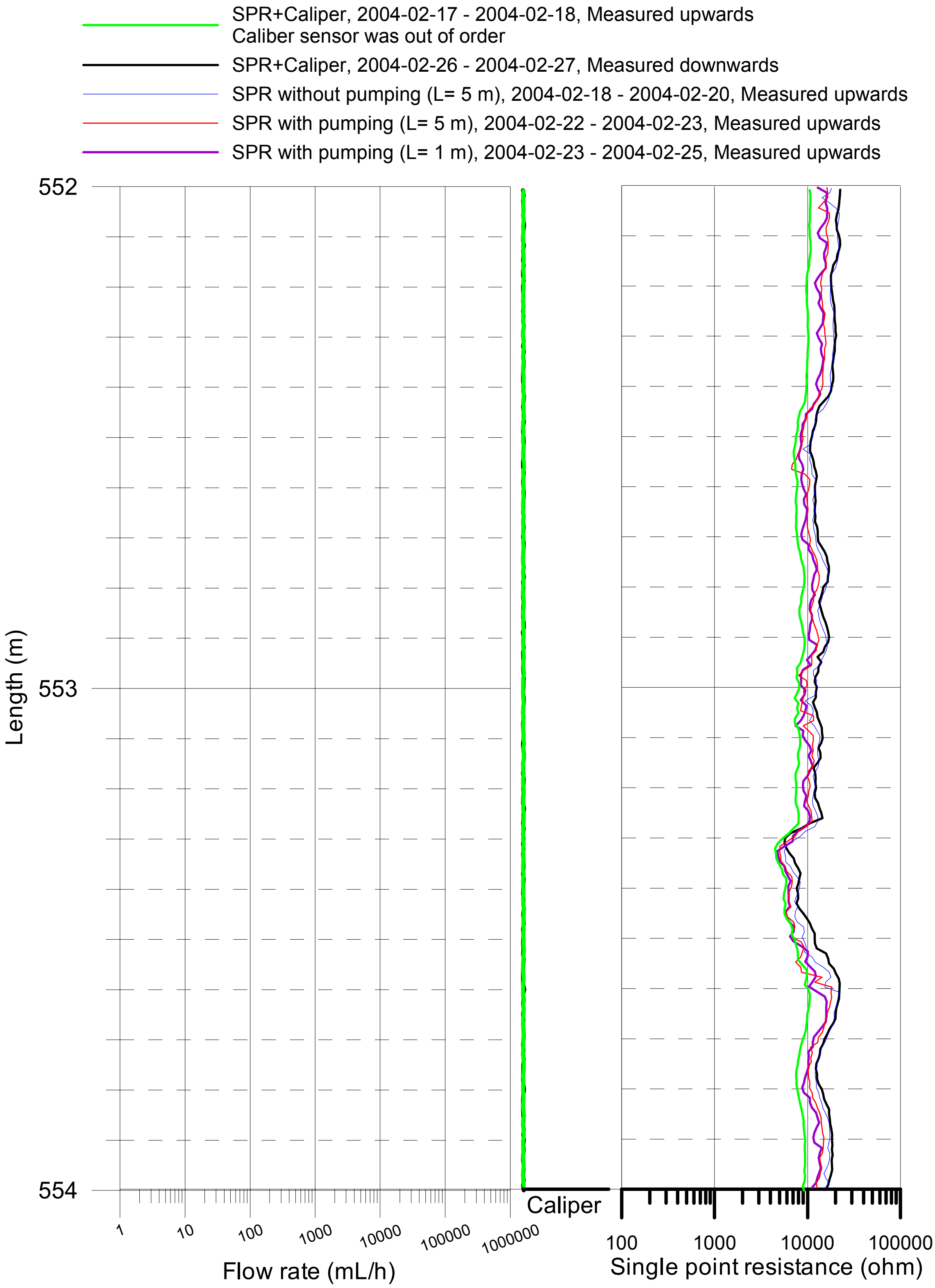

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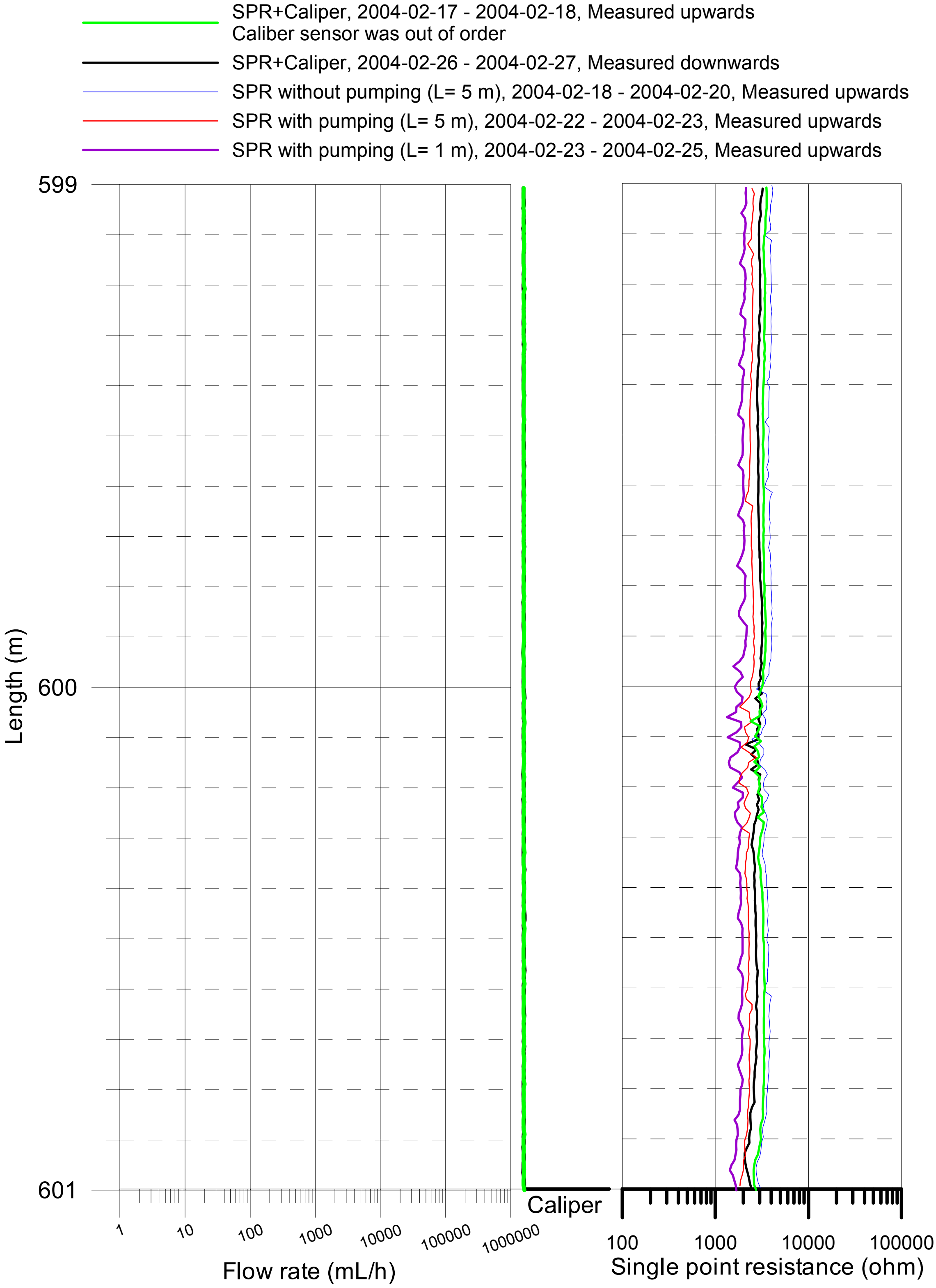

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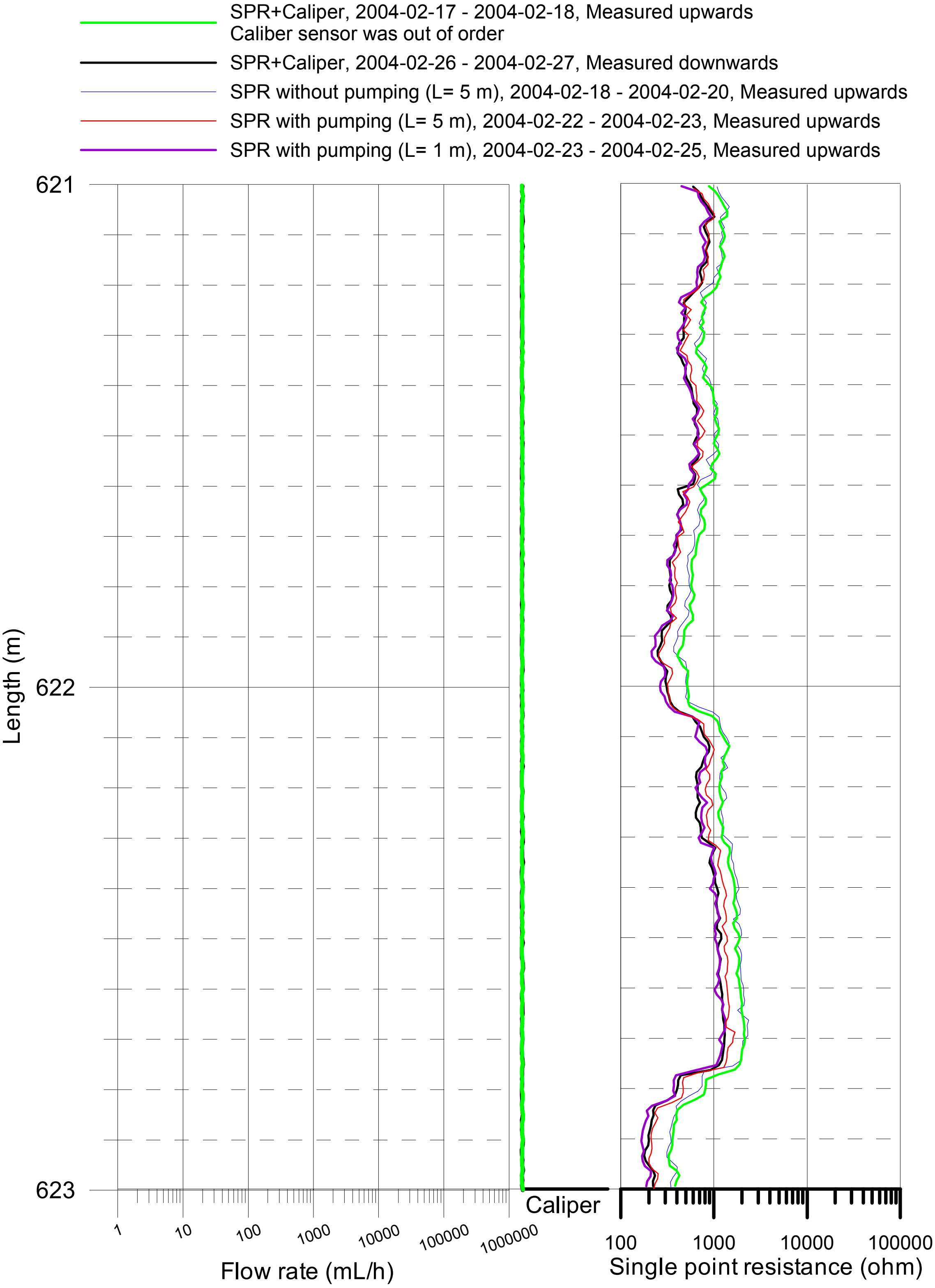

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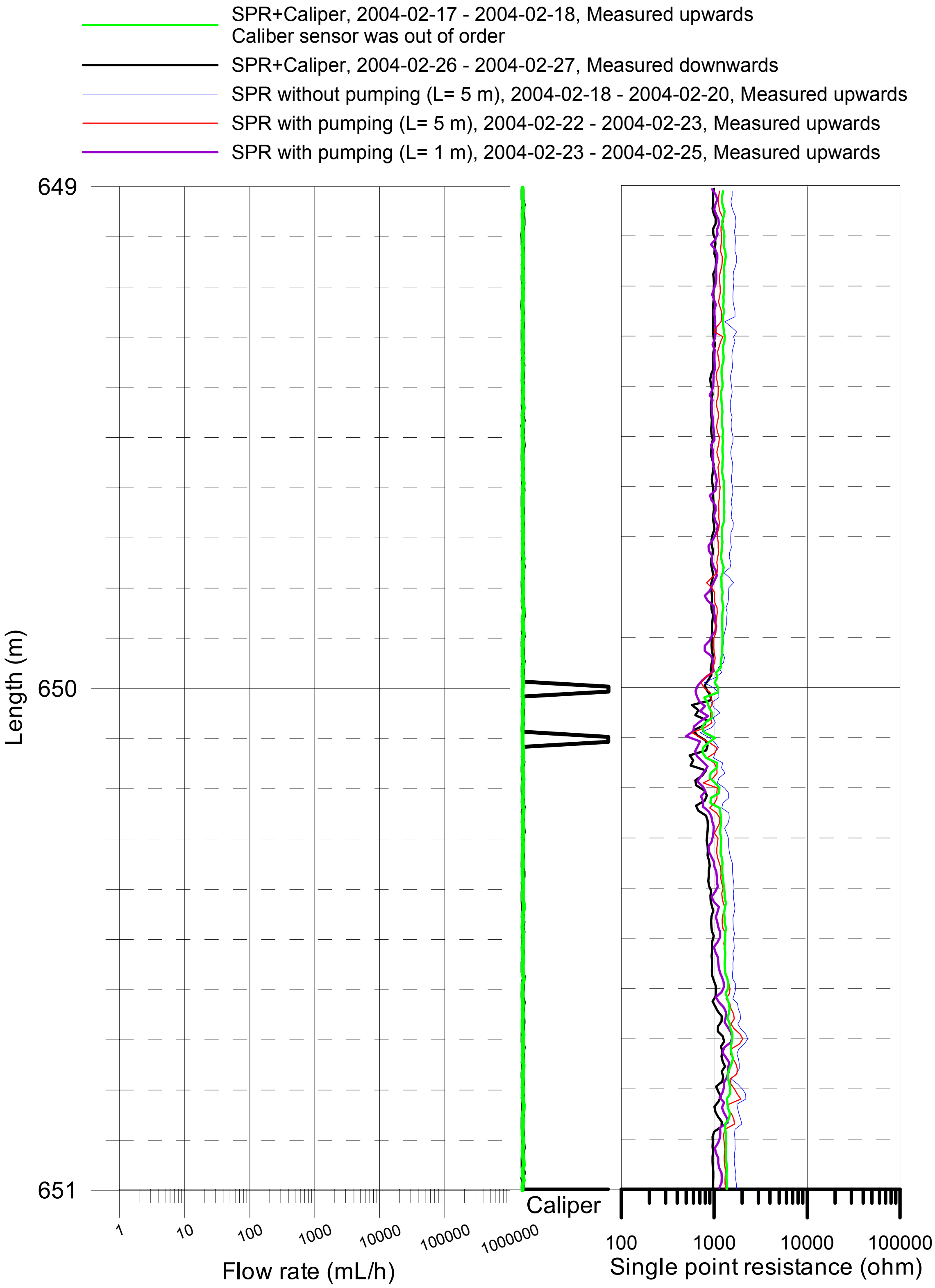

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SPR and Caliper results after depth correction

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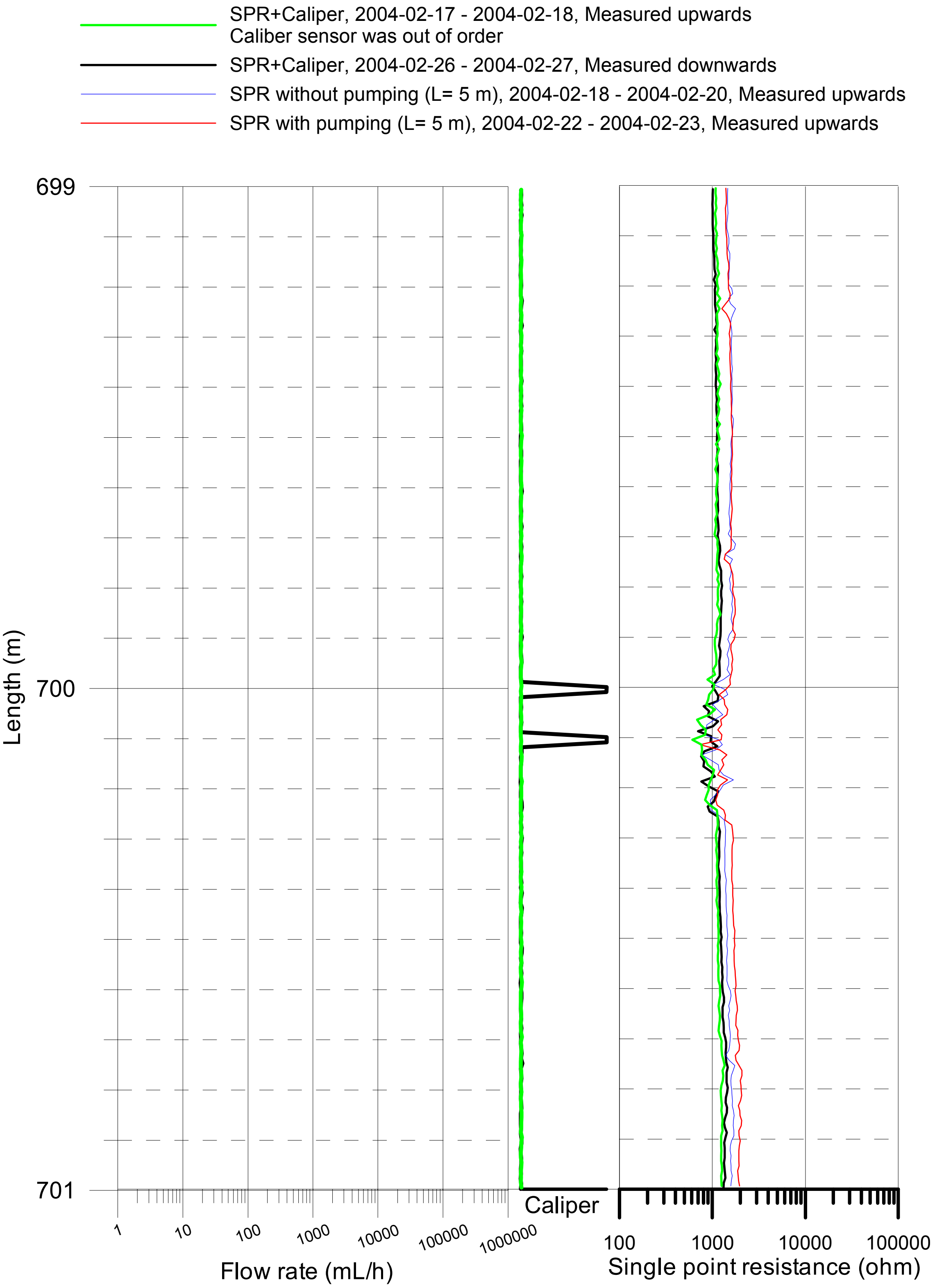

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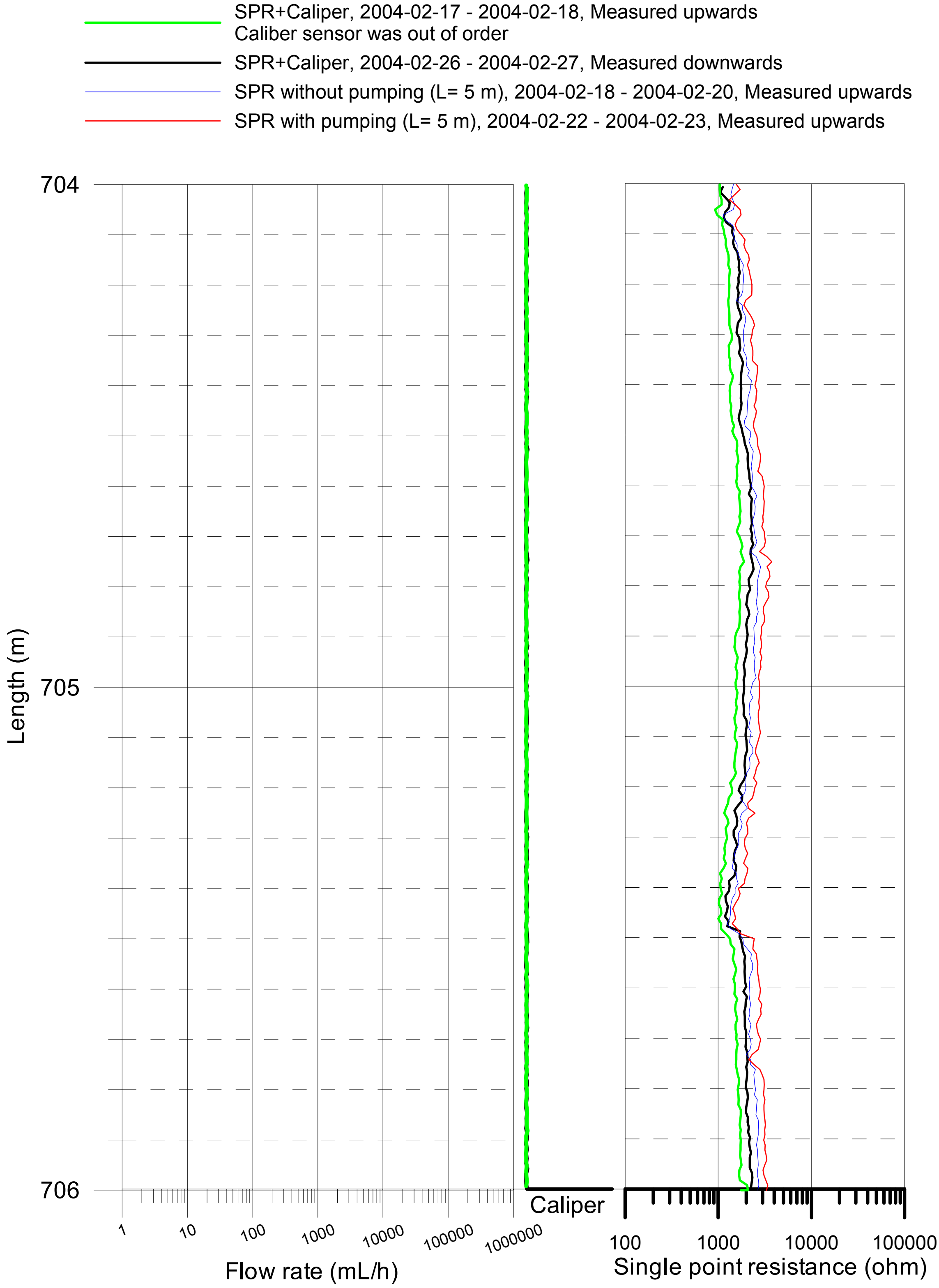
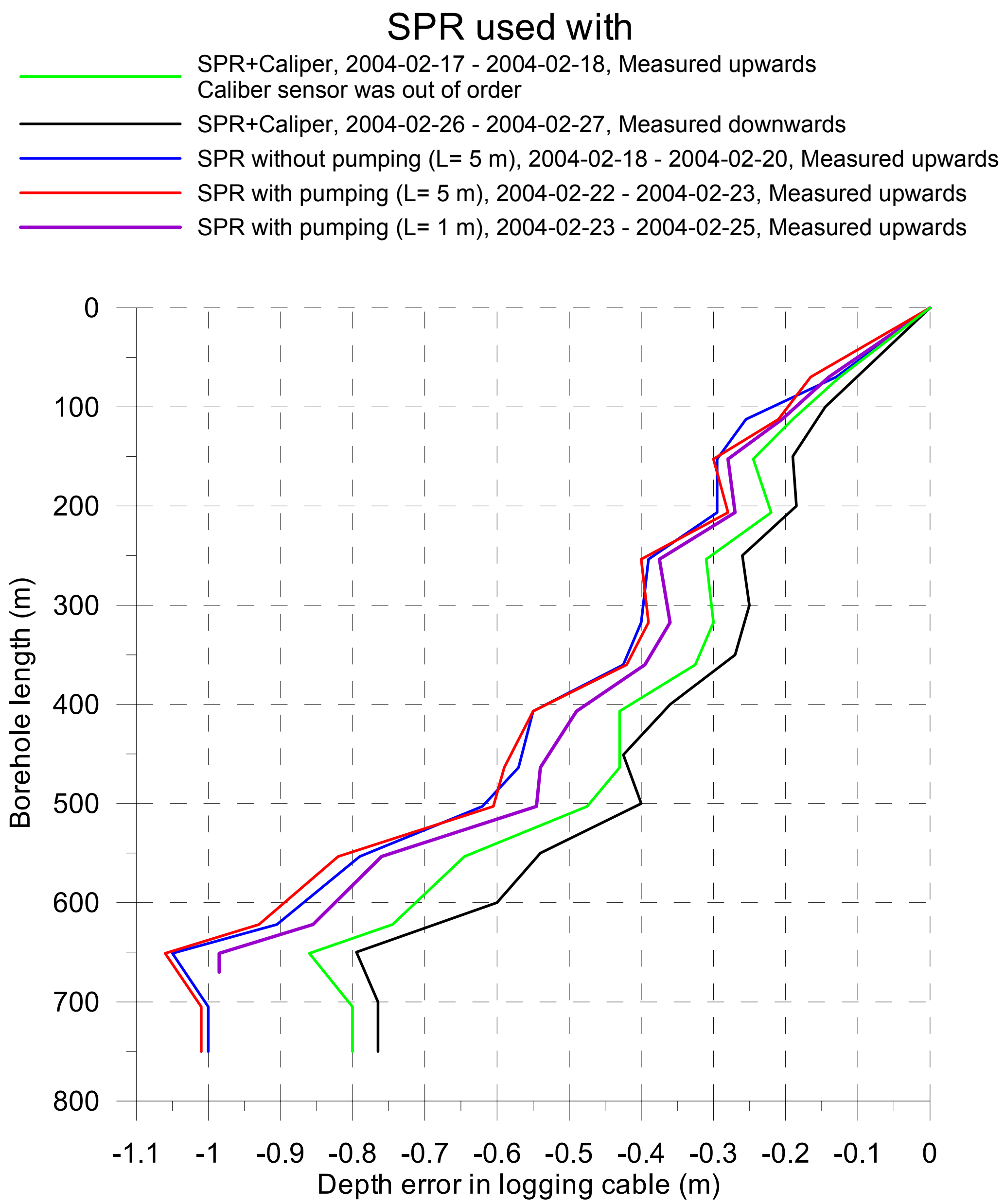
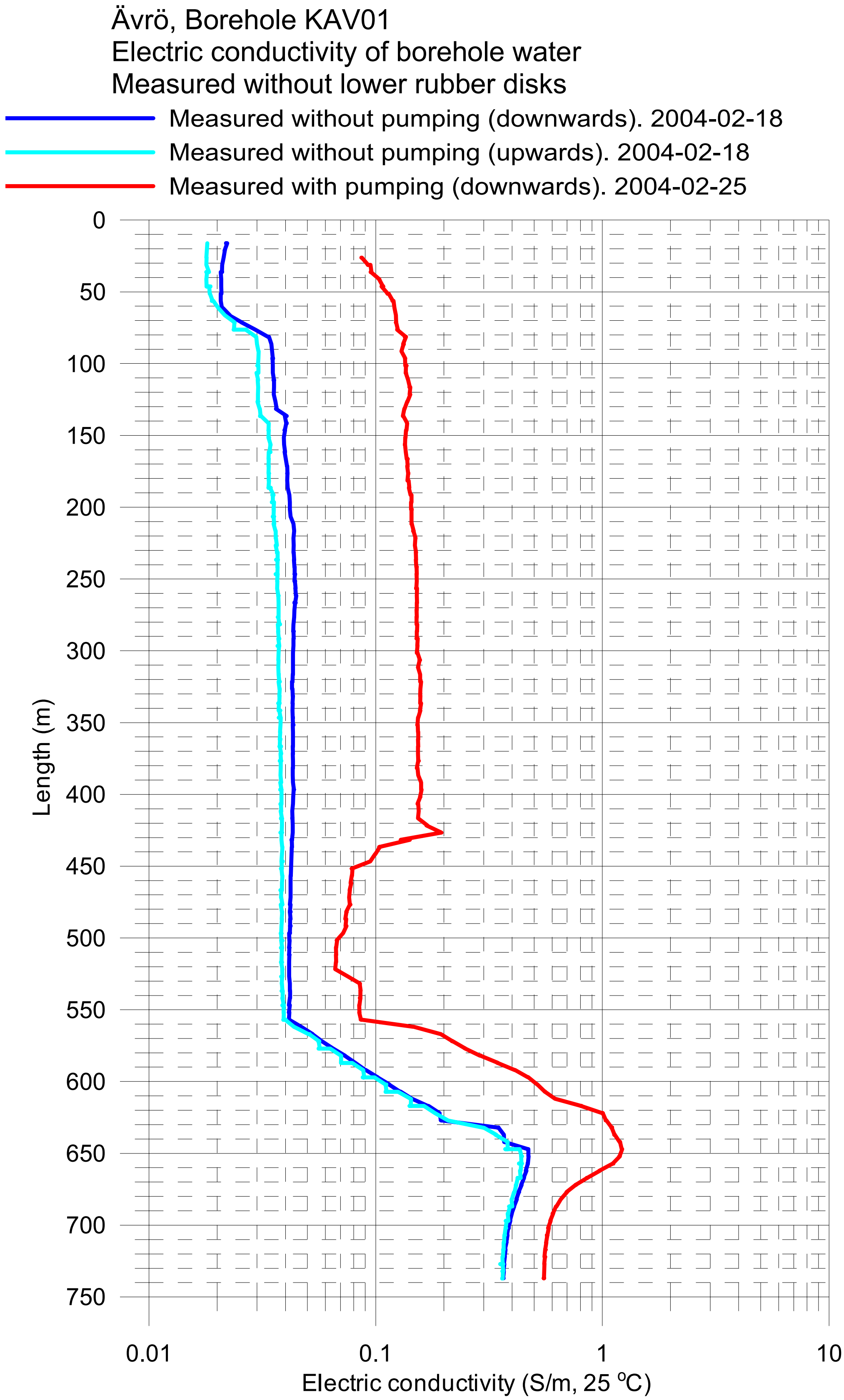
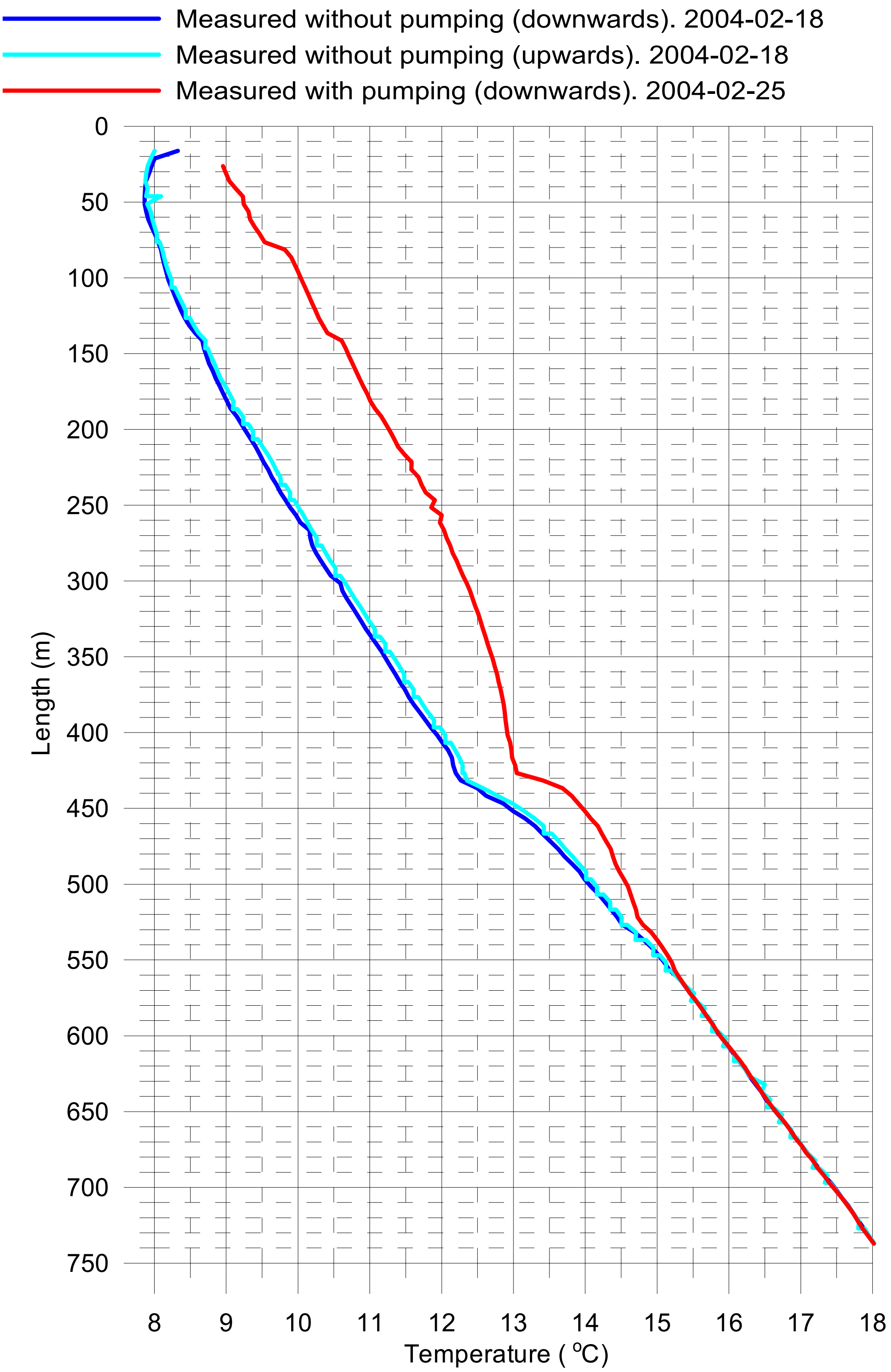
SPR and Caliper results after depth correction




SPR used with
SPR+Caliper, 2004-02-17 - 2004-02-18, Measured upwards
Caliber sensor was out of order
SPR+Caliper, 2004-02-26 - 2004-02-27, Measured downwards
SPR without pumping (L= 5 m), 2004-02-18 - 2004-02-20, Measured upwards
SPR with pumping (L= 5 m), 2004-02-22 - 2004-02-23, Measured upwards
SPR with pumping (L= 1 m), 2004-02-23 - 2004-02-25, Measured upwards
Borehole length (m)
0
100
200
300
400
500
600
700
800
-1.1
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
Depth error in logging cable (m)

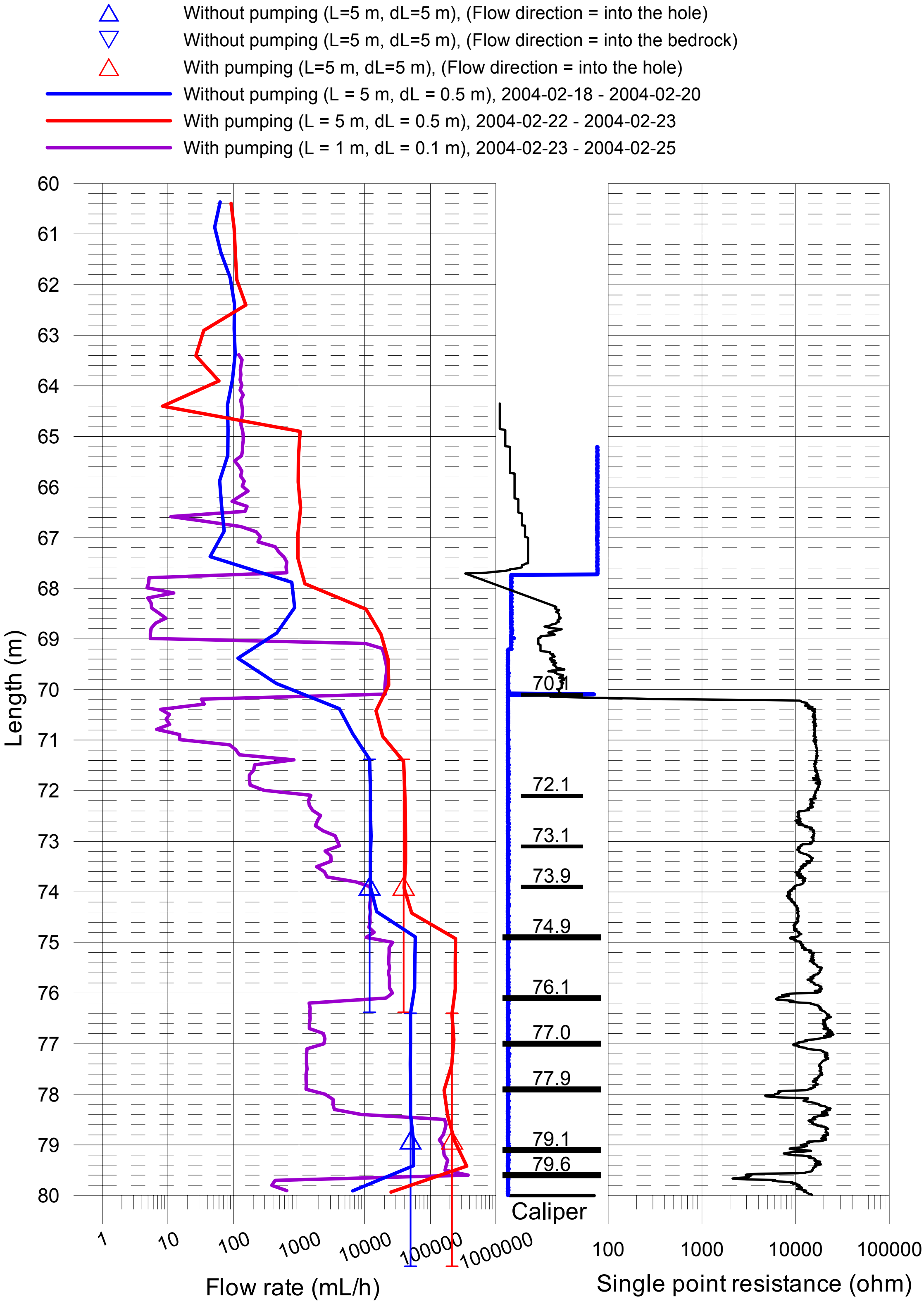

Ävrö, Borehole KAV01
Electric conductivity of borehole water
Measured without lower rubber disks
Measured without pumping (downwards). 2004-02-18
Measured without pumping (upwards). 2004-02-18
Measured with pumping (downwards). 2004-02-25
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
Length (m)
0.01
0.1
1
10
Electric conductivity (S/m, 25 °C)

Ävrö, Borehole KAV01
Temperature of borehole water
Measured without lower rubber disks



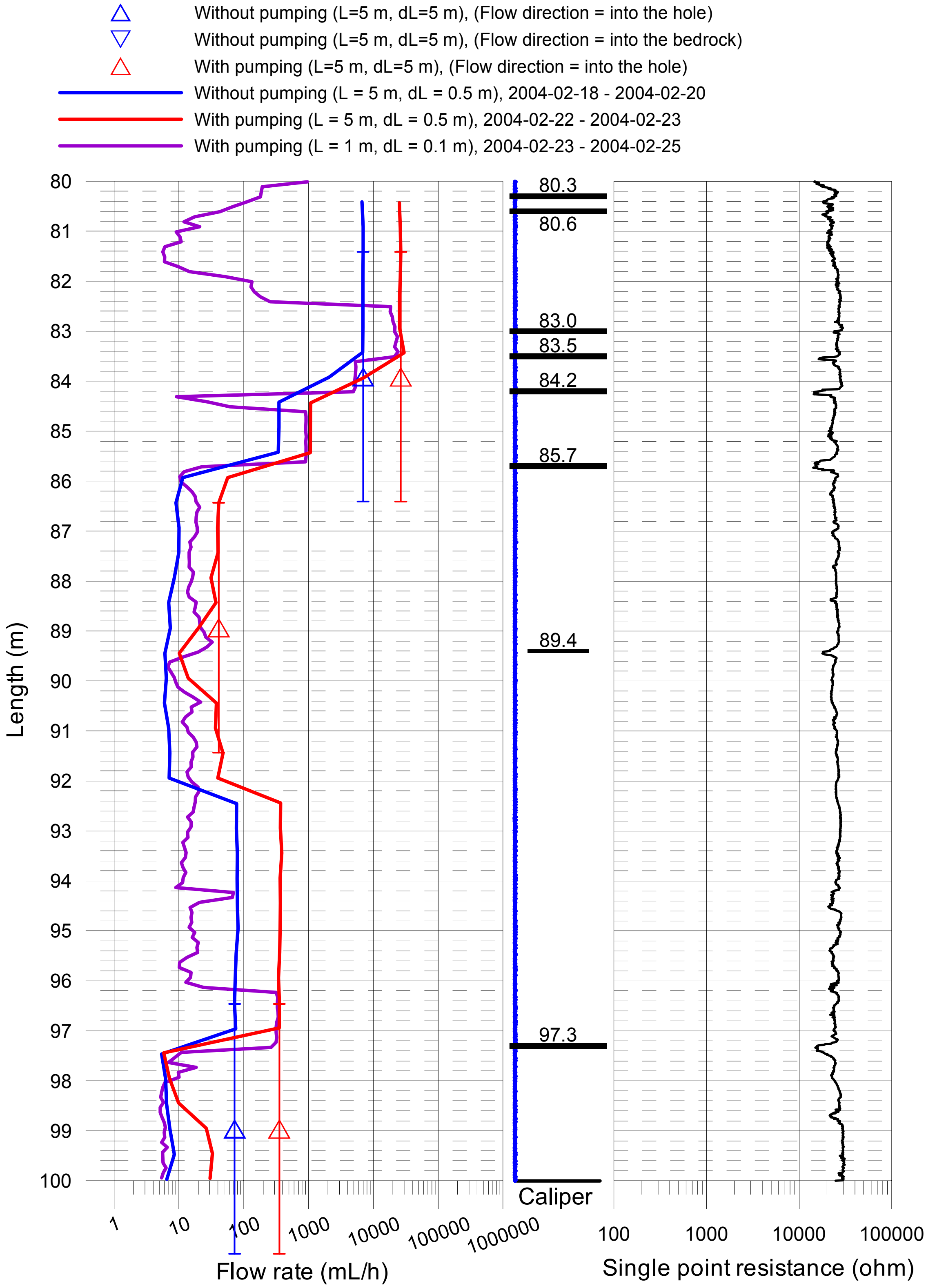
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



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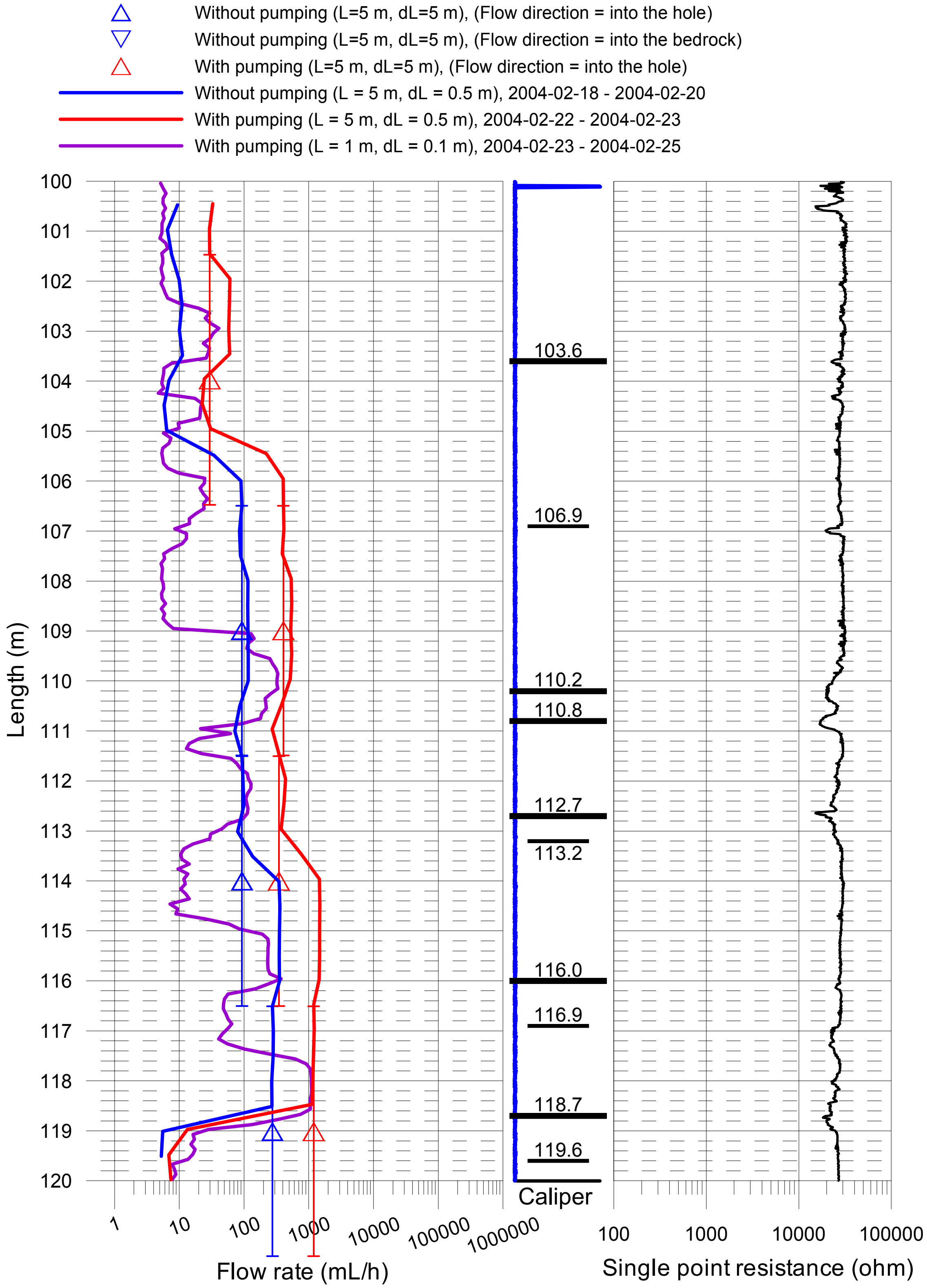
Flow measurement 2004-02-18 - 2004-02-25



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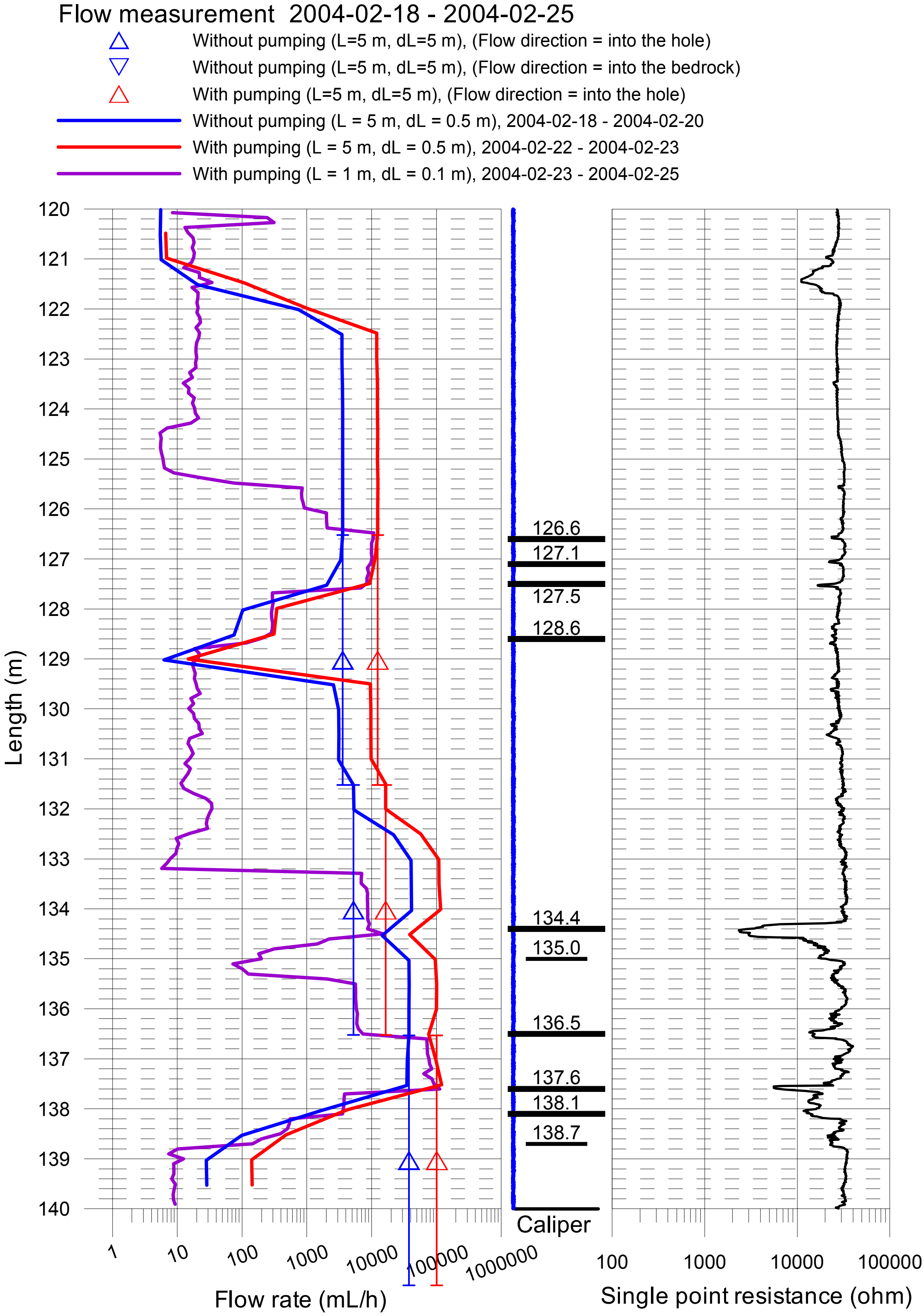

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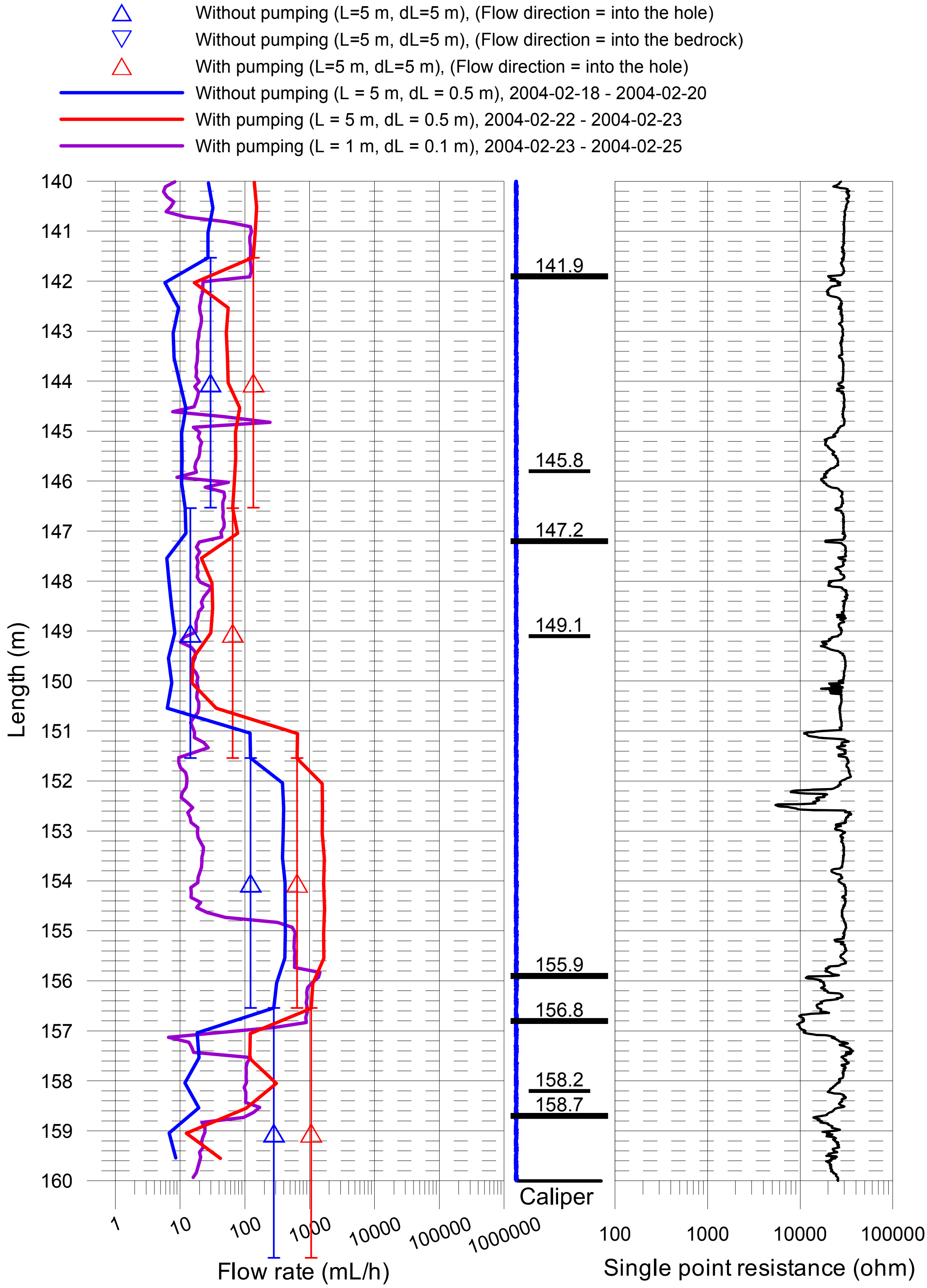
Flow measurement 2004-02-18 - 2004-02-25



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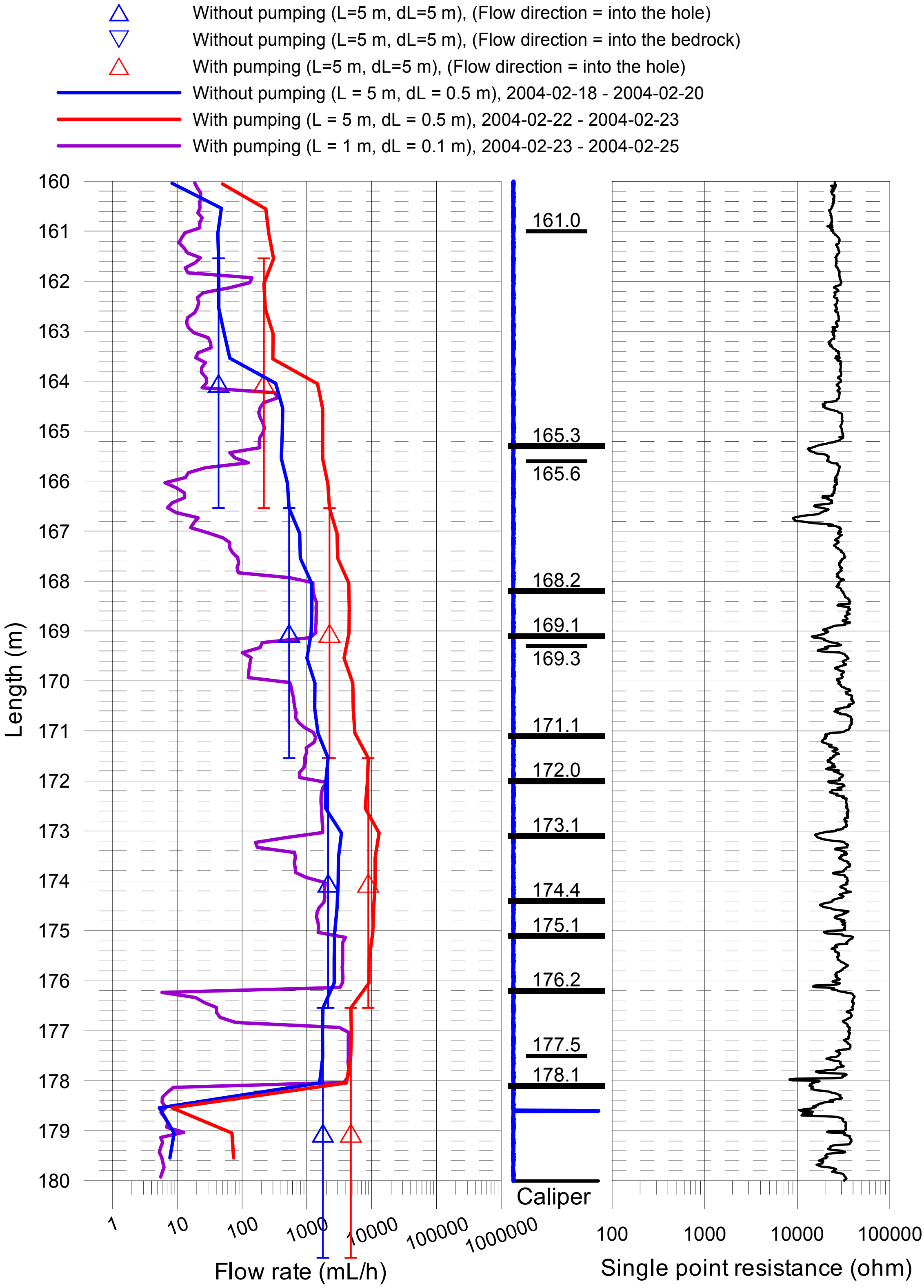
Flow measurement 2004-02-18 - 2004-02-25



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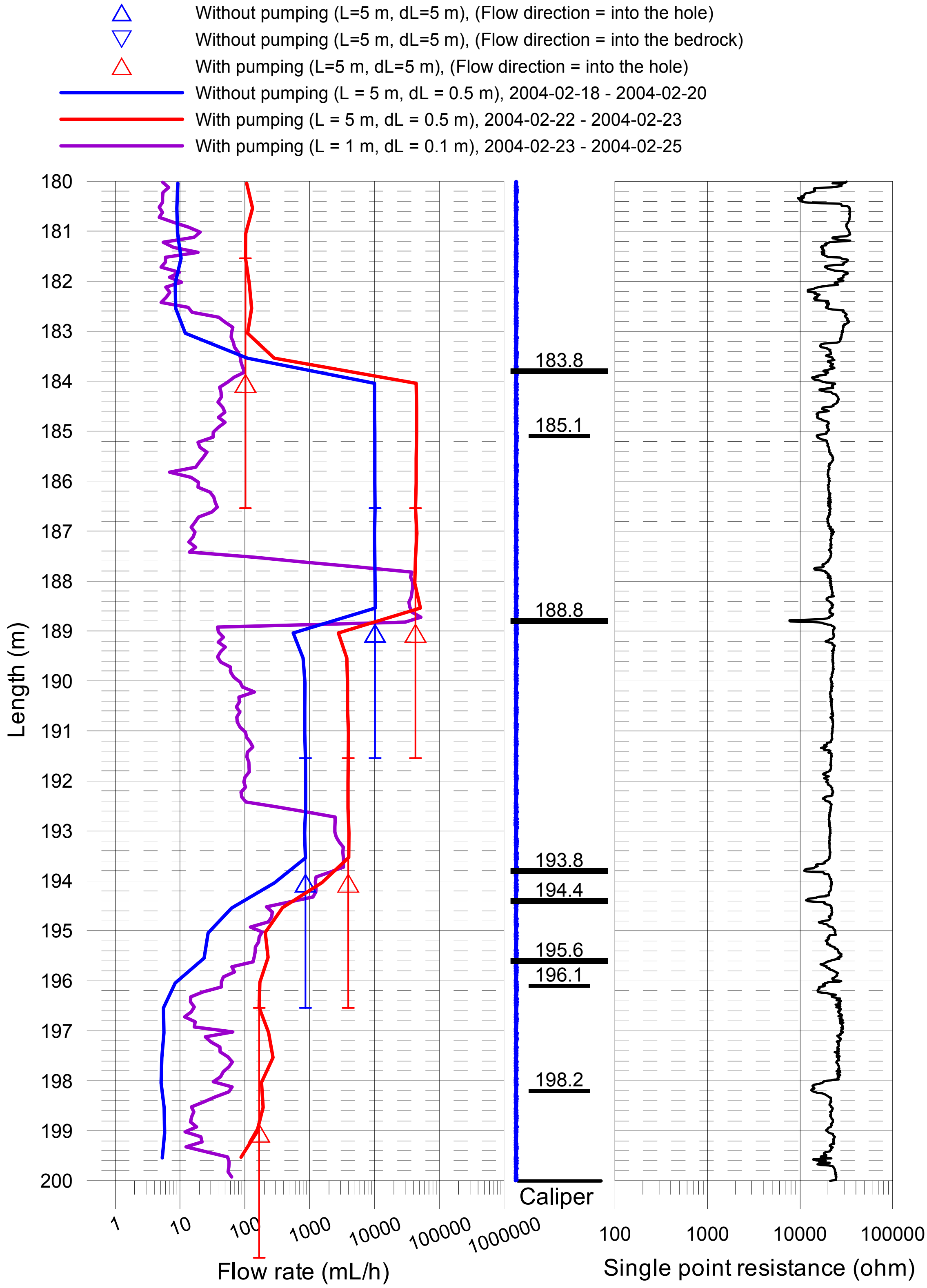
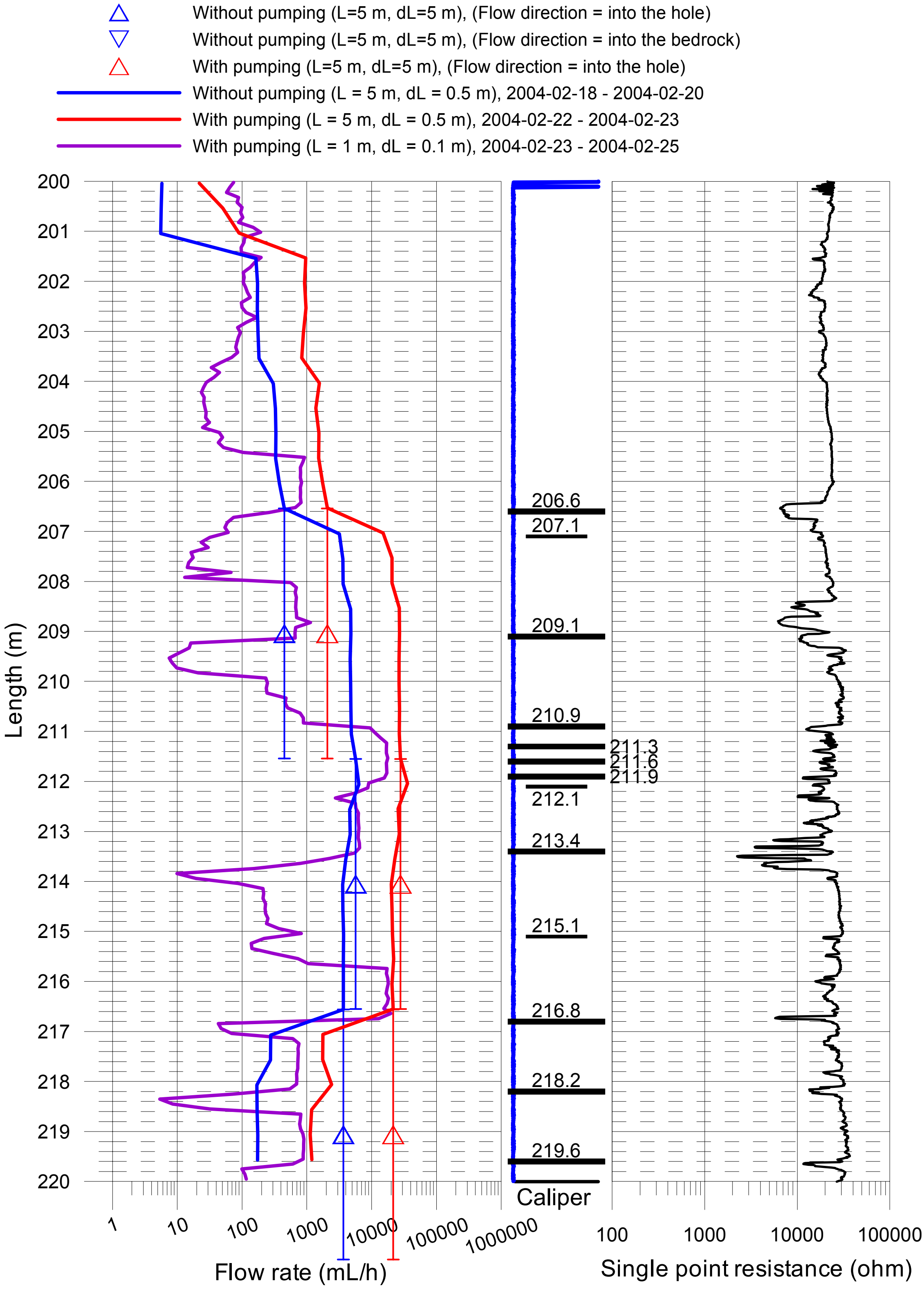
Flow measurement 2004-02-18 - 2004-02-25



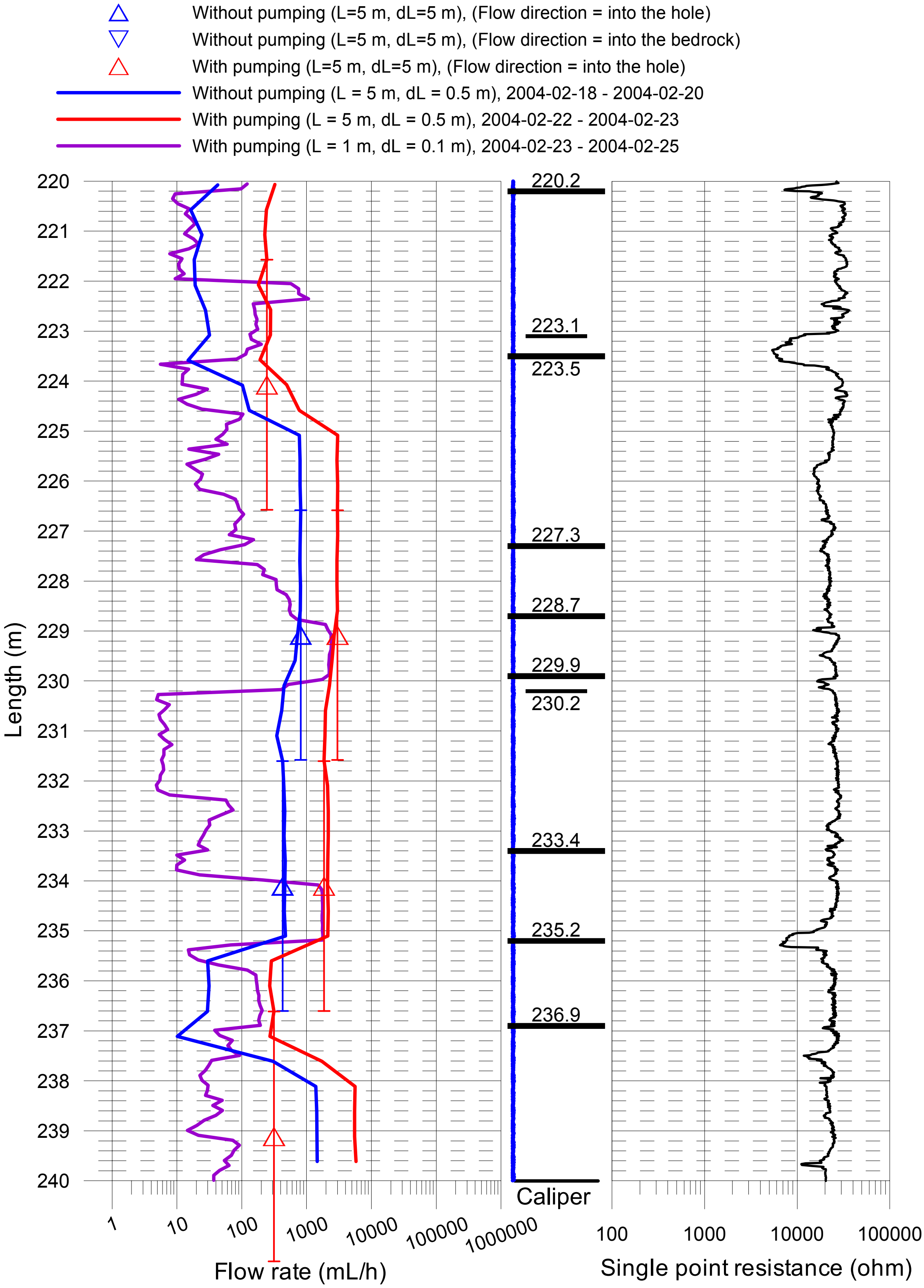
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



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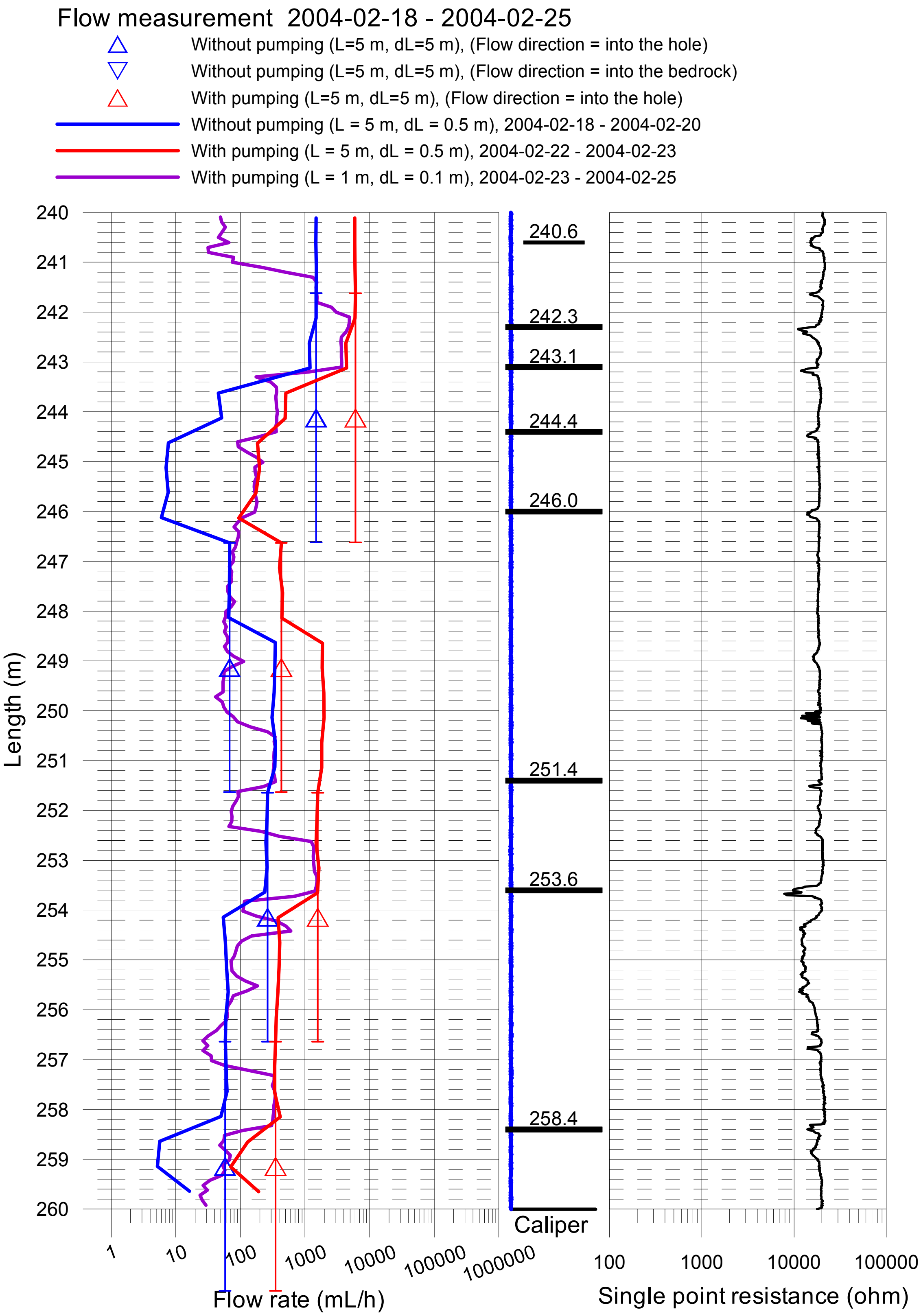
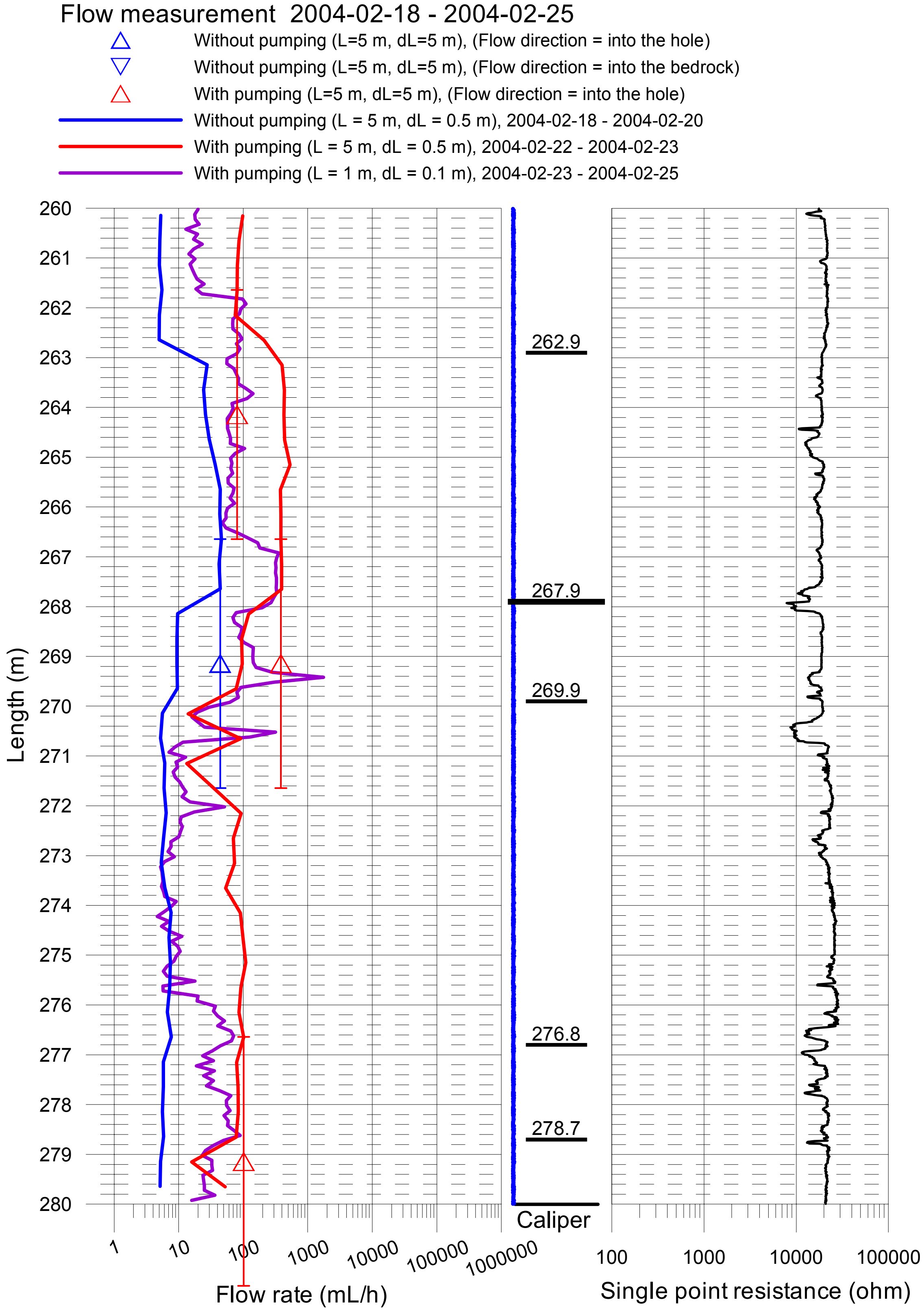
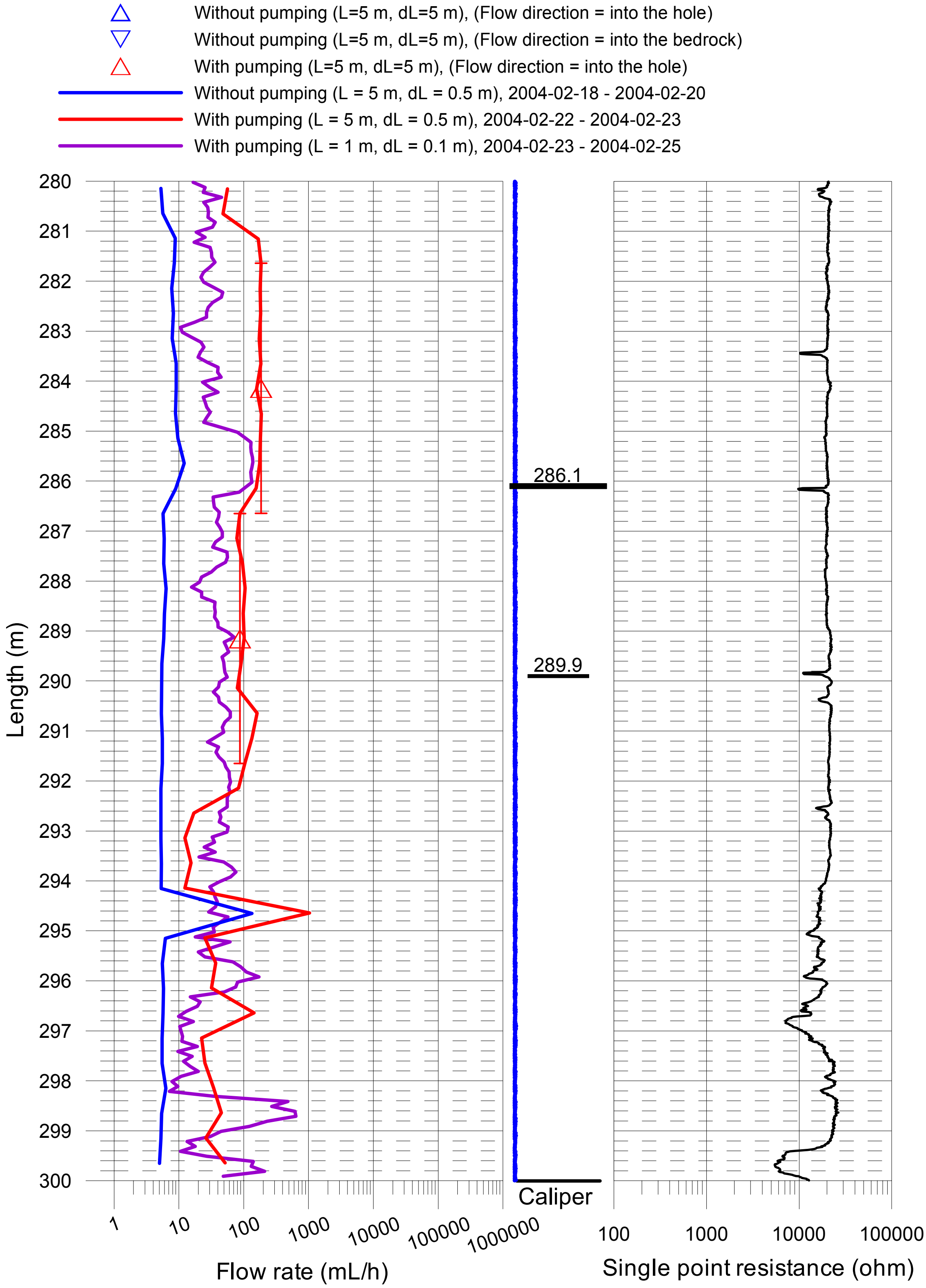


ÄVRÖ, Borehole KAV01



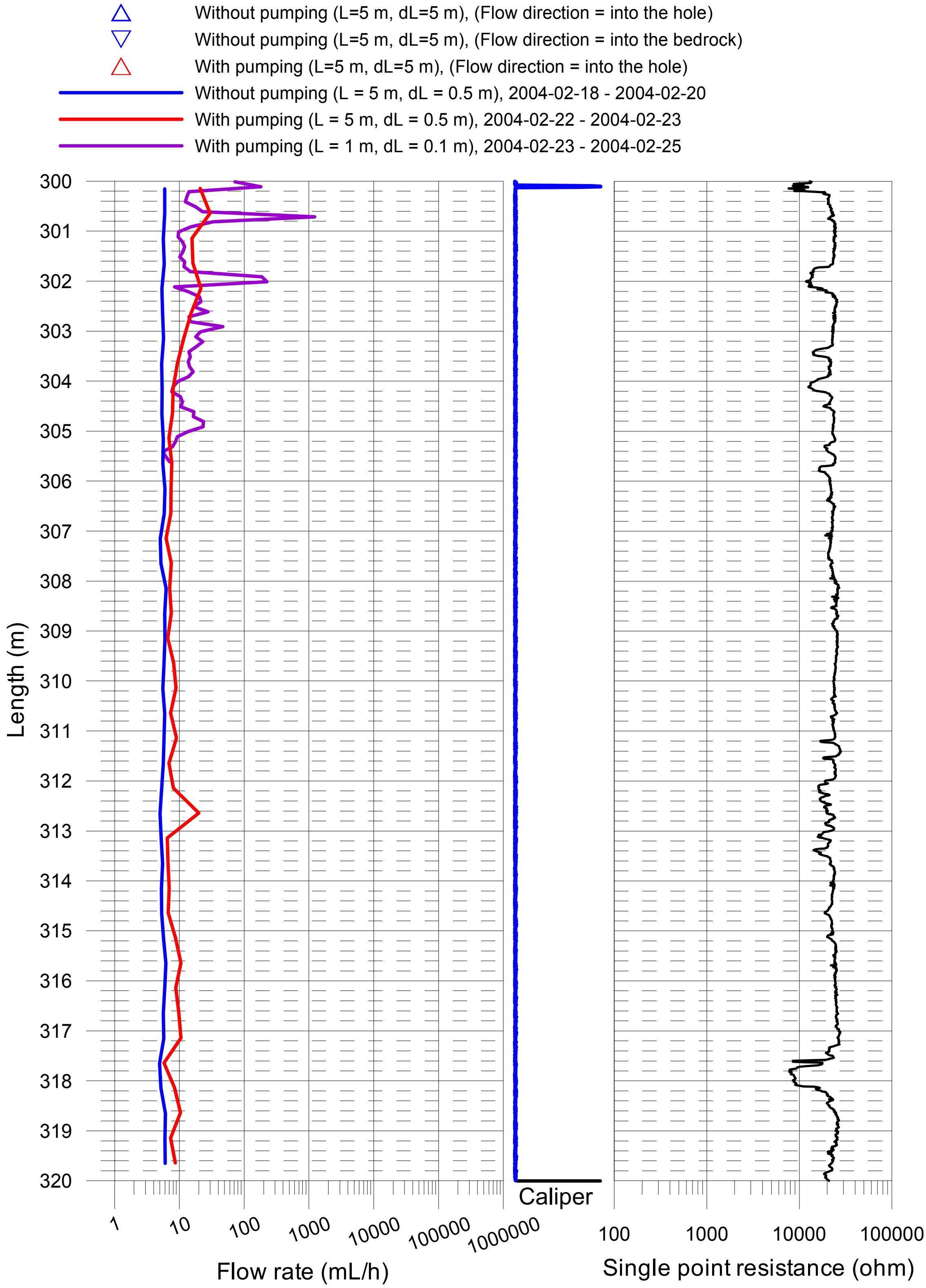
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



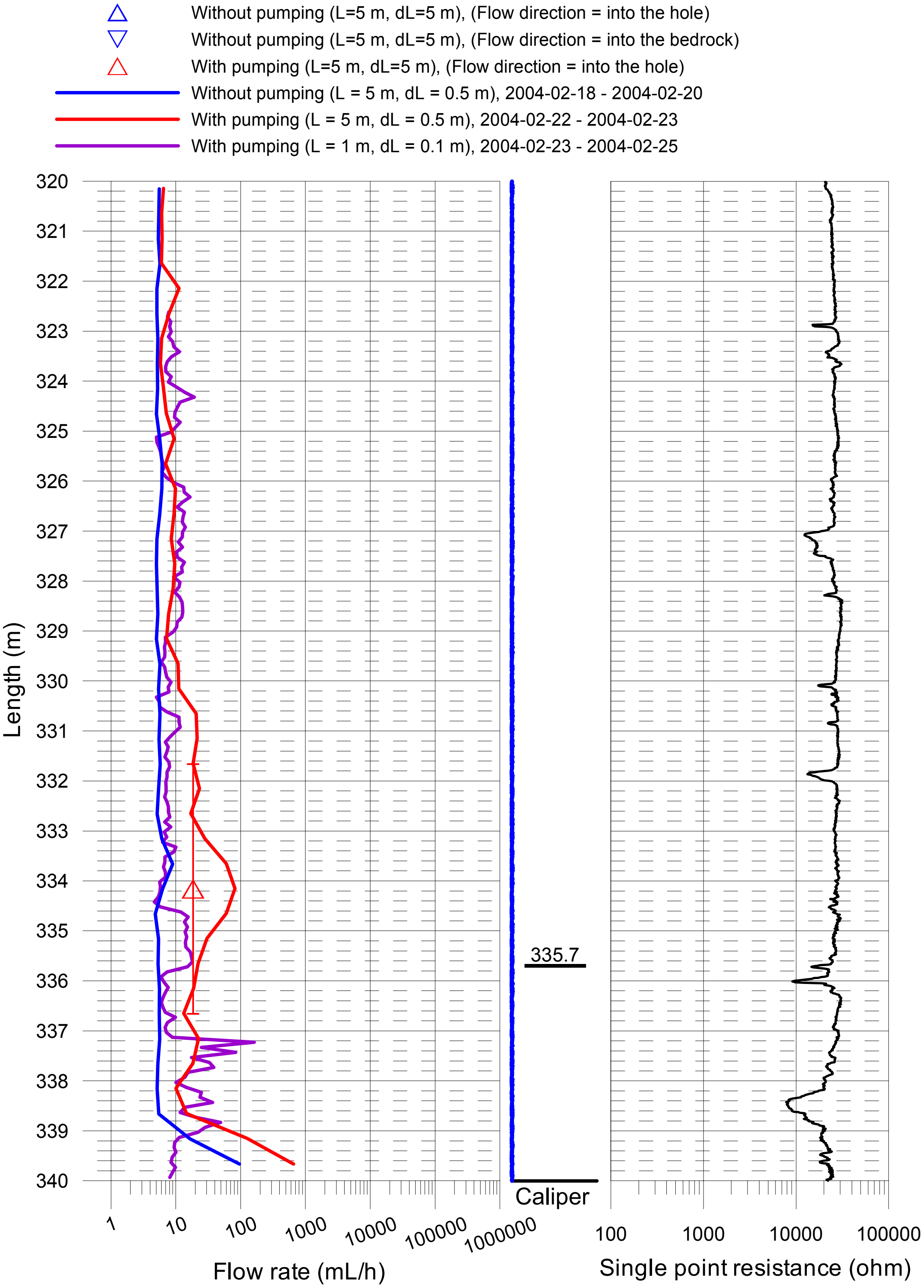
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



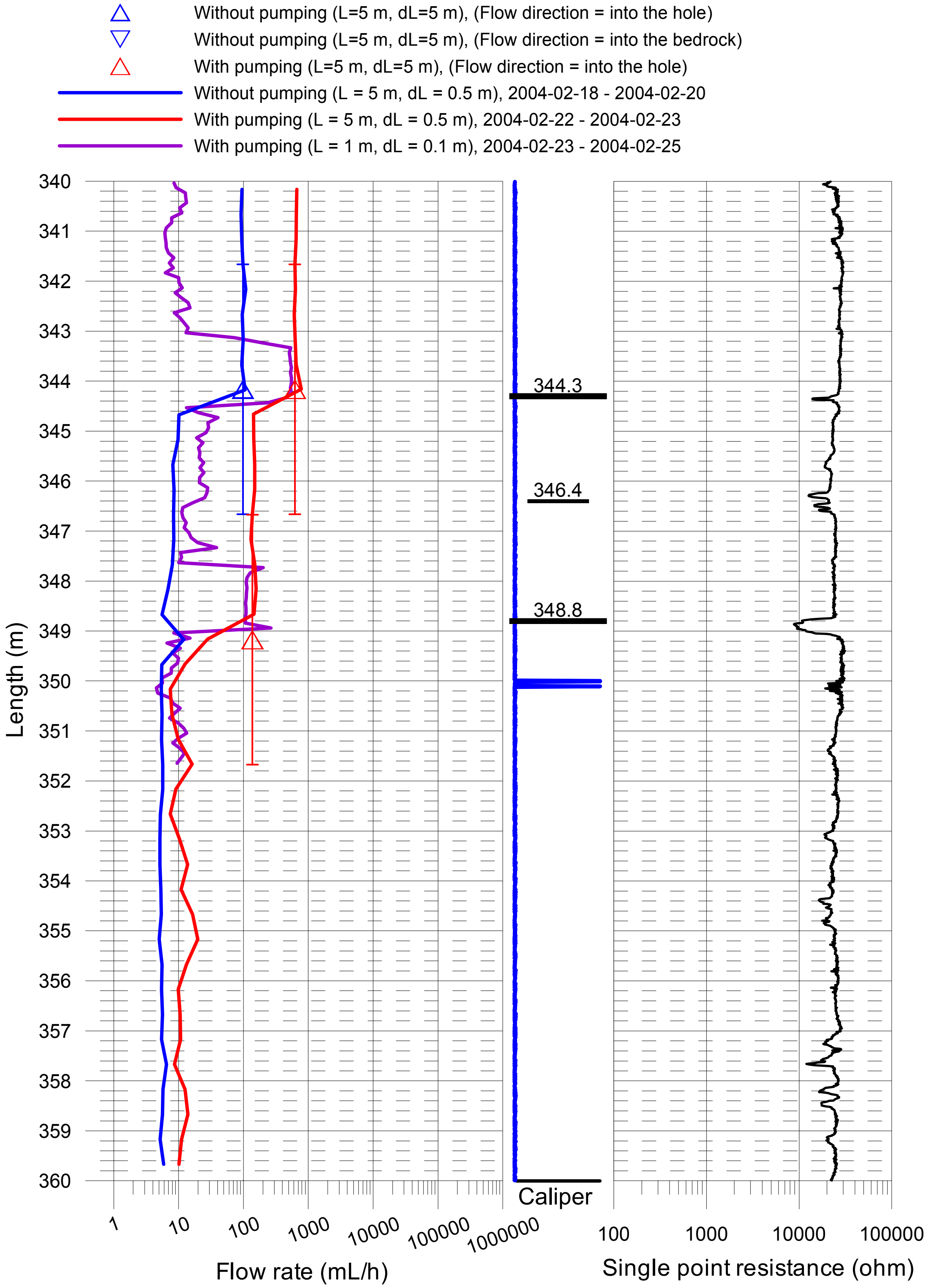
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



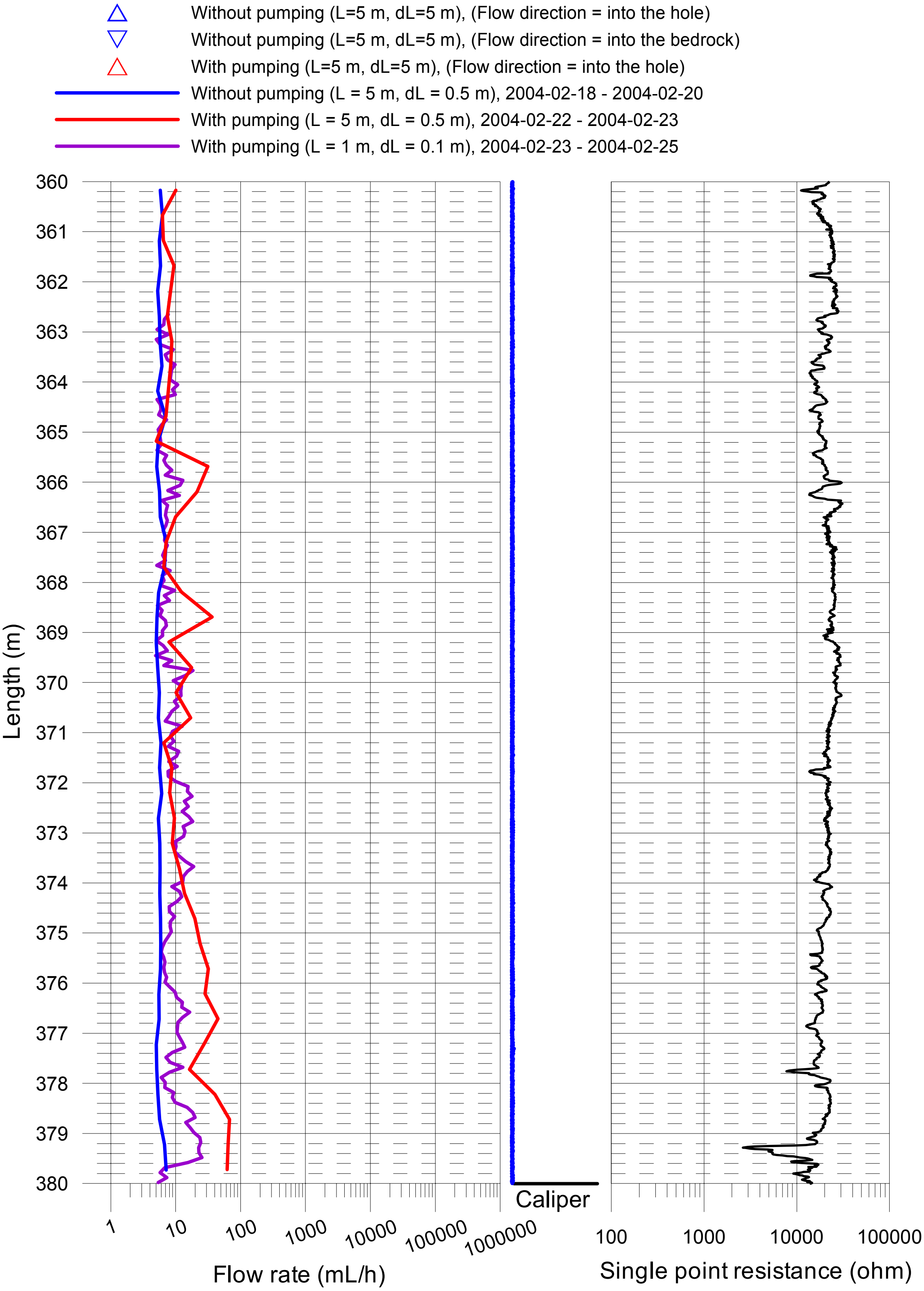
ÄVRÖ, Borehole KAV01

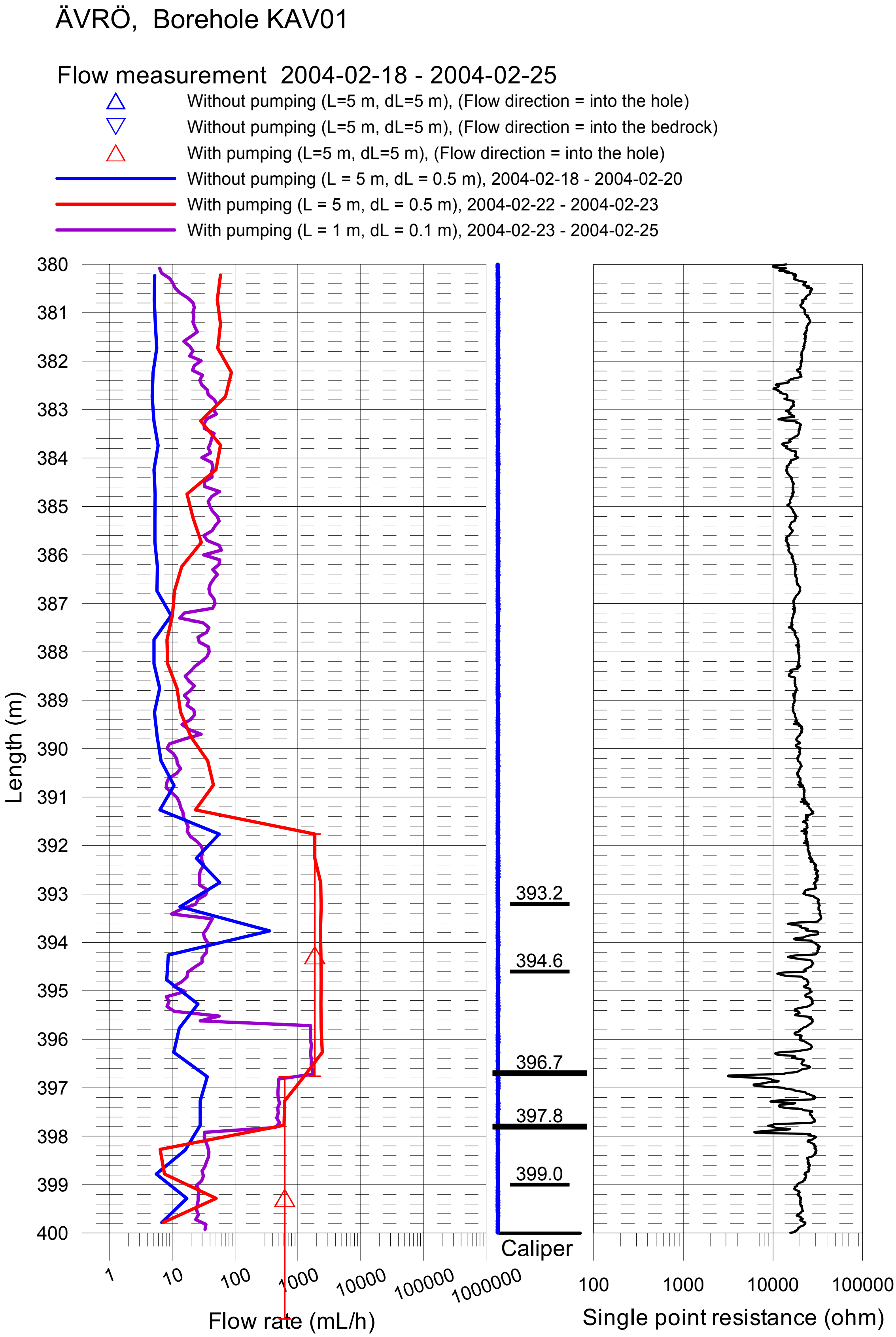
Flow measurement 2004-02-18 - 2004-02-25



ÄVRÖ, Borehole KAV01

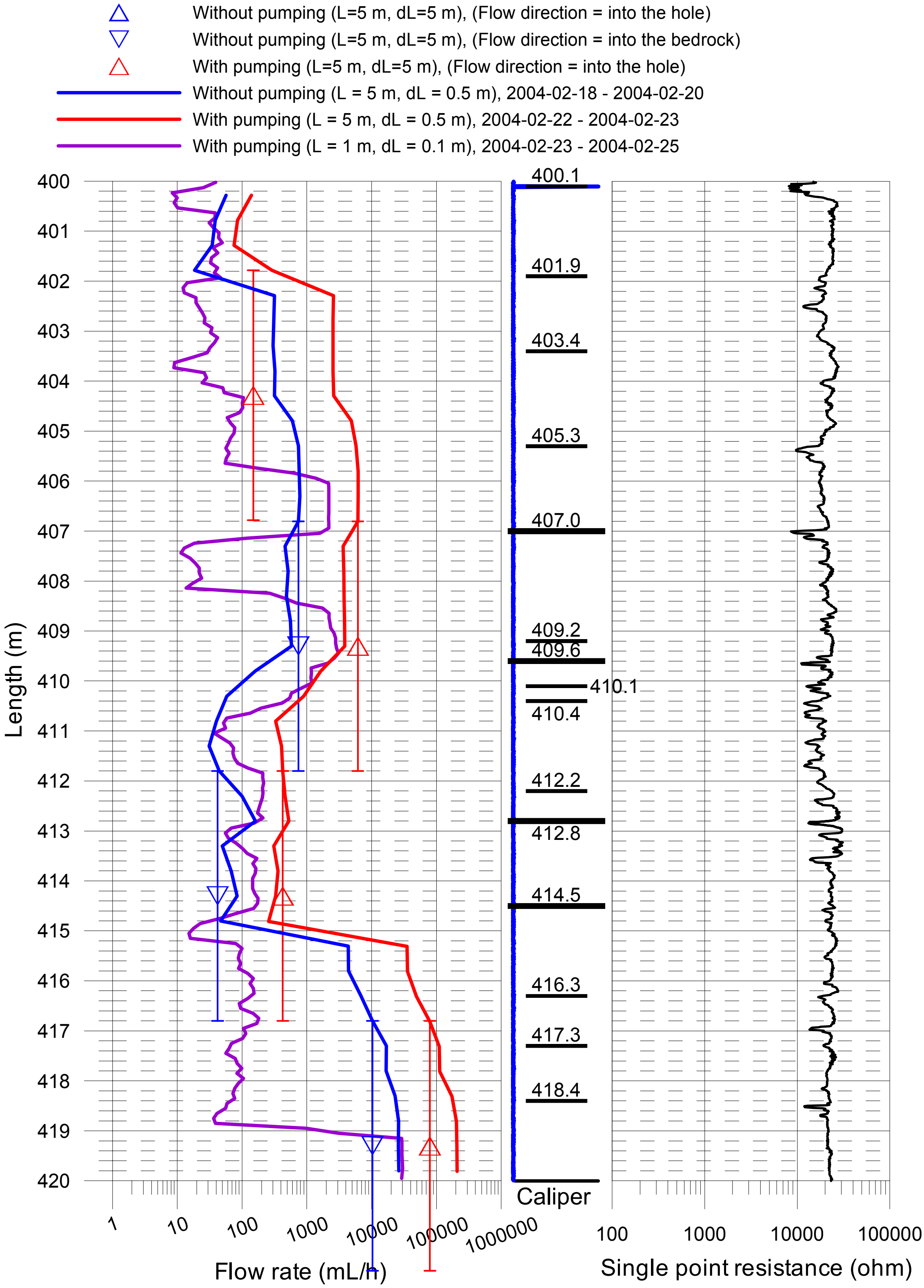
Flow measurement 2004-02-18 - 2004-02-25




ÄVRÖ, Borehole KAV01
Flow measurement 2004-02-18 - 2004-02-25
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)
Without pumping (L = 5 m, dL = 0.5 m), 2004-02-18 - 2004-02-20
With pumping (L = 5 m, dL = 0.5 m), 2004-02-22 - 2004-02-23
With pumping (L = 1 m, dL = 0.1 m), 2004-02-23 - 2004-02-25
Length (m)
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
393.2
394.6
396.7
397.8
399.0
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

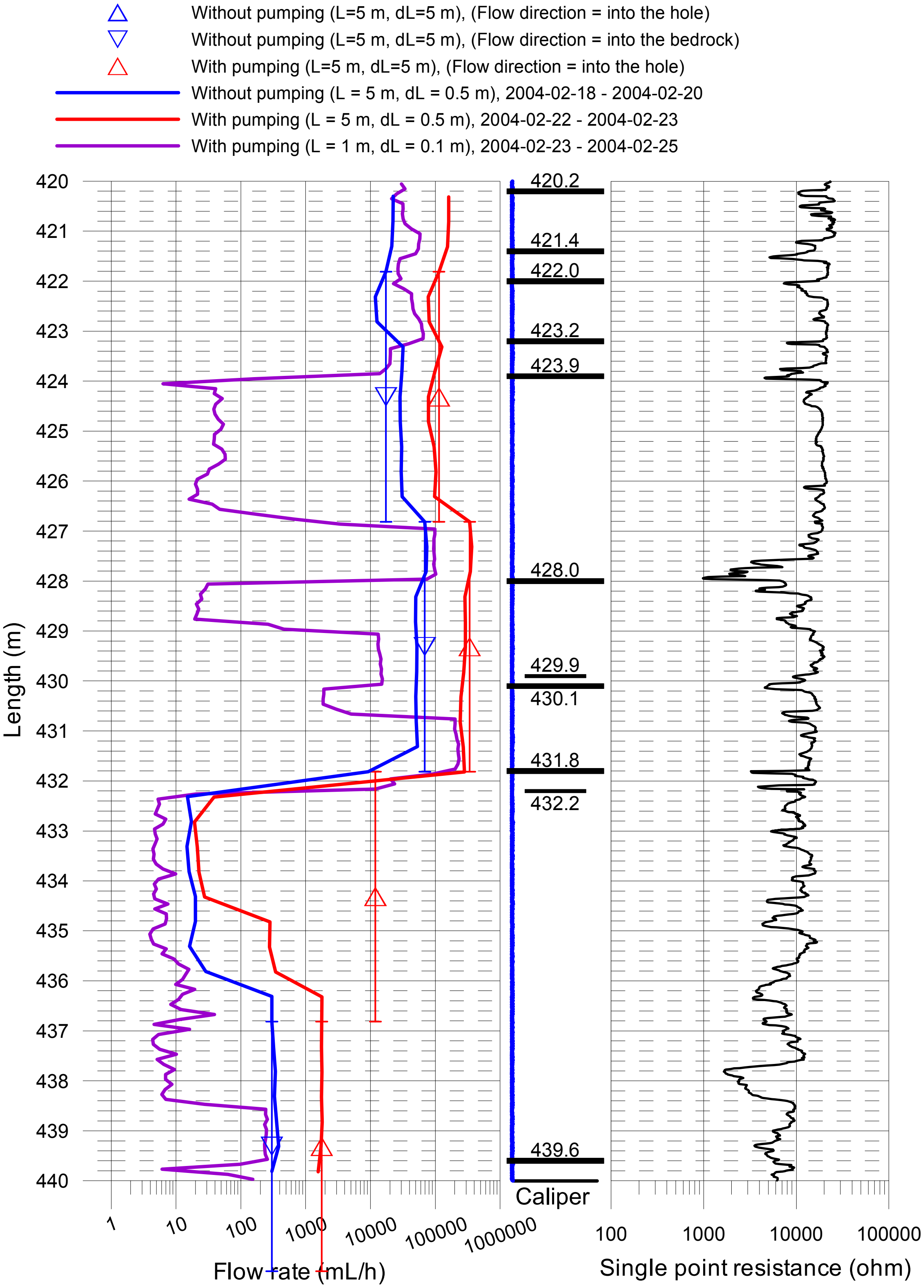
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



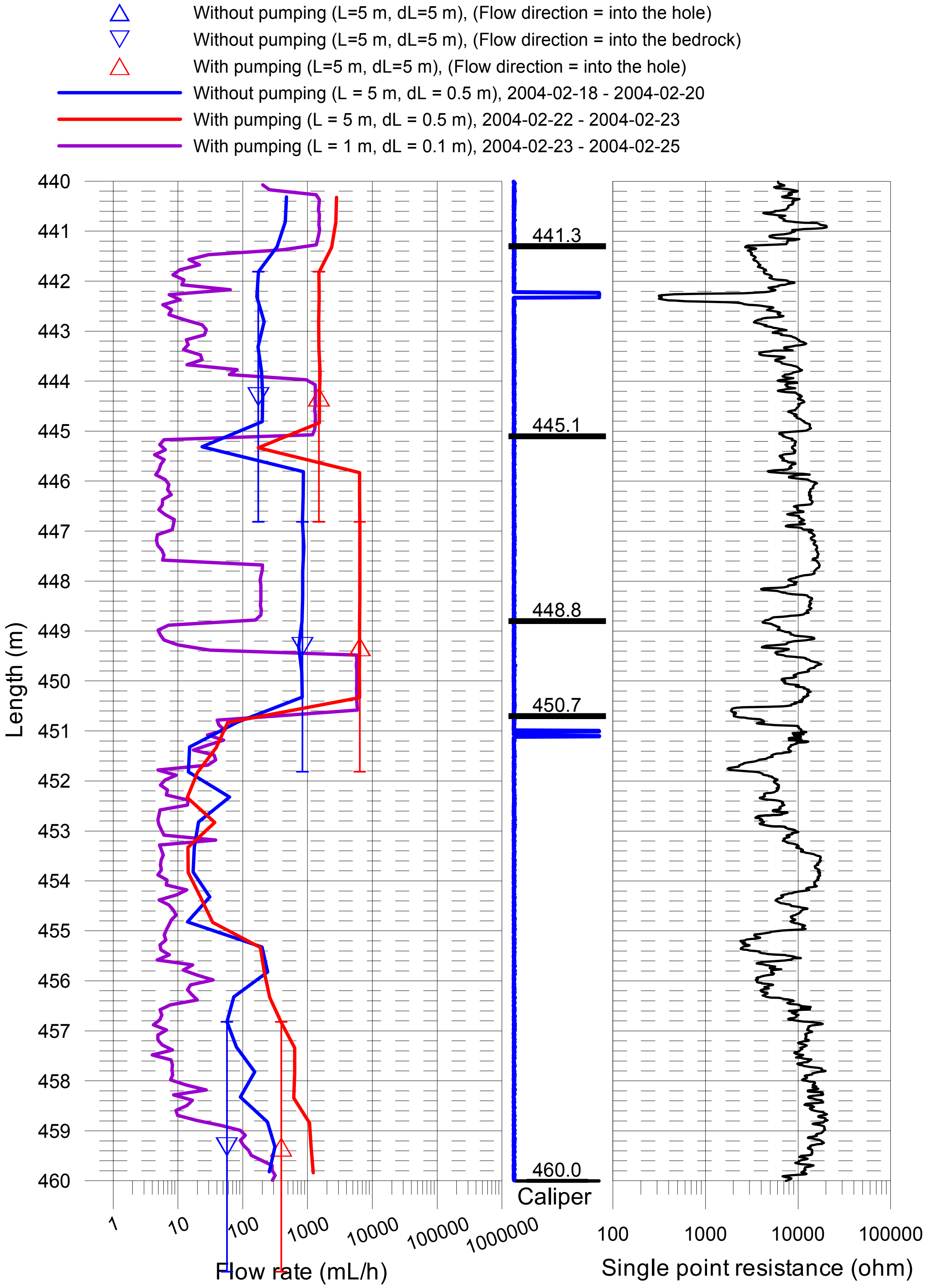
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



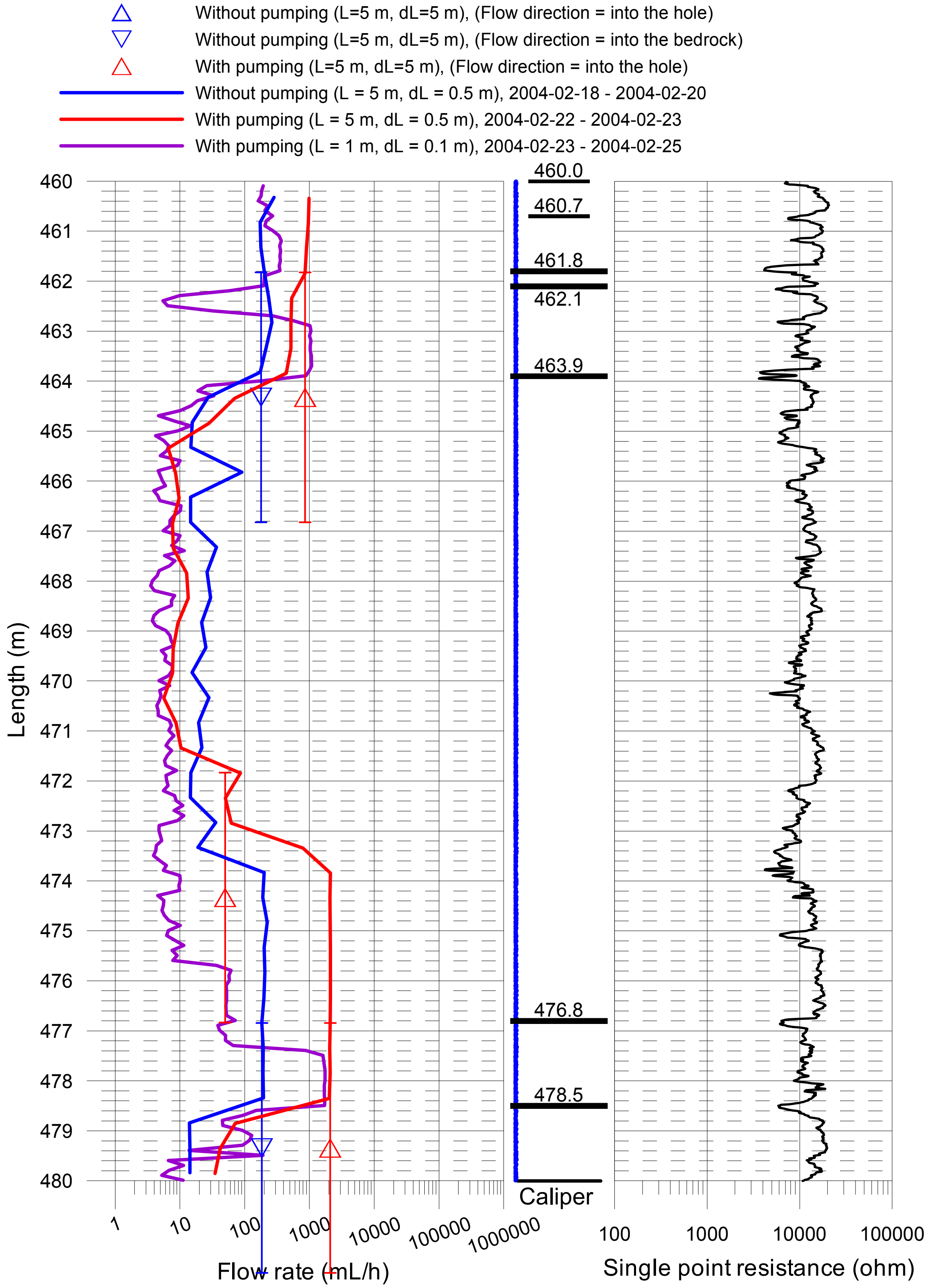
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



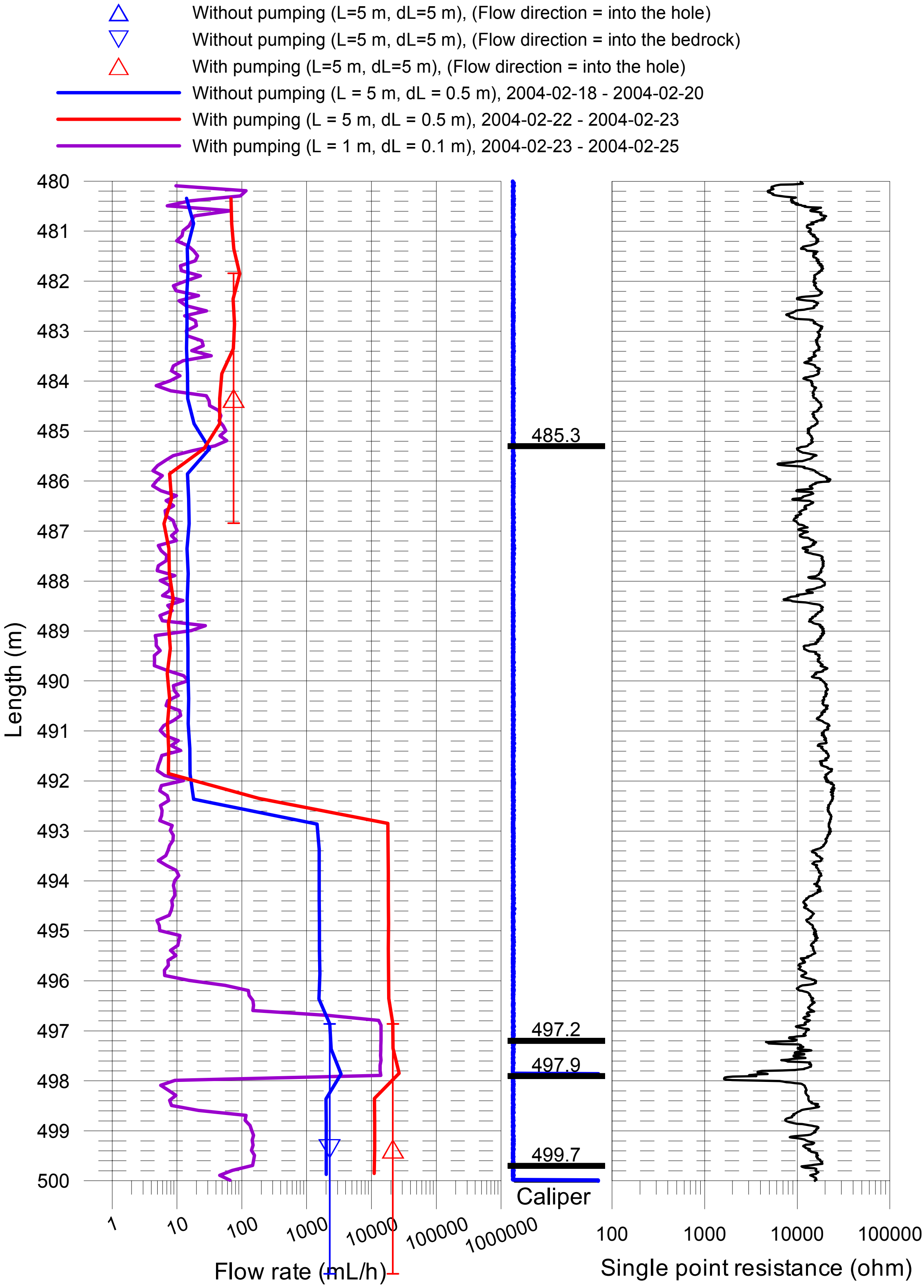
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



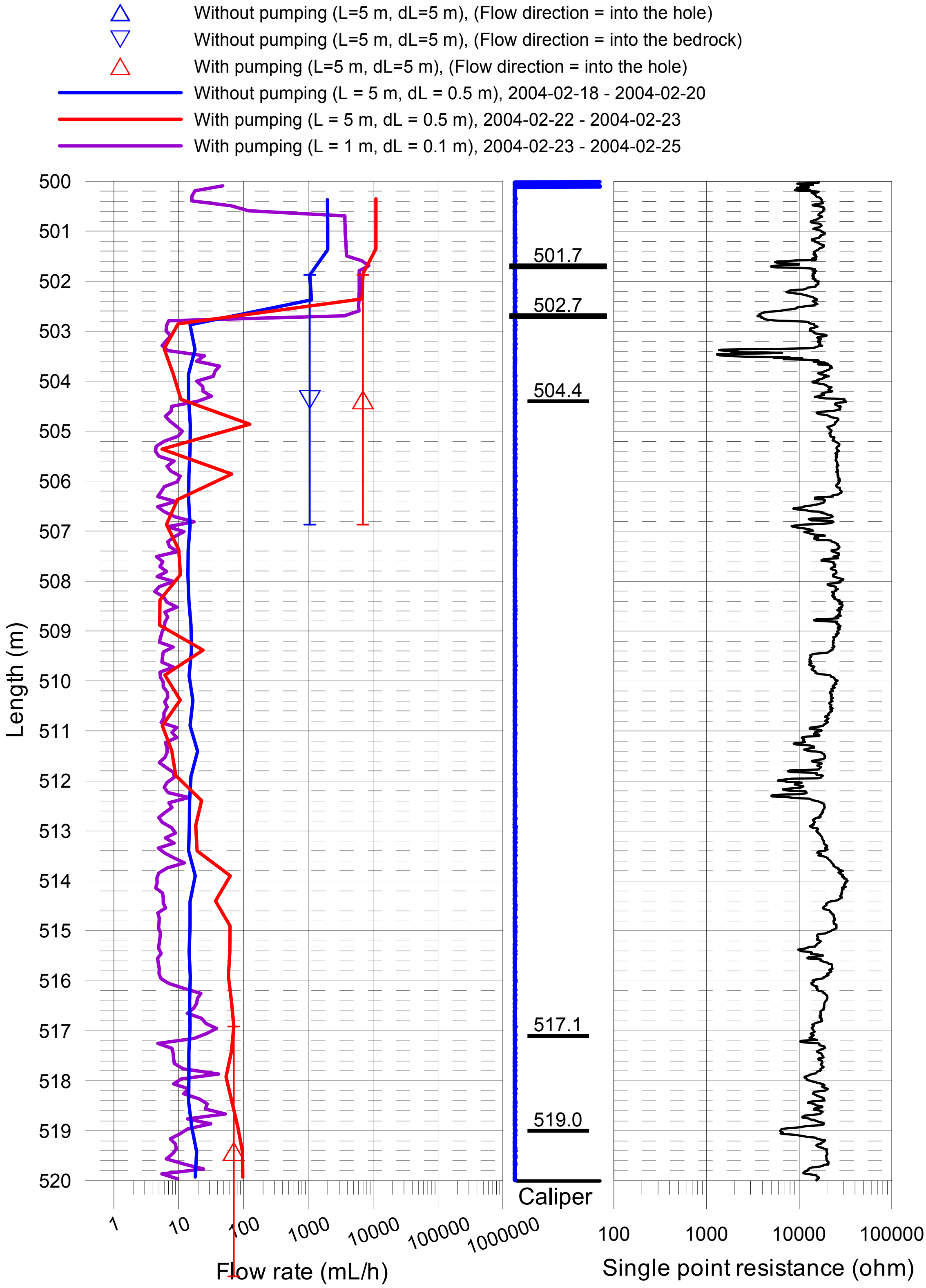
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



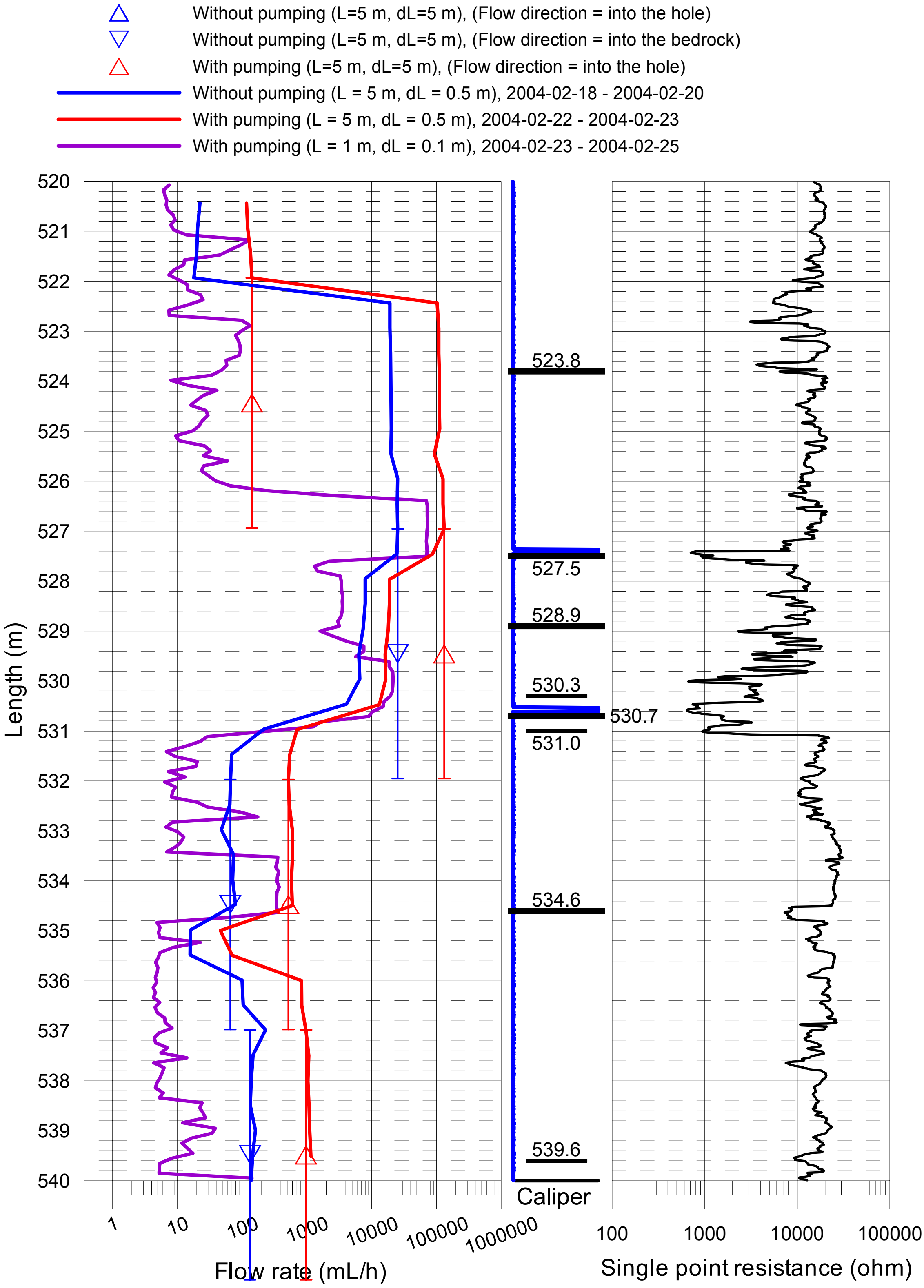
ÄVRÖ, Borehole KAV01

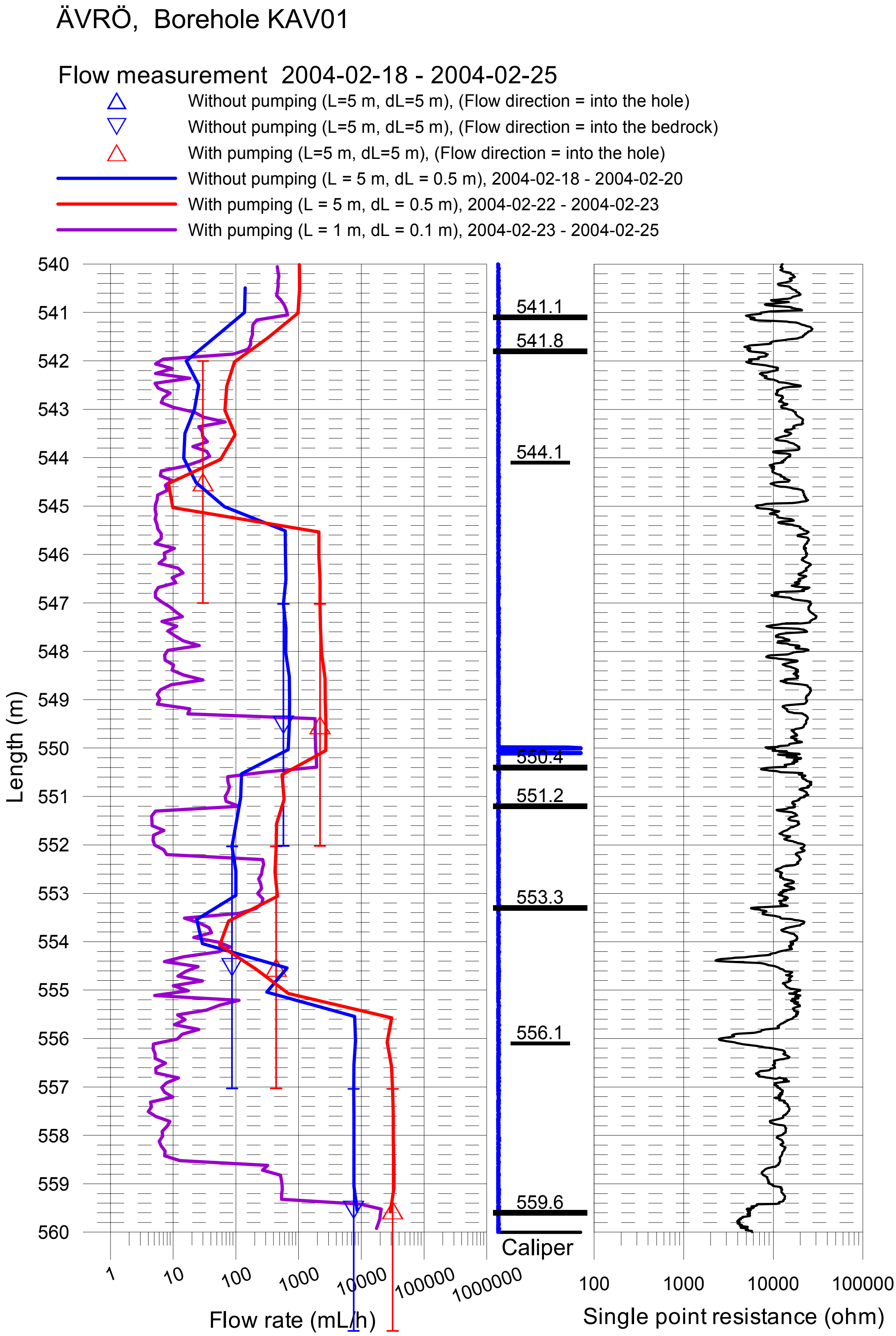
Flow measurement 2004-02-18 - 2004-02-25



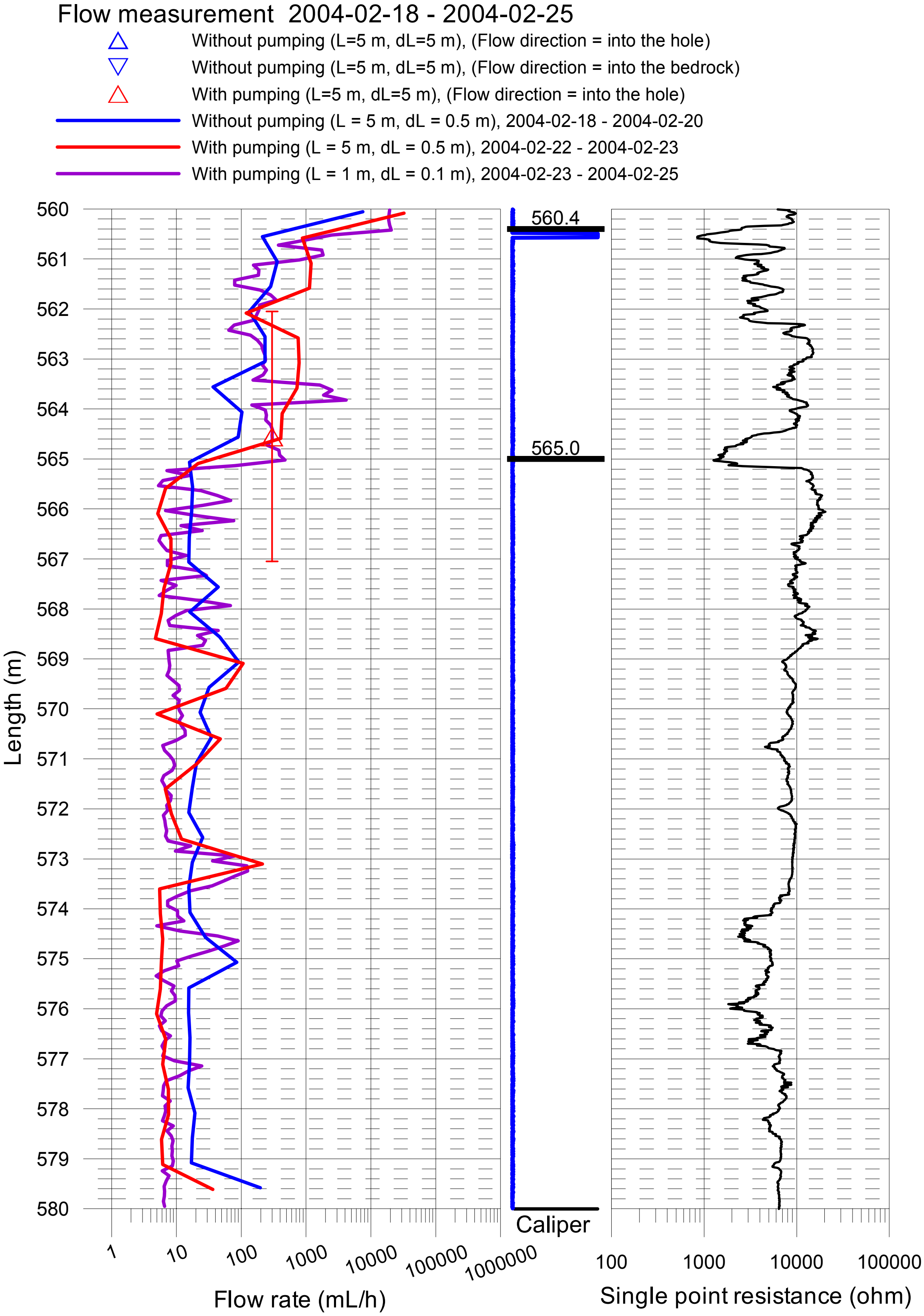
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



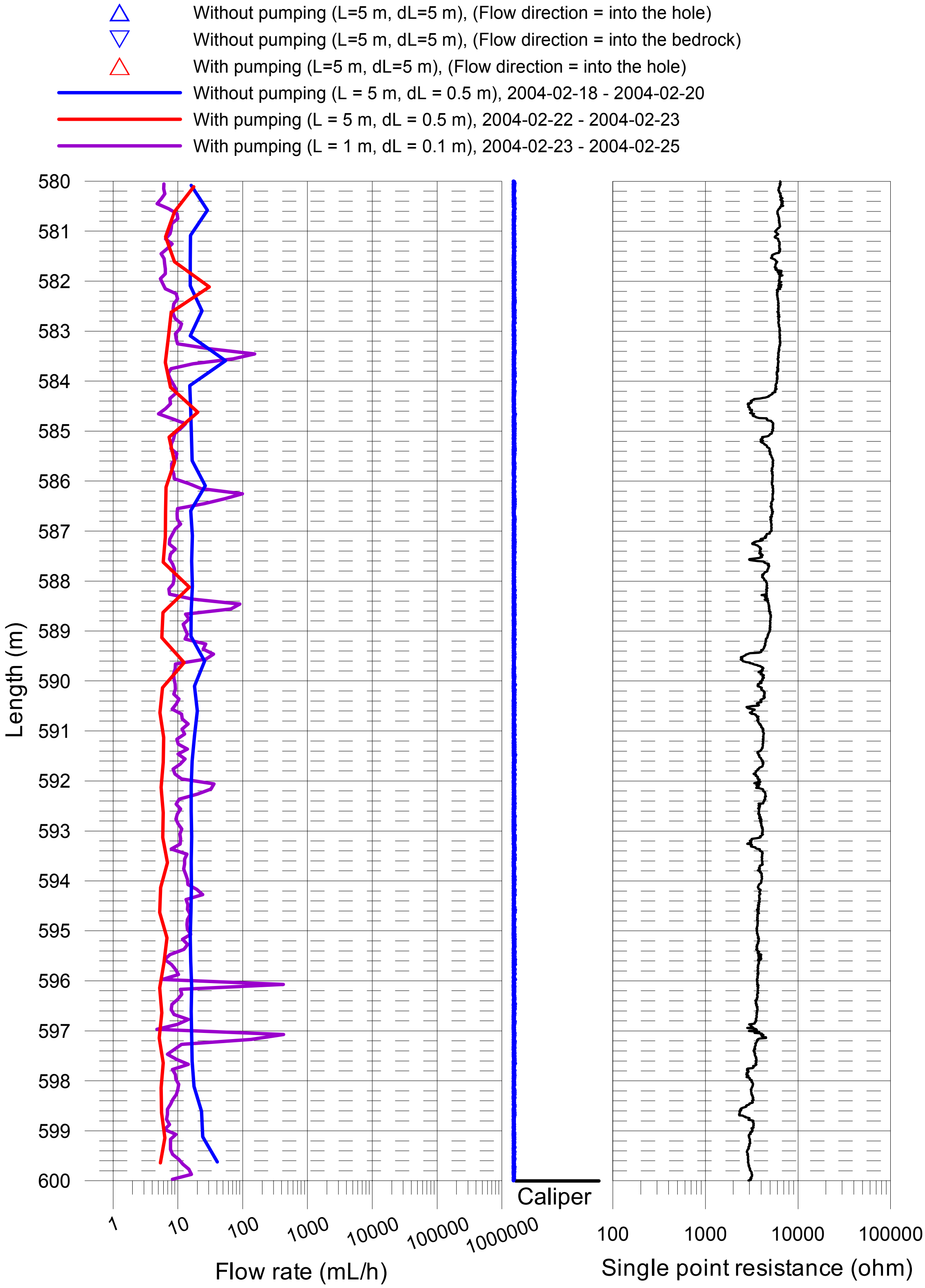

ÄVRÖ, Borehole KAV01
Flow measurement 2004-02-18 - 2004-02-25
Without pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L=5 m, dL=5 m), (Flow direction = into the bedrock)
With pumping (L=5 m, dL=5 m), (Flow direction = into the hole)
Without pumping (L = 5 m, dL = 0.5 m), 2004-02-18 - 2004-02-20
With pumping (L = 5 m, dL = 0.5 m), 2004-02-22 - 2004-02-23
With pumping (L = 1 m, dL = 0.1 m), 2004-02-23 - 2004-02-25
Length (m)
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
541.1
541.8
544.1
550.4
551.2
553.3
556.1
559.6
Caliper
1
10
100
1000
10000
100000
1000000
Flow rate (mL/h)
100
1000
10000
100000
Single point resistance (ohm)

ÄVRÖ, Borehole KAV01



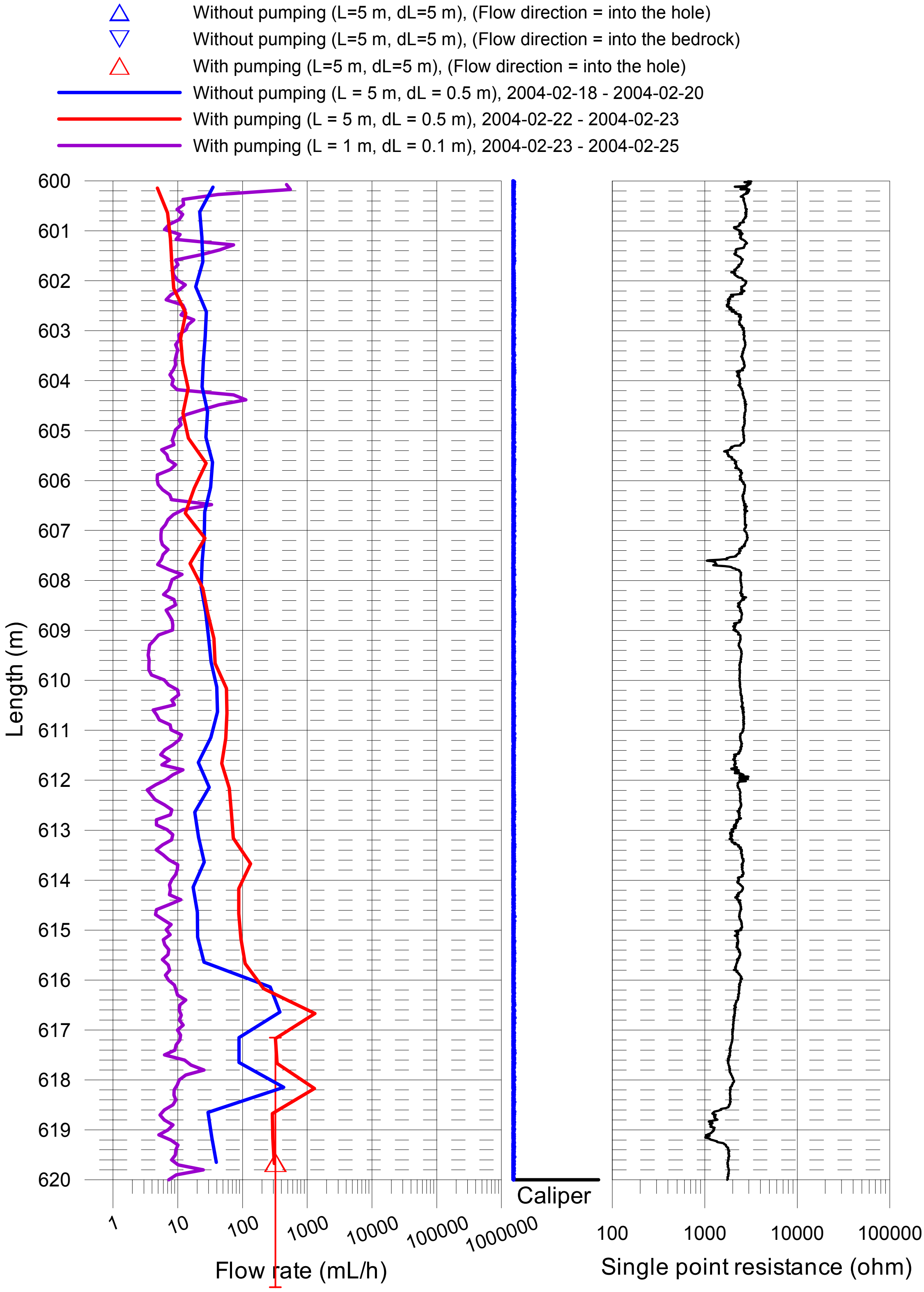
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



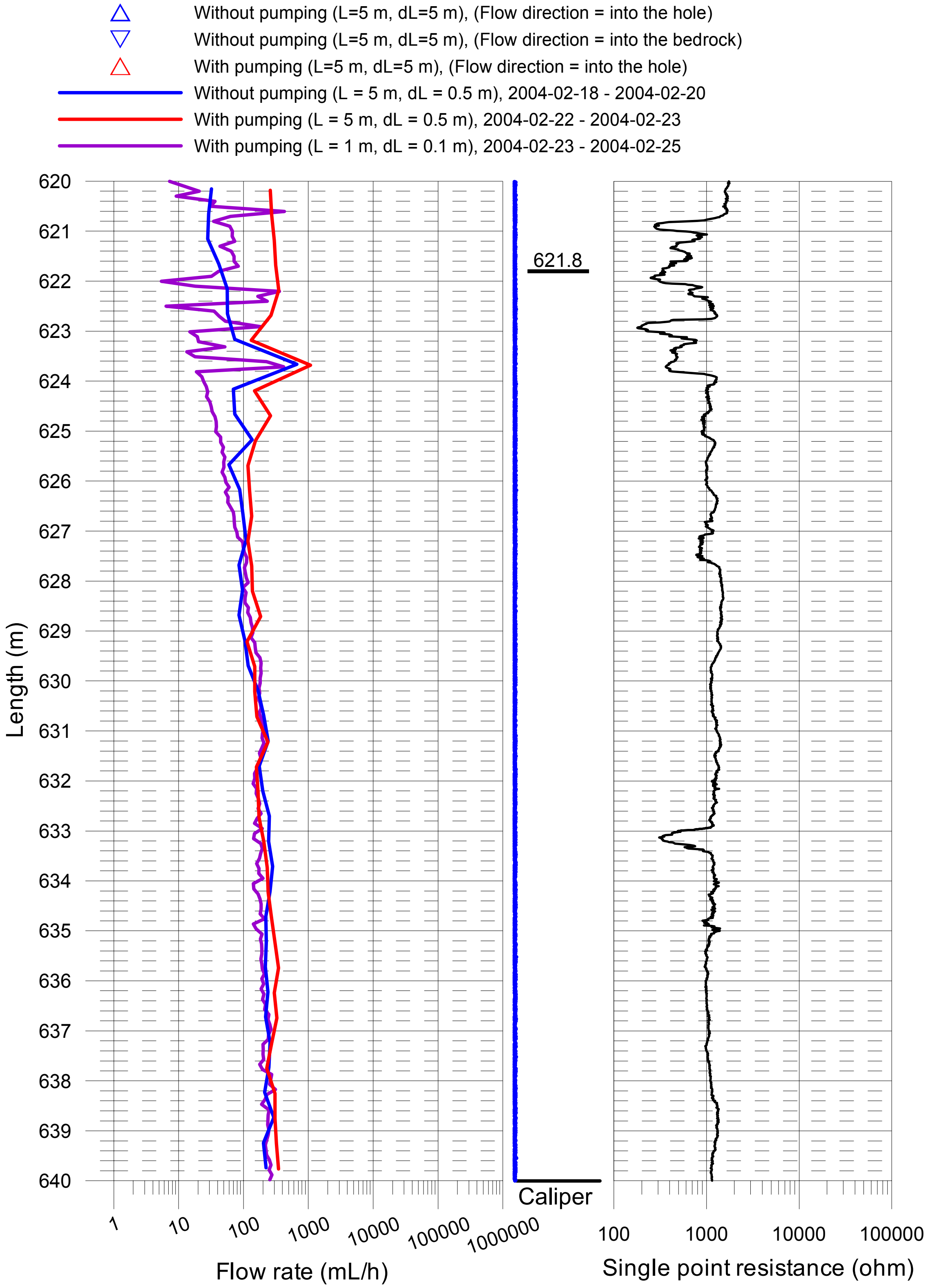
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25

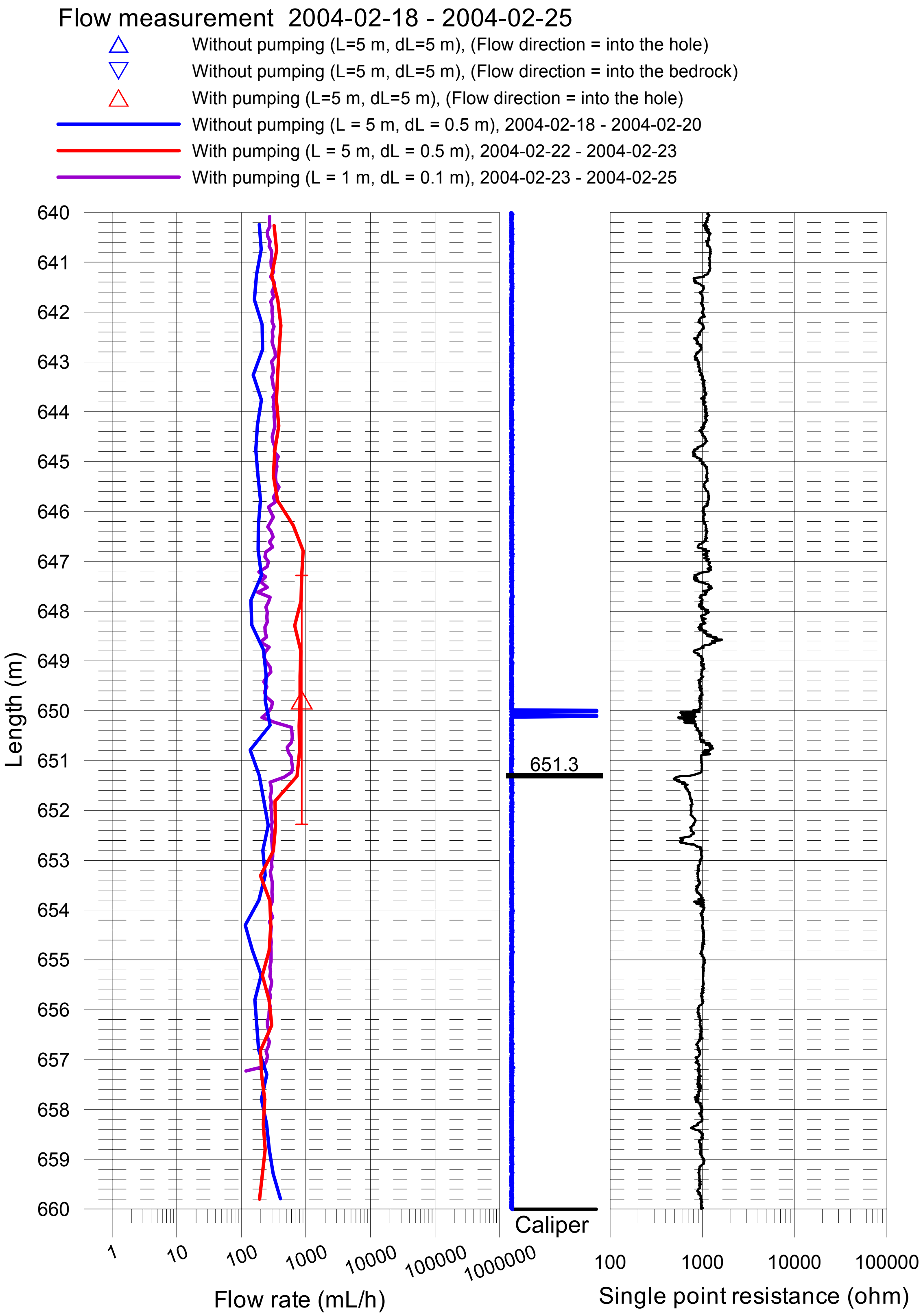


ÄVRÖ, Borehole KAV01

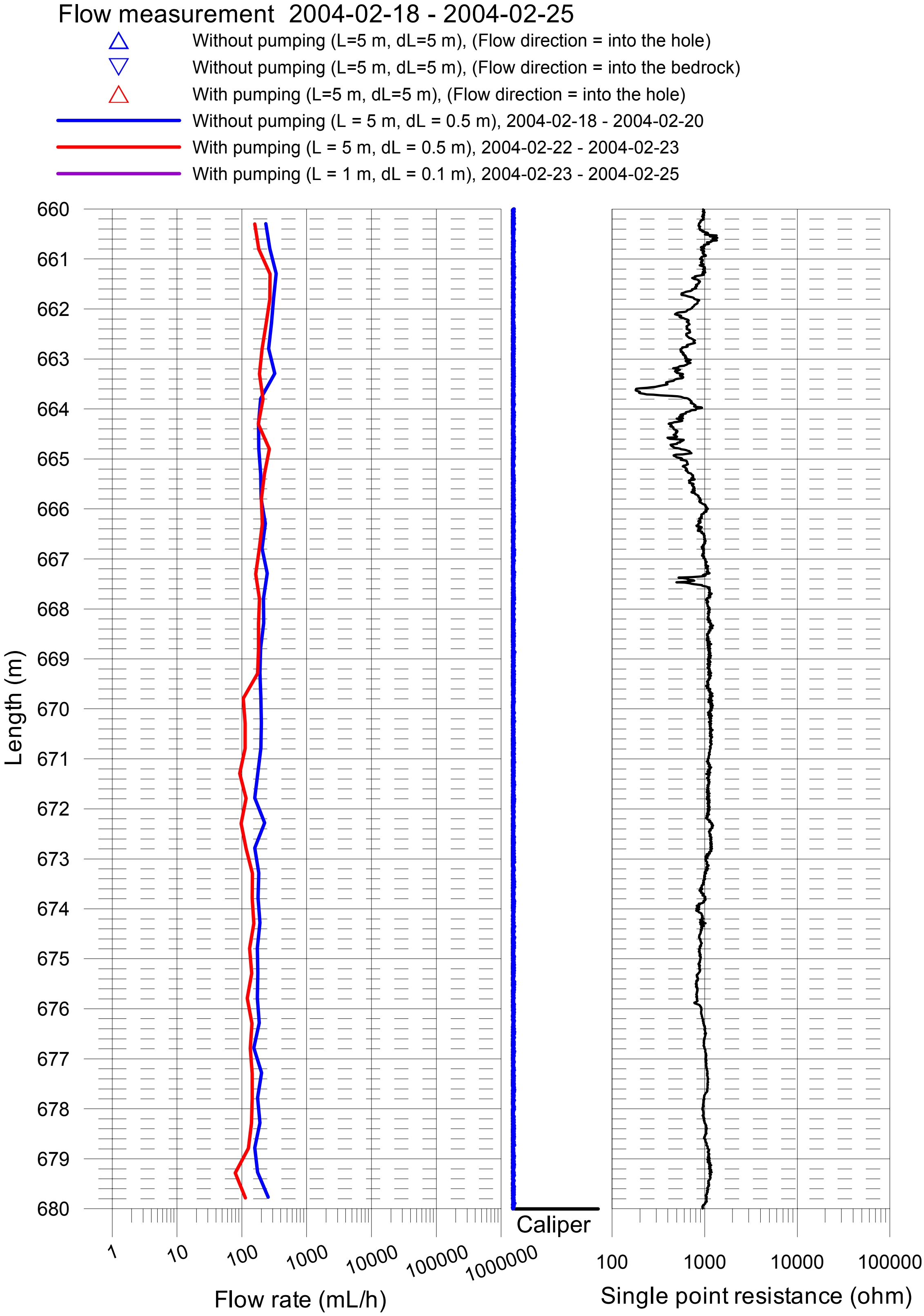
Flow measurement 2004-02-18 - 2004-02-25



ÄVRÖ, Borehole KAV01

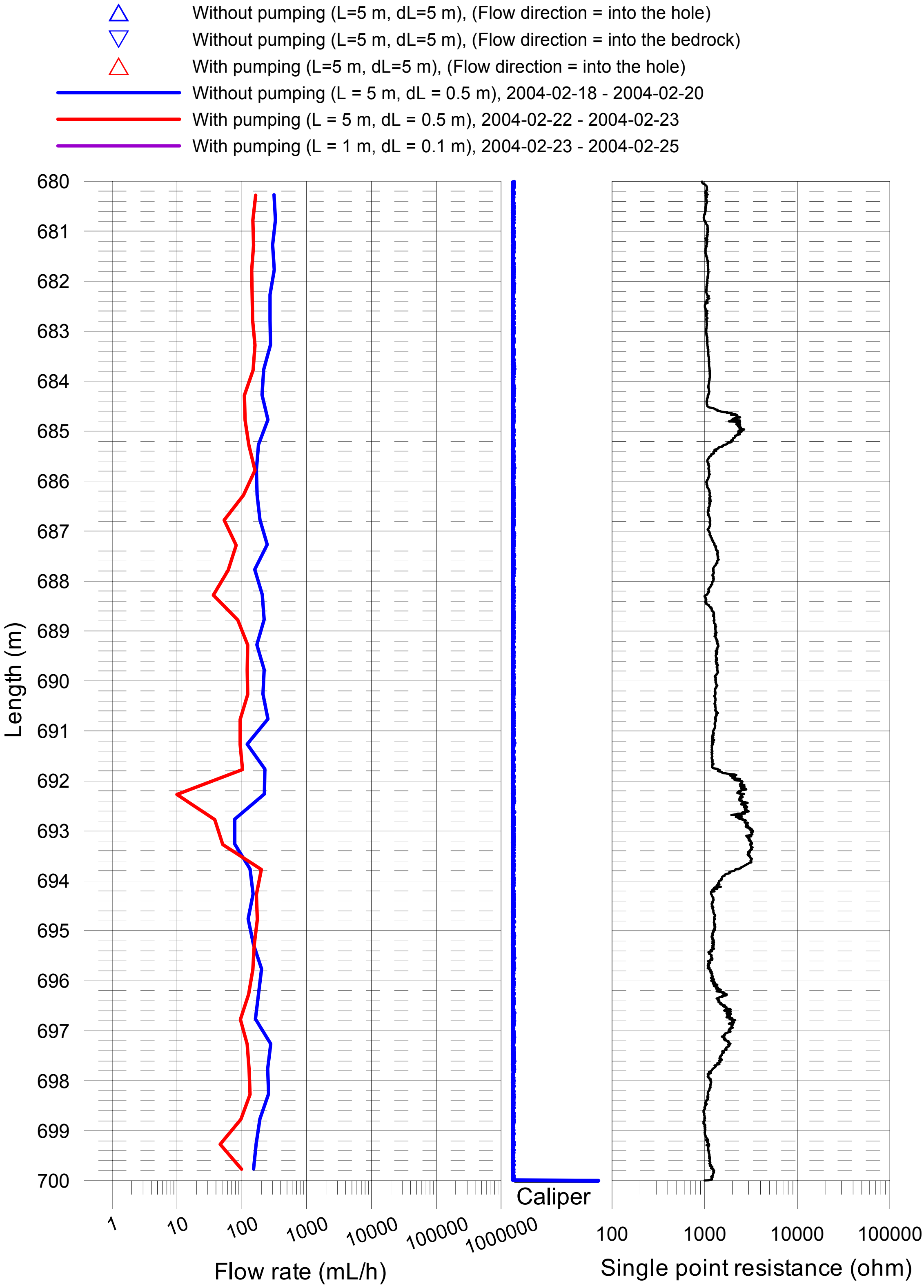


ÄVRÖ, Borehole KAV01



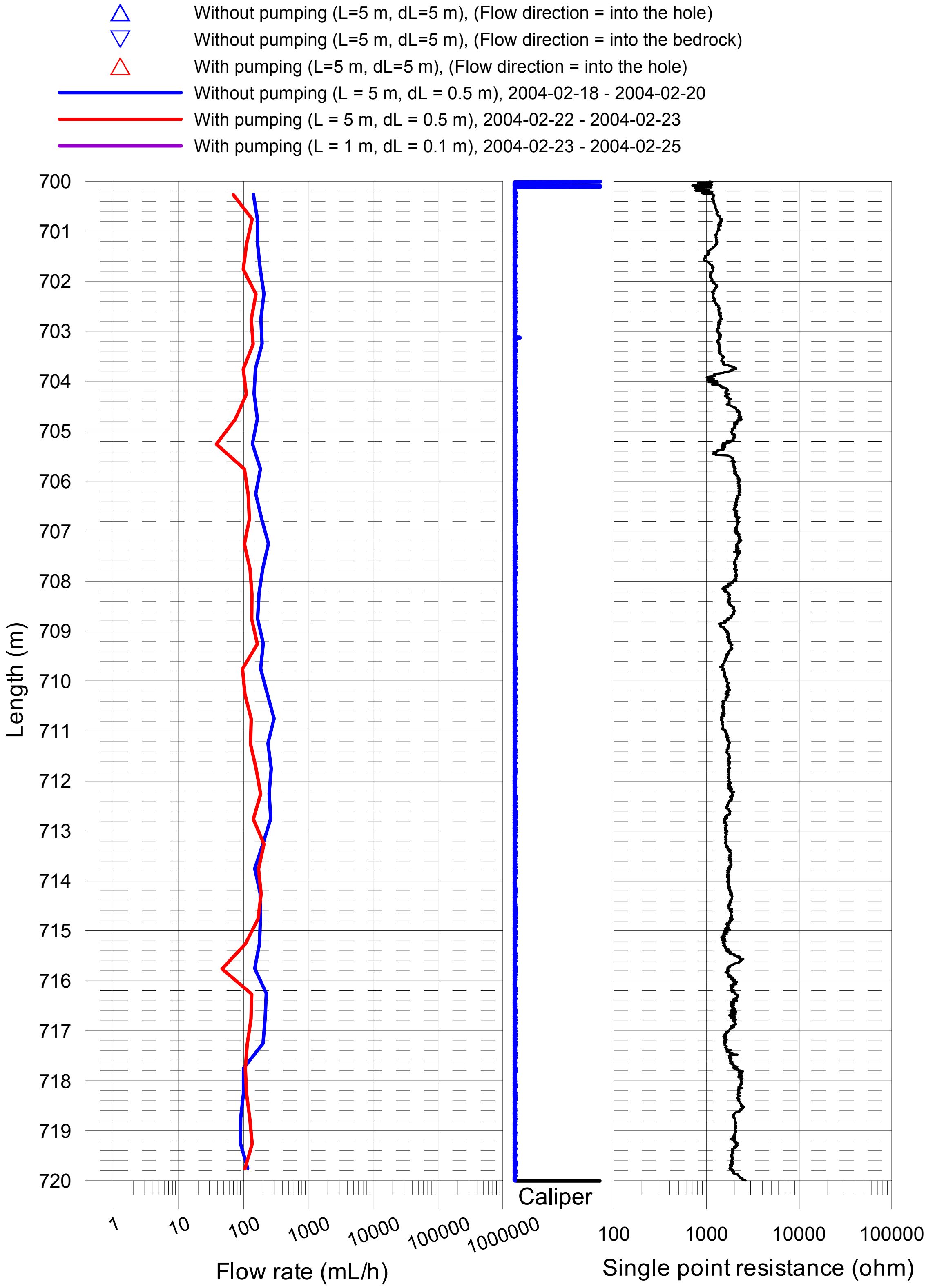
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25



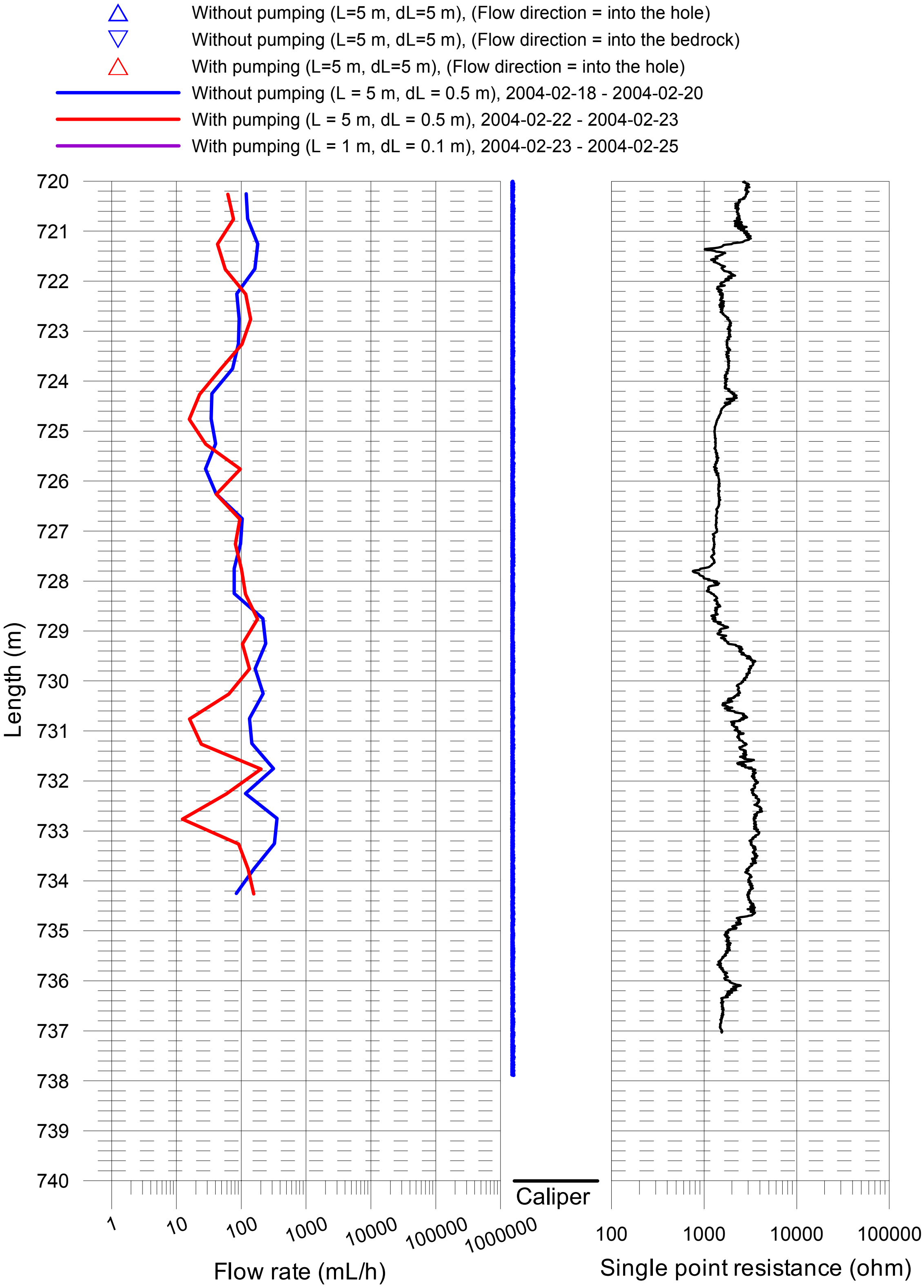
ÄVRÖ, Borehole KAV01

Flow measurement 2004-02-18 - 2004-02-25

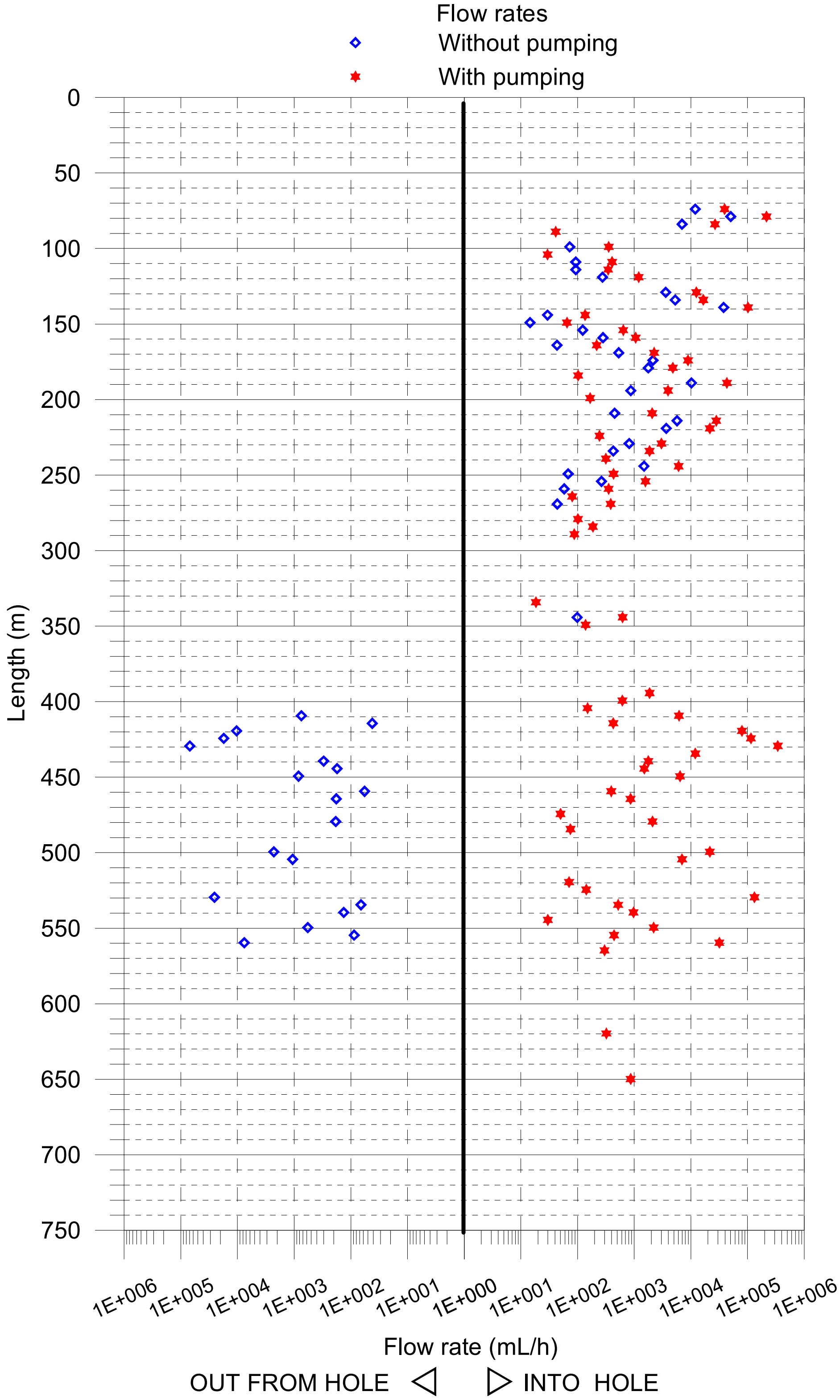


ÄVRÖ, Borehole KAV01

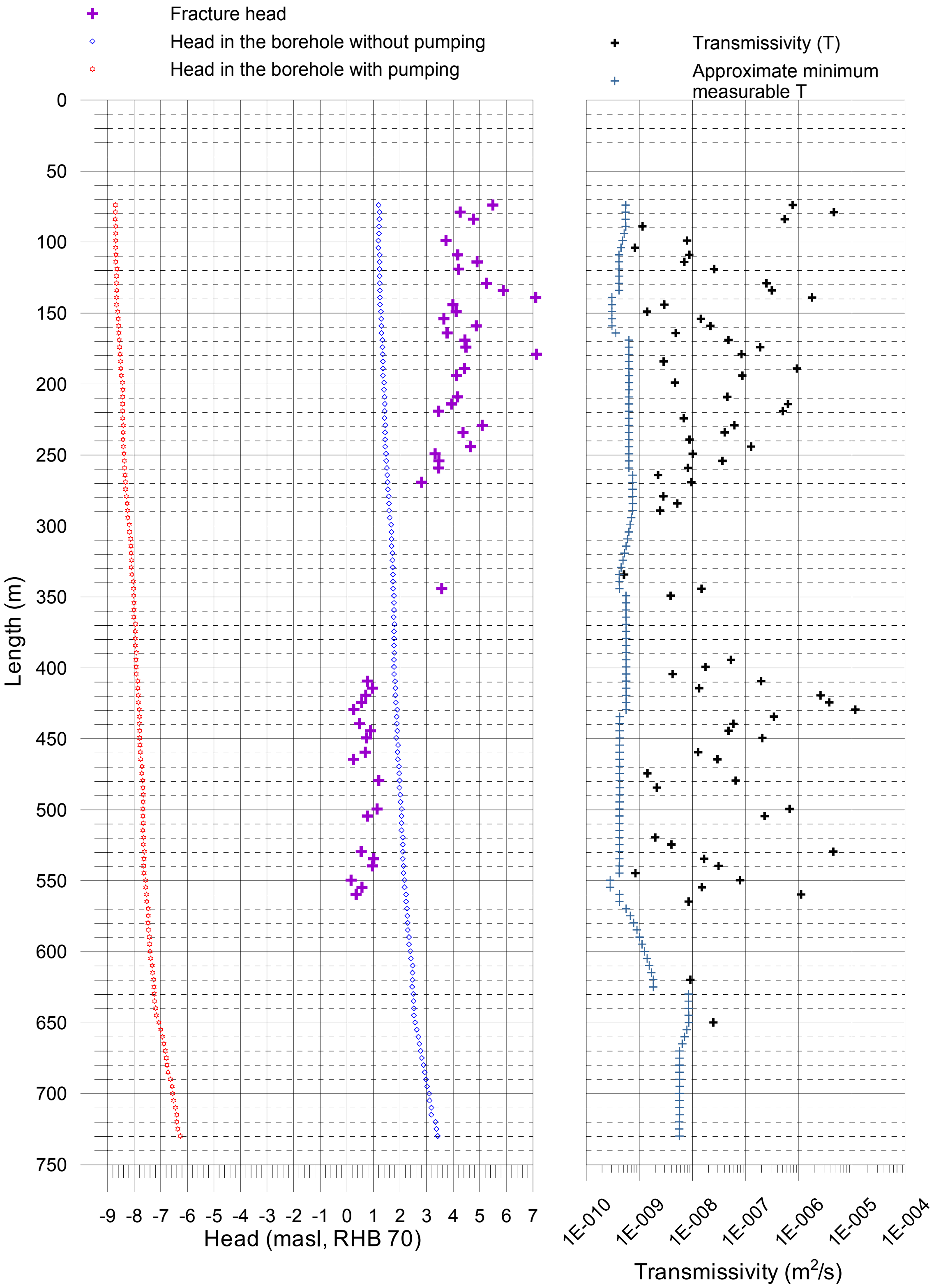
Flow measurement 2004-02-18 - 2004-02-25

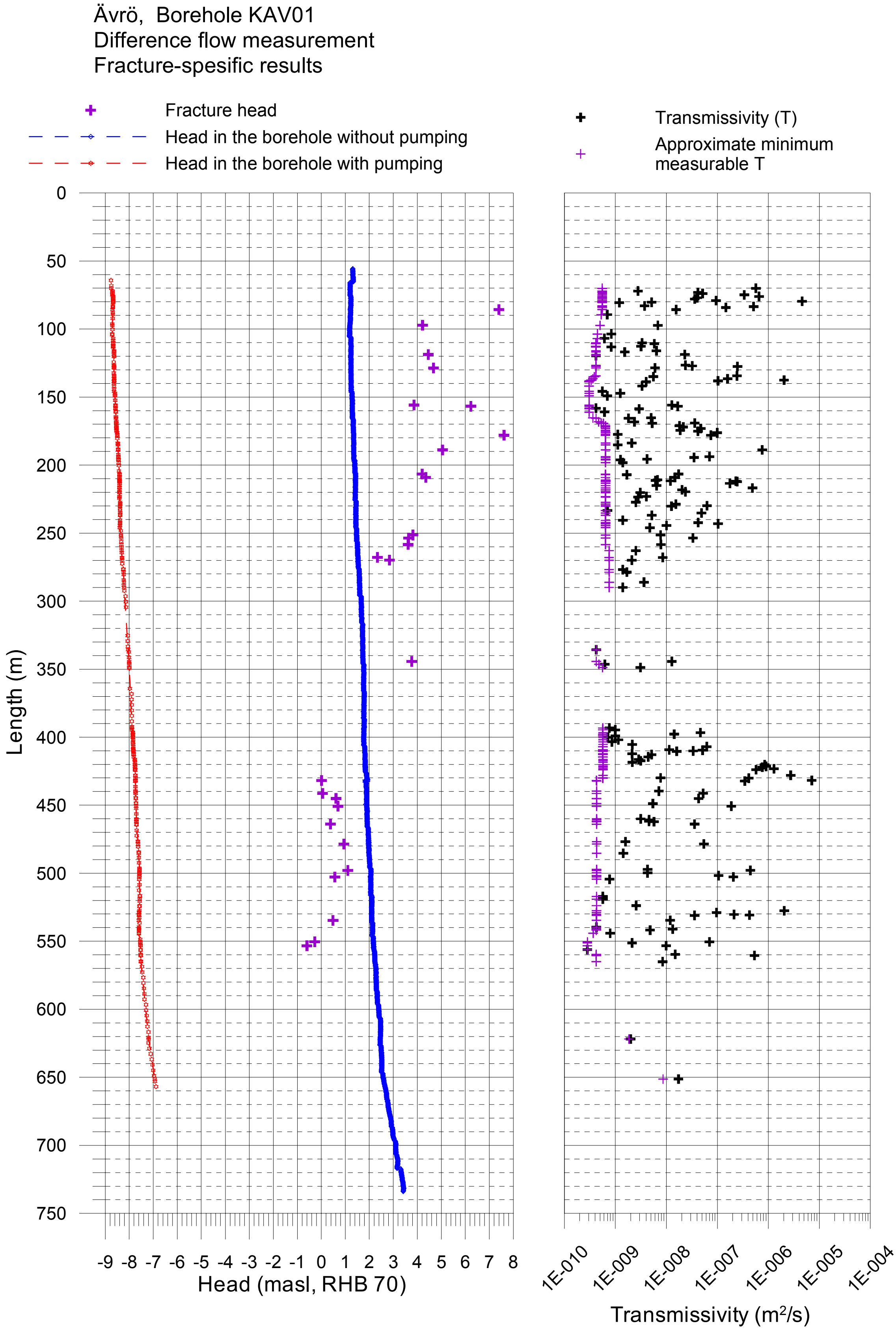


Ävrö, Borehole KAV01
Difference flow measurement with thermal pulse 2004-02-18 - 2004-02-25
Length of section 5 m, depth increment 5 m



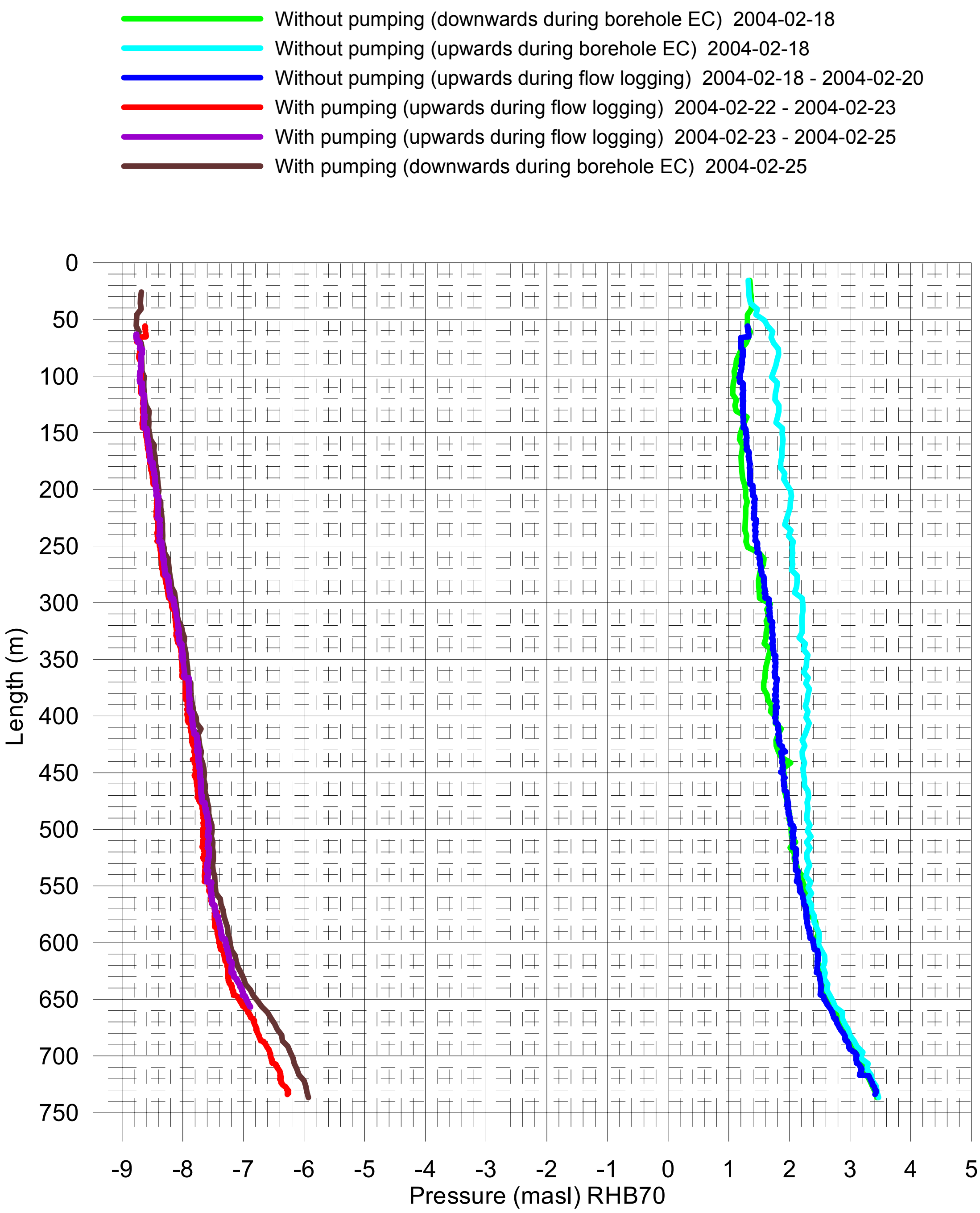
Ävrö, Borehole KAV01
Difference flow measurement with thermal pulse 2004-02-18 - 2004-02-25
Length of section 5 m, depth increment 5 m




Ävrö, Borehole KAV01
Difference flow measurement
Fracture-spesific results
Fracture head
Head in the borehole without pumping
Head in the borehole with pumping
Transmissivity (T)
Approximate minimum measurable T
Length (m)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
-9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8
Head (masl, RHB 70)
1E-010
1E-009
1E-008
1E-007
1E-006
1E-005
1E-004
Transmissivity (m²/s)

Head during flow logging in borehole KAV01

Head(masl)= (Absolute pressure (Pa) - Airpressure (Pa) + Offset) /(1000 kg/m^3 * 9.80665 m/s^2) + Elevation (m)
Offset = 2460 Pa (Correction for absolut pressure sensor)



5. PFL-Difference flow logging – Basic test data

Borehole ID	Logged interval Secup (m)	Seclow (m)	Test type (1–6)	Date of test, start YYYYMMDD	Time of test, start hh:mm	Date of flowl, start YYYYMMDD	Time of flowl, start hh:mm	Date of test, stop YYYYMMDD	Time of test, stop hh:mm	L_w (m)	dL (m)	Q_{p1} (m^3/s)	Q_{p2} (m^3/s)
KAV01	**71.38**	**732.25**	**5A**	**20040221**	**9:23**	**20040218**	**16:25**	**20040225**	**16:02**	**5**	**5**	**3.2E–4**	

5. PFL-Difference flow logging – Basic test data

t_{p1} (s)	t_{p2} (s)	t_{F1} (s)	t_{F2} (s)	h_0 (m)	h_1 (m)	h_2 (m)	s_1 (m)	s_2 (m)	T Entire hole (m^2/s)	Reference (–)	Comments (–)
369540		**81882**		**1.3**	**–8.7**		**–9.98**		**3.17 E–5**		

Difference flow logging – Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	Lw (m)	Q0 (m³/s)	Q1 (m³/s)	dh0 (m)	dh1 (m)	TD (m²/s)	hi (m)	TD-measl (m²/s)	ECw1 (S/m)	ECw2 (S/m)	Tew1 (C)	Tew2 (C)	Comments
KAV01	727.26	732.26	5	0.00E+00	0.00E+00	3.42	–6.27			5.67E–09	0.669	0.200	17.98	17.97	
KAV01	722.26	727.26	5	0.00E+00	0.00E+00	3.37	–6.36			5.65E–09	0.662	0.184	17.93	17.91	
KAV01	717.26	722.26	5	0.00E+00	0.00E+00	3.33	–6.40			5.65E–09	0.761	0.196	17.86	17.86	
KAV01	712.26	717.26	5	0.00E+00	0.00E+00	3.18	–6.40			5.74E–09	0.478	0.159	17.62	17.80	
KAV01	707.26	712.26	5	0.00E+00	0.00E+00	3.18	–6.45			5.71E–09	0.277	0.189	17.68	17.72	
KAV01	702.26	707.26	5	0.00E+00	0.00E+00	3.11	–6.52			5.71E–09	0.516	0.208	17.63	17.63	
KAV01	697.27	702.27	5	0.00E+00	0.00E+00	3.10	–6.55			5.69E–09	0.259	0.203	17.54	17.55	
KAV01	692.27	697.27	5	0.00E+00	0.00E+00	3.02	–6.57			5.73E–09	0.324	0.183	17.46	17.46	
KAV01	687.28	692.28	5	0.00E+00	0.00E+00	2.98	–6.63			5.72E–09	0.520	0.217	17.38	17.36	
KAV01	682.28	687.28	5	0.00E+00	0.00E+00	2.93	–6.73			5.69E–09	0.288	0.203	17.29	17.29	
KAV01	677.29	682.29	5	0.00E+00	0.00E+00	2.89	–6.76			5.69E–09	0.286	0.230	17.21	17.23	
KAV01	672.29	677.29	5	0.00E+00	0.00E+00	2.82	–6.79			5.72E–09	0.508	0.231	17.14	17.15	
KAV01	667.30	672.30	5	0.00E+00	0.00E+00	2.78	–6.83			5.72E–09	0.584	0.216	17.06	17.06	
KAV01	662.30	667.30	5	0.00E+00	0.00E+00	2.73	–6.88			6.44E–09	0.409	0.210	16.98	17.00	
KAV01	657.31	662.31	5	0.00E+00	0.00E+00	2.69	–6.94			7.13E–09	0.281	0.258	16.90	16.91	
KAV01	652.31	657.31	5	0.00E+00	0.00E+00	2.63	–7.00			7.85E–09	0.508	0.403	16.82	16.83	
KAV01	647.29	652.29	5	0.00E+00	2.41E–07	2.57	–7.07	2.47E–08		8.55E–09	0.635	0.755	16.74	16.74	
KAV01	642.26	647.26	5	0.00E+00	0.00E+00	2.52	–7.17			8.51E–09	0.604	1.014	16.64	16.63	
KAV01	637.24	642.24	5	0.00E+00	0.00E+00	2.52	–7.19			8.49E–09	0.244	1.146	16.57	16.57	
KAV01	632.21	637.21	5	0.00E+00	0.00E+00	2.51	–7.23			8.46E–09	0.291	0.779	16.50	16.50	
KAV01	627.19	632.19	5	0.00E+00	0.00E+00	2.50	–7.24			8.46E–09	0.327	0.645	16.42	16.43	
KAV01	622.17	627.17	5	0.00E+00	0.00E+00	2.46	–7.25			1.84E–09	0.328	0.566	16.34	16.37	
KAV01	617.16	622.16	5	0.00E+00	8.94E–08	2.47	–7.26	9.10E–09		1.84E–09	0.211	0.501	16.30	16.29	
KAV01	612.15	617.15	5	0.00E+00	0.00E+00	2.47	–7.31			1.69E–09	0.154	0.461	16.20	16.19	
KAV01	607.14	612.14	5	0.00E+00	0.00E+00	2.47	–7.32			1.54E–09	0.131	0.441	16.16	16.18	
KAV01	602.14	607.14	5	0.00E+00	0.00E+00	2.41	–7.38			1.40E–09	0.122	0.381	16.11	16.16	
KAV01	597.13	602.13	5	0.00E+00	0.00E+00	2.39	–7.41			1.26E–09	0.108	0.329	16.05	16.11	
KAV01	592.12	597.12	5	0.00E+00	0.00E+00	2.34	–7.42			1.13E–09	0.095	0.286	15.95	15.90	

Difference flow logging – Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	Lw (m)	Q0 (m³/s)	Q1 (m³/s)	dh0 (m)	dh1 (m)	TD (m²/s)	hi (m)	TD-measl (m²/s)	ECw1 (S/m)	ECw2 (S/m)	Tew1 (C)	Tew2 (C)	Comments
KAV01	587.11	592.11	5	0.00E+00	0.00E+00	2.34	–7.43			1.01E–09	0.085	0.250	15.90	15.95	
KAV01	582.10	587.10	5	0.00E+00	0.00E+00	2.30	–7.46			9.01E–10	0.077	0.221	15.82	15.81	
KAV01	577.10	582.10	5	0.00E+00	0.00E+00	2.29	–7.48			7.88E–10	0.069	0.198	15.72	15.71	
KAV01	572.09	577.09	5	0.00E+00	0.00E+00	2.28	–7.47			6.76E–10	0.061	0.180	15.66	15.65	
KAV01	567.08	572.08	5	0.00E+00	0.00E+00	2.26	–7.47			5.64E–10	0.054	0.160	15.58	15.66	
KAV01	562.07	567.07	5	0.00E+00	8.33E–08	2.23	–7.52	8.45E–09		4.22E–10	0.046	0.144	15.48	15.48	
KAV01	557.06	562.06	5	–2.10E–06	8.81E–06	2.23	–7.53	1.11E–06	0.35	4.22E–10	0.038	0.268	15.35	15.37	
KAV01	552.05	557.05	5	–2.42E–08	1.23E–07	2.17	–7.57	1.50E–08	0.57	2.82E–10	0.032	0.252	15.23	15.30	
KAV01	547.03	552.03	5	–1.59E–07	6.12E–07	2.17	–7.57	7.85E–08	0.16	2.82E–10	0.032	0.088	15.17	15.28	
KAV01	542.01	547.01	5	0.00E+00	8.33E–09	2.13	–7.63	8.45E–10		4.22E–10	0.031	0.243	15.07	15.19	
KAV01	536.99	541.99	5	–3.69E–08	2.70E–07	2.13	–7.64	3.10E–08	0.96	4.22E–10	0.031	0.145	15.04	15.15	
KAV01	531.98	536.98	5	–1.83E–08	1.44E–07	2.11	–7.63	1.66E–08	1.01	4.23E–10	0.031	0.252	14.89	15.05	
KAV01	526.95	531.95	5	–7.05E–06	3.68E–05	2.11	–7.62	4.46E–06	0.54	4.24E–10	0.030	0.159	14.76	15.00	
KAV01	521.93	526.93	5	0.00E+00	3.96E–08	2.10	–7.66	4.02E–09		4.22E–10	0.030	0.085	14.57	14.78	
KAV01	516.91	521.91	5	0.00E+00	1.97E–08	2.10	–7.64	2.00E–09		4.23E–10	0.030	0.116	14.53	14.77	
KAV01	511.90	516.90	5	0.00E+00	0.00E+00	2.06	–7.67			4.24E–10	0.030	0.121	14.49	14.76	
KAV01	506.88	511.88	5	0.00E+00	0.00E+00	2.06	–7.66			4.24E–10	0.030	0.066	14.42	14.77	
KAV01	501.86	506.86	5	–2.95E–07	1.94E–06	2.06	–7.67	2.27E–07	0.77	4.24E–10	0.029	0.065	14.31	14.69	
KAV01	496.86	501.86	5	–6.33E–07	5.98E–06	2.07	–7.67	6.70E–07	1.14	4.23E–10	0.030	0.105	14.17	14.61	
KAV01	491.86	496.86	5	0.00E+00	0.00E+00	2.02	–7.66			4.26E–10	0.030	0.095	14.11	14.46	
KAV01	486.85	491.85	5	0.00E+00	0.00E+00	2.01	–7.66			4.26E–10	0.030	0.081	14.05	14.53	
KAV01	481.85	486.85	5	0.00E+00	2.08E–08	1.98	–7.67	2.14E–09		4.27E–10	0.030	0.065	13.98	14.56	
KAV01	476.84	481.84	5	–5.14E–08	5.84E–07	1.98	–7.68	6.50E–08	1.2	4.27E–10	0.030	0.064	13.86	14.60	
KAV01	471.84	476.84	5	0.00E+00	1.39E–08	1.97	–7.71	1.42E–09		4.25E–10	0.029	0.098	13.72	14.39	
KAV01	466.83	471.83	5	0.00E+00	0.00E+00	1.96	–7.70			4.26E–10	0.030	0.086	13.69	14.38	
KAV01	461.83	466.83	5	–5.00E–08	2.39E–07	1.92	–7.75	2.96E–08	0.25	4.26E–10	0.029	0.065	13.59	14.38	
KAV01	456.83	461.83	5	–1.58E–08	1.09E–07	1.91	–7.77	1.28E–08	0.69	4.26E–10	0.029	0.098	13.39	14.26	
KAV01	451.83	456.83	5	0.00E+00	0.00E+00	1.93	–7.78			4.24E–10	0.029	0.101	13.27	14.20	
KAV01	446.82	451.82	5	–2.33E–07	1.78E–06	1.86	–7.79	2.07E–07	0.74	4.27E–10	0.029	0.065	13.16	14.11	

Difference flow logging – Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	Lw (m)	Q0 (m³/s)	Q1 (m³/s)	dh0 (m)	dh1 (m)	TD (m²/s)	hi (m)	TD-measl (m²/s)	ECw1 (S/m)	ECw2 (S/m)	Tew1 (C)	Tew2 (C)	Comments
KAV01	441.82	446.82	5	–4.86E–08	4.18E–07	1.90	–7.79	4.77E–08	0.89	4.26E–10	0.029	0.129	12.91	13.95	
KAV01	436.82	441.82	5	–8.39E–08	4.93E–07	1.88	–7.80	5.90E–08	0.47	4.25E–10	0.029	0.133	12.70	13.97	
KAV01	431.82	436.82	5	0.00E+00	3.33E–06	1.87	–7.80	3.41E–07		4.26E–10	0.029	0.136	12.49	13.85	
KAV01	426.81	431.81	5	–1.92E–05	9.47E–05	1.90	–7.81	1.16E–05	0.26	5.66E–10	0.029	0.230	12.25	13.32	
KAV01	421.81	426.81	5	–4.83E–06	3.18E–05	1.84	–7.84	3.75E–06	0.56	5.68E–10	0.029	0.195	12.21	13.01	
KAV01	416.81	421.81	5	–2.88E–06	2.21E–05	1.83	–7.85	2.56E–06	0.71	5.68E–10	0.029	0.106	12.18	12.91	
KAV01	411.80	416.80	5	–1.17E–08	1.19E–07	1.83	–7.86	1.33E–08	0.96	5.67E–10	0.029	0.089	12.15	12.92	
KAV01	406.80	411.80	5	–2.06E–07	1.71E–06	1.81	–7.87	1.96E–07	0.77	5.68E–10	0.029	0.136	12.09	12.95	
KAV01	401.78	406.78	5	0.00E+00	4.17E–08	1.78	–7.92	4.25E–09		5.67E–10	0.029	0.093	12.03	12.93	
KAV01	396.77	401.77	5	0.00E+00	1.72E–07	1.77	–7.93	1.76E–08		5.67E–10	0.029	0.139	11.97	12.92	
KAV01	391.76	396.76	5	0.00E+00	5.19E–07	1.77	–7.93	5.30E–08		5.66E–10	0.028	0.114	11.90	12.92	
KAV01	386.74	391.74	5	0.00E+00	0.00E+00	1.79	–7.92			5.66E–10	0.028	0.091	11.82	12.88	
KAV01	381.73	386.73	5	0.00E+00	0.00E+00	1.78	–7.96			5.65E–10	0.028	0.136	11.75	12.88	
KAV01	376.72	381.72	5	0.00E+00	0.00E+00	1.78	–7.96			5.65E–10	0.028	0.137	11.68	12.87	
KAV01	371.70	376.70	5	0.00E+00	0.00E+00	1.78	–7.96			5.64E–10	0.028	0.136	11.59	12.83	
KAV01	366.69	371.69	5	0.00E+00	0.00E+00	1.79	–7.95			5.64E–10	0.028	0.137	11.53	12.82	
KAV01	361.68	366.68	5	0.00E+00	0.00E+00	1.76	–8.01			5.62E–10	0.028	0.136	11.47	12.81	
KAV01	356.67	361.67	5	0.00E+00	0.00E+00	1.77	–8.01			5.62E–10	0.028	0.135	11.40	12.80	
KAV01	351.67	356.67	5	0.00E+00	0.00E+00	1.77	–8.01			5.62E–10	0.028	0.135	11.33	12.75	
KAV01	346.67	351.67	5	0.00E+00	3.84E–08	1.77	–8.02	3.88E–09		5.61E–10	0.028	0.136	11.26	12.72	
KAV01	341.66	346.66	5	2.74E–08	1.73E–07	1.74	–8.02	1.48E–08	3.57	4.22E–10	0.027	0.134	11.22	12.68	
KAV01	336.66	341.66	5	0.00E+00	0.00E+00	1.73	–8.03			4.22E–10	0.028	0.135	11.12	12.63	
KAV01	331.66	336.66	5	0.00E+00	5.13E–09	1.73	–8.08	5.15E–10		4.20E–10	0.028	0.135	11.09	12.64	
KAV01	326.66	331.66	5	0.00E+00	0.00E+00	1.72	–8.11			4.55E–10	0.028	0.136	11.00	12.60	
KAV01	321.65	326.65	5	0.00E+00	0.00E+00	1.72	–8.10			4.93E–10	0.027	0.134	10.93	12.55	
KAV01	316.65	321.65	5	0.00E+00	0.00E+00	1.72	–8.12			5.28E–10	0.028	0.135	10.85	12.50	
KAV01	311.65	316.65	5	0.00E+00	0.00E+00	1.68	–8.12			5.66E–10	0.027	0.134	10.80	12.53	
KAV01	306.65	311.65	5	0.00E+00	0.00E+00	1.68	–8.13			6.02E–10	0.028	0.134	10.72	12.43	
KAV01	301.65	306.65	5	0.00E+00	0.00E+00	1.68	–8.17			6.36E–10	0.027	0.133	10.66	12.38	
KAV01	296.65	301.65	5	0.00E+00	0.00E+00	1.67	–8.19			6.72E–10	0.027	0.133	10.59	12.36	

Difference flow logging – Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	Lw (m)	Q0 (m³/s)	Q1 (m³/s)	dh0 (m)	dh1 (m)	TD (m²/s)	hi (m)	TD-measl (m²/s)	ECw1 (S/m)	ECw2 (S/m)	Tew1 (C)	Tew2 (C)	Comments
KAV01	291.65	296.65	5	0.00E+00	0.00E+00	1.61	–8.24			7.09E–10	0.027	0.133	10.53	12.28	
KAV01	286.65	291.65	5	0.00E+00	2.44E–08	1.60	–8.25	2.46E–09		7.45E–10	0.027	0.134	10.47	12.25	
KAV01	281.65	286.65	5	0.00E+00	5.17E–08	1.59	–8.26	5.20E–09		7.53E–10	0.027	0.133	10.43	12.22	
KAV01	276.65	281.65	5	0.00E+00	2.83E–08	1.58	–8.29	2.84E–09		7.52E–10	0.027	0.133	10.38	12.16	
KAV01	271.65	276.65	5	0.00E+00	0.00E+00	1.54	–8.33			7.52E–10	0.027	0.133	10.27	12.19	
KAV01	266.65	271.65	5	1.22E–08	1.07E–07	1.53	–8.33	9.50E–09	2.81	7.52E–10	0.027	0.132	10.20	12.13	
KAV01	261.65	266.65	5	0.00E+00	2.24E–08	1.52	–8.34	2.25E–09		7.52E–10	0.027	0.133	10.11	11.99	
KAV01	256.65	261.65	5	1.61E–08	9.78E–08	1.51	–8.36	8.20E–09	3.45	6.40E–10	0.027	0.133	10.07	11.97	
KAV01	251.64	256.64	5	7.36E–08	4.40E–07	1.48	–8.37	3.68E–08	3.46	6.42E–10	0.027	0.133	10.00	11.90	
KAV01	246.63	251.63	5	1.90E–08	1.20E–07	1.48	–8.38	1.02E–08	3.32	6.41E–10	0.027	0.103	9.91	11.82	
KAV01	241.62	246.62	5	4.12E–07	1.68E–06	1.45	–8.41	1.27E–07	4.65	6.41E–10	0.027	0.129	9.88	11.79	
KAV01	236.61	241.61	5	0.00E+00	8.78E–08	1.45	–8.42	8.80E–09		6.41E–10	0.028	0.100	9.82	11.64	
KAV01	231.60	236.60	5	1.19E–07	5.19E–07	1.44	–8.41	4.02E–08	4.37	6.41E–10	0.027	0.131	9.79	11.68	
KAV01	226.58	231.58	5	2.26E–07	8.38E–07	1.45	–8.41	6.15E–08	5.09	6.41E–10	0.028	0.093	9.67	11.58	
KAV01	221.57	226.57	5	0.00E+00	6.81E–08	1.42	–8.43	6.85E–09		6.41E–10	0.028	0.093	9.60	11.58	
KAV01	216.56	221.56	5	1.02E–06	6.01E–06	1.43	–8.43	5.00E–07	3.45	6.41E–10	0.027	0.130	9.58	11.51	
KAV01	211.55	216.55	5	1.58E–06	7.80E–06	1.43	–8.43	6.25E–07	3.94	6.41E–10	0.033	0.077	9.57	11.29	
KAV01	206.54	211.54	5	1.26E–07	5.77E–07	1.42	–8.43	4.53E–08	4.16	6.41E–10	0.031	0.077	9.49	11.09	
KAV01	201.54	206.54	5	0.00E+00	0.00E+00	1.40	–8.42			6.43E–10	0.029	0.081	9.36	11.19	
KAV01	196.54	201.54	5	0.00E+00	4.65E–08	1.40	–8.44	4.67E–09		6.42E–10	0.028	0.113	9.32	11.20	
KAV01	191.54	196.54	5	2.41E–07	1.10E–06	1.35	–8.49	8.65E–08	4.12	6.42E–10	0.026	0.123	9.30	11.18	
KAV01	186.54	191.54	5	2.85E–06	1.20E–05	1.36	–8.50	9.20E–07	4.42	6.41E–10	0.030	0.081	9.18	11.03	
KAV01	181.54	186.54	5	0.00E+00	2.85E–08	1.36	–8.51	2.86E–09		6.40E–10	0.032	0.070	9.17	10.66	
KAV01	176.54	181.54	5	4.92E–07	1.33E–06	1.35	–8.53	8.40E–08	7.13	6.40E–10	0.025	0.118	9.09	10.91	
KAV01	171.54	176.54	5	5.95E–07	2.47E–06	1.34	–8.55	1.88E–07	4.48	6.39E–10	0.032	0.079	9.00	10.75	
KAV01	166.54	171.54	5	1.49E–07	6.23E–07	1.34	–8.56	4.74E–08	4.44	6.39E–10	0.032	0.080	8.95	10.73	
KAV01	161.55	166.55	5	1.21E–08	6.06E–08	1.30	–8.58	4.85E–09	3.77	3.62E–10	0.032	0.072	8.89	10.72	
KAV01	156.55	161.55	5	7.83E–08	2.95E–07	1.30	–8.58	2.17E–08	4.87	3.06E–10	0.028	0.118	8.87	10.73	
KAV01	151.55	156.55	5	3.42E–08	1.78E–07	1.29	–8.60	1.44E–08	3.65	3.05E–10	0.028	0.112	8.80	10.69	
KAV01	146.54	151.54	5	4.03E–09	1.81E–08	1.28	–8.62	1.41E–09	4.11	3.05E–10	0.029	0.117	8.77	10.59	

Difference flow logging – Sequential flow logging

Borehole ID	Secup L(m)	Seclow L(m)	Lw (m)	Q0 (m³/s)	Q1 (m³/s)	dh0 (m)	dh1 (m)	TD (m²/s)	hi (m)	TD-measl (m²/s)	ECw1 (S/m)	ECw2 (S/m)	Tew1 (C)	Tew2 (C)	Comments
KAV01	141.53	146.53	5	8.19E–09	3.78E–08	1.25	–8.66	2.96E–09	3.99	3.05E–10	0.029	0.116	8.77	10.60	
KAV01	136.52	141.52	5	1.05E–05	2.83E–05	1.24	–8.66	1.78E–06	7.1	3.05E–10	0.028	0.116	8.72	10.62	
KAV01	131.51	136.51	5	1.46E–06	4.59E–06	1.24	–8.65	3.13E–07	5.88	4.17E–10	0.029	0.058	8.68	9.70	
KAV01	126.51	131.51	5	1.00E–06	3.47E–06	1.24	–8.66	2.47E–07	5.25	4.16E–10	0.030	0.053	8.57	10.11	
KAV01	121.50	126.50	5	0.00E+00	0.00E+00	1.23	–8.66			4.16E–10	0.030	0.056	8.50	10.08	
KAV01	116.49	121.49	5	7.67E–08	3.32E–07	1.23	–8.65	2.56E–08	4.2	4.17E–10	0.027	0.106	8.45	10.15	
KAV01	111.48	116.48	5	2.60E–08	9.64E–08	1.24	–8.69	7.00E–09	4.9	4.15E–10	0.032	0.100	8.37	10.10	
KAV01	106.47	111.47	5	2.58E–08	1.13E–07	1.24	–8.68	8.70E–09	4.17	4.15E–10	0.030	0.105	8.34	10.08	
KAV01	101.46	106.46	5	0.00E+00	8.22E–09	1.19	–8.70	8.25E–10		4.52E–10	0.022	0.105	8.29	10.03	
KAV01	96.45	101.45	5	2.02E–08	9.89E–08	1.19	–8.69	7.90E–09	3.73	4.87E–10	0.022	0.106	8.27	9.99	
KAV01	91.44	96.44	5	0.00E+00	0.00E+00	1.21	–8.69			5.20E–10	0.026	0.105	8.22	9.92	
KAV01	86.43	91.43	5	0.00E+00	1.15E–08	1.21	–8.69	1.15E–09		5.55E–10	0.022	0.104	8.21	9.94	
KAV01	81.42	86.42	5	1.94E–06	7.40E–06	1.23	–8.72	5.45E–07	4.76	5.53E–10	0.021	0.105	8.18	9.85	
KAV01	76.41	81.41	5	1.40E–05	5.99E–05	1.23	–8.71	4.57E–06	4.26	5.53E–10	0.028	0.048	8.14	9.56	
KAV01	71.40	76.40	5	3.31E–06	1.10E–05	1.20	–8.71	7.65E–07	5.49	5.55E–10	0.022	0.040	8.11	9.02	

PFL – Difference flow logging – Inferred flow anomalies from overlapping flow logging

Borehole ID	Length to flow anom. L (m)	Lw (m)	dL (m)	Q0 (m³/s)	Q1 (m³/s)	dh0 (m)	dh1 (m)	TD (m²/s)	TD-measl (m²/s)	hi	Comments
KAV01	70.1	1.0	0.1	–	5.72E–06	1.21	–8.75	5.69E–07	5.52E–10	–	Uncertain
KAV01	72.1	1.0	0.1	–	2.78E–08	1.21	–8.70	2.77E–09	5.54E–10	–	Uncertain
KAV01	73.1	1.0	0.1	–	4.17E–07	1.20	–8.70	4.16E–08	5.55E–10	–	Uncertain
KAV01	73.9	1.0	0.1	–	5.14E–07	1.19	–8.70	5.14E–08	5.55E–10	–	Uncertain
KAV01	74.9	1.0	0.1	–	3.39E–06	1.20	–8.71	3.38E–07	5.55E–10	–	
KAV01	76.1	1.0	0.1	–	6.58E–06	1.23	–8.68	6.57E–07	5.55E–10	–	
KAV01	77.0	1.0	0.1	–	4.03E–07	1.24	–8.67	4.02E–08	5.55E–10	–	
KAV01	77.9	1.0	0.1	–	3.61E–07	1.22	–8.68	3.61E–08	5.55E–10	–	
KAV01	79.1	1.0	0.1	–	9.44E–07	1.23	–8.68	9.43E–08	5.55E–10	–	
KAV01	79.6	1.0	0.1	–	4.58E–05	1.24	–8.67	4.58E–06	5.55E–10	–	
KAV01	80.3	1.0	0.1	–	5.14E–08	1.23	–8.68	5.13E–09	5.54E–10	–	
KAV01	80.6	1.0	0.1	–	1.19E–08	1.23	–8.68	1.19E–09	5.55E–10	–	
KAV01	83.0	1.0	0.1	–	3.75E–08	1.23	–8.69	3.74E–09	5.54E–10	–	
KAV01	83.5	1.0	0.1	–	5.17E–06	1.23	–8.68	5.16E–07	5.54E–10	–	
KAV01	84.2	1.0	0.1	–	1.47E–06	1.23	–8.68	1.47E–07	5.55E–10	–	
KAV01	85.7	1.0	0.1	9.72E–08	2.53E–07	1.21	–8.69	1.55E–08	5.55E–10	7.40	
KAV01	89.4	1.0	0.1	–	6.94E–09	1.21	–8.69	6.94E–10	5.28E–10	–	Uncertain
KAV01	97.3	1.0	0.1	2.08E–08	8.89E–08	1.19	–8.70	6.80E–09	5.00E–10	4.22	
KAV01	103.6	1.0	0.1	–	8.33E–09	1.19	–8.71	8.33E–10	4.44E–10	–	
KAV01	106.9	1.0	0.1	–	6.11E–09	1.24	–8.67	6.10E–10	4.44E–10	–	Uncertain
KAV01	110.2	1.0	0.1	–	3.33E–08	1.23	–8.67	3.33E–09	4.16E–10	–	
KAV01	110.8	1.0	0.1	–	5.83E–08	1.23	–8.67	5.83E–09	4.16E–10	–	
KAV01	112.7	1.0	0.1	–	3.19E–08	1.25	–8.67	3.19E–09	4.16E–10	–	
KAV01	113.2	1.0	0.1	–	8.33E–09	1.25	–8.67	8.31E–10	4.16E–10	–	Uncertain
KAV01	116.0	1.0	0.1	–	6.39E–08	1.24	–8.64	6.40E–09	4.17E–10	–	
KAV01	116.9	1.0	0.1	–	1.53E–08	1.25	–8.64	1.53E–09	4.17E–10	–	Uncertain
KAV01	118.7	1.0	0.1	7.50E–08	3.06E–07	1.24	–8.64	2.31E–08	4.17E–10	4.46	
KAV01	119.6	1.0	0.1	–	4.17E–09	1.23	–8.64	4.18E–10	4.18E–10	–	Uncertain
KAV01	126.6	1.0	0.1	–	2.36E–07	1.24	–8.64	2.36E–08	4.17E–10	–	

PFL – Difference flow logging – Inferred flow anomalies from overlapping flow logging

Borehole ID	Length to flow anom. L (m)	Lw (m)	dL (m)	Q0 (m³/s)	Q1 (m³/s)	dh0 (m)	dh1 (m)	TD (m²/s)	TD-measl (m²/s)	hi	Comments
KAV01	127.1	1.0	0.1	–	3.22E–07	1.24	–8.65	3.22E–08	4.17E–10	–	
KAV01	127.5	1.0	0.1	–	2.47E–06	1.24	–8.64	2.47E–07	4.17E–10	–	
KAV01	128.6	1.0	0.1	2.08E–08	8.06E–08	1.24	–8.64	5.98E–09	4.17E–10	4.68	
KAV01	134.4	1.0	0.1	–	2.42E–06	1.24	–8.63	2.42E–07	4.18E–10	–	
KAV01	135.0	1.0	0.1	–	5.56E–08	1.24	–8.64	5.56E–09	3.89E–10	–	Uncertain
KAV01	136.5	1.0	0.1	–	1.58E–06	1.23	–8.63	1.59E–07	3.62E–10	–	
KAV01	137.6	1.0	0.1	–	2.03E–05	1.25	–8.63	2.03E–06	3.34E–10	–	
KAV01	138.1	1.0	0.1	–	1.03E–06	1.25	–8.63	1.03E–07	3.06E–10	–	
KAV01	138.7	1.0	0.1	–	4.03E–08	1.24	–8.64	4.03E–09	3.06E–10	–	Uncertain
KAV01	141.9	1.0	0.1	–	3.33E–08	1.26	–8.64	3.33E–09	3.05E–10	–	
KAV01	145.8	1.0	0.1	–	5.56E–09	1.24	–8.64	5.57E–10	3.06E–10	–	Uncertain
KAV01	147.2	1.0	0.1	–	1.25E–08	1.28	–8.59	1.25E–09	3.06E–10	–	
KAV01	149.1	1.0	0.1	–	6.94E–09	1.28	–8.59	6.96E–10	3.06E–10	–	Uncertain
KAV01	155.9	1.0	0.1	3.33E–08	1.61E–07	1.29	–8.58	1.28E–08	3.06E–10	3.86	
KAV01	156.8	1.0	0.1	8.33E–08	2.50E–07	1.30	–8.57	1.67E–08	3.06E–10	6.23	
KAV01	158.2	1.0	0.1	–	4.17E–09	1.29	–8.57	4.18E–10	3.06E–10	–	Uncertain
KAV01	158.7	1.0	0.1	–	2.92E–08	1.29	–8.57	2.93E–09	3.06E–10	–	
KAV01	161.0	1.0	0.1	–	6.11E–09	1.30	–8.56	6.13E–10	3.07E–10	–	Uncertain
KAV01	165.3	1.0	0.1	–	5.00E–08	1.30	–8.56	5.02E–09	3.62E–10	–	
KAV01	165.6	1.0	0.1	–	1.81E–08	1.31	–8.55	1.81E–09	4.18E–10	–	Uncertain
KAV01	168.2	1.0	0.1	–	2.36E–08	1.33	–8.54	2.37E–09	4.73E–10	–	
KAV01	169.1	1.0	0.1	–	3.61E–07	1.33	–8.54	3.62E–08	5.29E–10	–	
KAV01	169.3	1.0	0.1	–	5.28E–08	1.34	–8.54	5.28E–09	5.84E–10	–	Uncertain
KAV01	171.1	1.0	0.1	–	1.81E–07	1.32	–8.54	1.81E–08	6.41E–10	–	
KAV01	172.0	1.0	0.1	–	2.14E–07	1.34	–8.54	2.14E–08	6.40E–10	–	
KAV01	173.1	1.0	0.1	–	4.72E–07	1.33	–8.54	4.73E–08	6.40E–10	–	
KAV01	174.4	1.0	0.1	–	1.86E–07	1.34	–8.53	1.87E–08	6.41E–10	–	
KAV01	175.1	1.0	0.1	–	4.17E–07	1.35	–8.53	4.17E–08	6.40E–10	–	
KAV01	176.2	1.0	0.1	–	9.86E–07	1.34	–8.51	9.91E–08	6.42E–10	–	
KAV01	177.5	1.0	0.1	–	1.11E–08	1.35	–8.50	1.12E–09	6.42E–10	–	Uncertain

PFL – DIFFERENCE FLOW LOGGING – Inferred flow anomalies from overlapping flow logging

Borehole ID	Length to flow anom. L (m)	Lw (m)	dL (m)	Q0 (m^3/s)	Q1 (m^3/s)	dh0 (m)	dh1 (m)	TD (m^2/s)	TD-measl (m^2/s)	hi	Comments
KAV01	178.1	1.0	0.1	4.72E–07	1.22E–06	1.36	–8.50	7.47E–08	6.41E–10	7.61	
KAV01	183.8	1.0	0.1	–	2.08E–08	1.36	–8.48	2.09E–09	6.42E–10	–	
KAV01	185.1	1.0	0.1	–	1.11E–08	1.35	–8.47	1.12E–09	6.44E–10	–	Uncertain
KAV01	188.8	1.0	0.1	2.83E–06	1.04E–05	1.35	–8.46	7.59E–07	6.44E–10	5.05	
KAV01	193.8	1.0	0.1	–	6.94E–07	1.36	–8.45	7.00E–08	6.44E–10	–	
KAV01	194.4	1.0	0.1	–	3.47E–07	1.35	–8.45	3.50E–08	6.45E–10	–	
KAV01	195.6	1.0	0.1	–	4.17E–08	1.36	–8.45	4.20E–09	6.44E–10	–	
KAV01	196.1	1.0	0.1	–	1.25E–08	1.35	–8.45	1.26E–09	6.45E–10	–	Uncertain
KAV01	198.2	1.0	0.1	–	1.39E–08	1.39	–8.44	1.40E–09	6.43E–10	–	Uncertain
KAV01	206.6	1.0	0.1	4.86E–08	2.22E–07	1.44	–8.40	1.74E–08	6.42E–10	4.20	
KAV01	207.1	1.0	0.1	–	1.67E–08	1.44	–8.40	1.67E–09	6.42E–10	–	Uncertain
KAV01	209.1	1.0	0.1	4.31E–08	1.89E–07	1.44	–8.41	1.46E–08	6.42E–10	4.35	
KAV01	210.9	1.0	0.1	–	6.67E–08	1.43	–8.40	6.71E–09	6.43E–10	–	
KAV01	211.3	1.0	0.1	–	6.11E–08	1.41	–8.41	6.16E–09	6.44E–10	–	
KAV01	211.6	1.0	0.1	–	1.19E–07	1.40	–8.40	1.20E–08	6.44E–10	–	
KAV01	211.9	1.0	0.1	–	2.29E–06	1.44	–8.40	2.30E–07	6.42E–10	–	
KAV01	212.1	1.0	0.1	–	2.43E–06	1.44	–8.40	2.44E–07	6.42E–10	–	Uncertain
KAV01	213.4	1.0	0.1	–	1.75E–06	1.43	–8.40	1.76E–07	6.43E–10	–	
KAV01	215.1	1.0	0.1	–	6.39E–08	1.43	–8.40	6.43E–09	6.43E–10	–	Uncertain
KAV01	216.8	1.0	0.1	–	4.86E–06	1.43	–8.41	4.89E–07	6.43E–10	–	
KAV01	218.2	1.0	0.1	–	2.03E–07	1.42	–8.41	2.04E–08	6.43E–10	–	
KAV01	219.6	1.0	0.1	–	2.36E–07	1.43	–8.41	2.37E–08	6.42E–10	–	
KAV01	220.2	1.0	0.1	–	3.06E–08	1.42	–8.41	3.08E–09	6.43E–10	–	
KAV01	223.1	1.0	0.1	–	4.03E–08	1.42	–8.41	4.05E–09	6.43E–10	–	Uncertain
KAV01	223.5	1.0	0.1	–	2.78E–08	1.42	–8.41	2.80E–09	6.43E–10	–	
KAV01	227.3	1.0	0.1	–	2.50E–08	1.45	–8.38	2.51E–09	6.43E–10	–	
KAV01	228.7	1.0	0.1	–	1.53E–07	1.44	–8.38	1.54E–08	6.43E–10	–	
KAV01	229.9	1.0	0.1	–	6.25E–07	1.46	–8.39	6.28E–08	6.42E–10	–	
KAV01	230.2	1.0	0.1	–	1.25E–07	1.45	–8.39	1.26E–08	6.43E–10	–	Uncertain
KAV01	233.4	1.0	0.1	–	6.94E–09	1.44	–8.38	6.99E–10	6.43E–10	–	

PFL – Difference flow logging – Inferred flow anomalies from overlapping flow logging

Borehole ID	Length to flow anom. L (m)	Lw (m)	dL (m)	Q0 (m³/s)	Q1 (m³/s)	dh0 (m)	dh1 (m)	TD (m²/s)	TD-measl (m²/s)	hi	Comments
KAV01	235.2	1.0	0.1	–	4.86E–07	1.44	–8.38	4.90E–08	6.44E–10	–	
KAV01	236.9	1.0	0.1	–	5.14E–08	1.45	–8.38	5.17E–09	6.43E–10	–	
KAV01	240.6	1.0	0.1	–	1.39E–08	1.44	–8.38	1.40E–09	6.43E–10	–	Uncertain
KAV01	242.3	1.0	0.1	–	4.17E–07	1.44	–8.38	4.20E–08	6.43E–10	–	
KAV01	243.1	1.0	0.1	–	1.03E–06	1.44	–8.39	1.03E–07	6.43E–10	–	
KAV01	244.4	1.0	0.1	–	1.00E–07	1.45	–8.39	1.01E–08	6.43E–10	–	
KAV01	246.0	1.0	0.1	–	4.72E–08	1.44	–8.39	4.75E–09	6.43E–10	–	
KAV01	251.4	1.0	0.1	1.83E–08	9.44E–08	1.45	–8.34	7.68E–09	6.45E–10	3.81	
KAV01	253.6	1.0	0.1	7.22E–08	4.03E–07	1.49	–8.34	3.33E–08	6.43E–10	3.63	
KAV01	258.4	1.0	0.1	1.67E–08	9.44E–08	1.51	–8.33	7.82E–09	6.42E–10	3.62	
KAV01	262.9	1.0	0.1	–	2.50E–08	1.52	–8.32	2.51E–09	7.54E–10	–	Uncertain
KAV01	267.9	1.0	0.1	6.94E–09	9.17E–08	1.53	–8.31	8.52E–09	7.54E–10	2.34	
KAV01	269.9	1.0	0.1	2.78E–09	2.36E–08	1.53	–8.30	2.10E–09	7.55E–10	2.84	Uncertain
KAV01	276.8	1.0	0.1	–	1.39E–08	1.58	–8.24	1.40E–09	7.55E–10	–	Uncertain
KAV01	278.7	1.0	0.1	–	1.67E–08	1.58	–8.24	1.68E–09	7.55E–10	–	Uncertain
KAV01	286.1	1.0	0.1	–	3.61E–08	1.58	–8.22	3.64E–09	7.57E–10	–	
KAV01	289.9	1.0	0.1	–	1.39E–08	1.61	–8.22	1.40E–09	7.55E–10	–	Uncertain
KAV01	335.7	1.0	0.1	–	4.17E–09	1.72	–8.05	4.22E–10	4.22E–10	–	Uncertain
KAV01	344.3	1.0	0.1	2.64E–08	1.53E–07	1.74	–8.00	1.28E–08	4.23E–10	3.77	
KAV01	346.4	1.0	0.1	–	6.11E–09	1.76	–8.00	6.19E–10	4.79E–10	–	Uncertain
KAV01	348.8	1.0	0.1	–	3.06E–08	1.76	–8.00	3.10E–09	5.63E–10	–	
KAV01	393.2	1.0	0.1	–	7.50E–09	1.80	–7.89	7.66E–10	5.67E–10	–	Uncertain
KAV01	394.6	1.0	0.1	–	9.72E–09	1.77	–7.89	9.96E–10	5.69E–10	–	Uncertain
KAV01	396.7	1.0	0.1	–	4.53E–07	1.76	–7.85	4.66E–08	5.72E–10	–	
KAV01	397.8	1.0	0.1	–	1.39E–07	1.78	–7.85	1.43E–08	5.71E–10	–	
KAV01	399.0	1.0	0.1	–	9.72E–09	1.78	–7.86	9.98E–10	5.70E–10	–	Uncertain
KAV01	400.1	1.0	0.1	–	6.94E–09	1.77	–7.85	7.14E–10	5.71E–10	–	Uncertain
KAV01	401.9	1.0	0.1	–	1.11E–08	1.78	–7.84	1.14E–09	5.71E–10	–	Uncertain
KAV01	403.4	1.0	0.1	–	8.33E–09	1.77	–7.85	8.57E–10	5.71E–10	–	Uncertain
KAV01	405.3	1.0	0.1	–	2.08E–08	1.78	–7.84	2.14E–09	5.71E–10	–	Uncertain

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KAV01	407.0	1.0	0.1	–	6.06E–07	1.81	–7.84	6.21E–08	5.69E–10	–	
KAV01	409.2	1.0	0.1	–	1.11E–07	1.82	–7.84	1.14E–08	5.69E–10	–	Uncertain
KAV01	409.6	1.0	0.1	–	5.00E–07	1.81	–7.83	5.13E–08	5.70E–10	–	
KAV01	410.1	1.0	0.1	–	3.28E–07	1.82	–7.83	3.36E–08	5.69E–10	–	Uncertain
KAV01	410.4	1.0	0.1	–	1.56E–07	1.82	–7.82	1.60E–08	5.70E–10	–	Uncertain
KAV01	412.2	1.0	0.1	–	2.08E–08	1.84	–7.82	2.13E–09	5.69E–10	–	Uncertain
KAV01	412.8	1.0	0.1	–	5.00E–08	1.82	–7.82	5.13E–09	5.70E–10	–	
KAV01	414.5	1.0	0.1	–	4.31E–08	1.83	–7.81	4.42E–09	5.70E–10	–	
KAV01	416.3	1.0	0.1	–	2.78E–08	1.83	–7.77	2.86E–09	5.72E–10	–	Uncertain
KAV01	417.3	1.0	0.1	–	3.06E–08	1.85	–7.77	3.14E–09	5.72E–10	–	Uncertain
KAV01	418.4	1.0	0.1	–	2.08E–08	1.83	–7.76	2.15E–09	5.73E–10	–	Uncertain
KAV01	420.2	1.0	0.1	–	8.19E–06	1.83	–7.76	8.45E–07	5.73E–10	–	
KAV01	421.4	1.0	0.1	–	8.75E–06	1.81	–7.76	9.04E–07	5.74E–10	–	
KAV01	422.0	1.0	0.1	–	7.39E–06	1.85	–7.76	7.60E–07	5.72E–10	–	
KAV01	423.2	1.0	0.1	–	1.25E–05	1.84	–7.76	1.29E–06	5.72E–10	–	
KAV01	423.9	1.0	0.1	–	5.56E–06	1.84	–7.76	5.73E–07	5.73E–10	–	
KAV01	428.0	1.0	0.1	–	2.67E–05	1.88	–7.74	2.74E–06	5.71E–10	–	
KAV01	429.9	1.0	0.1	–	7.50E–08	1.90	–7.74	7.69E–09	5.70E–10	–	Uncertain
KAV01	430.1	1.0	0.1	–	4.03E–06	1.90	–7.75	4.13E–07	5.70E–10	–	
KAV01	431.8	1.0	0.1	–1.39E–05	5.56E–05	1.95	–7.74	7.09E–06	4.26E–10	0.01	
KAV01	432.2	1.0	0.1	–	3.33E–06	1.81	–7.74	3.45E–07	4.31E–10	–	Uncertain
KAV01	439.6	1.0	0.1	–	6.94E–08	1.88	–7.74	7.14E–09	4.28E–10	–	
KAV01	441.3	1.0	0.1	–9.72E–08	4.17E–07	1.87	–7.74	5.29E–08	4.29E–10	0.06	
KAV01	445.1	1.0	0.1	–5.56E–08	3.61E–07	1.90	–7.72	4.28E–08	4.28E–10	0.61	
KAV01	448.8	1.0	0.1	–	5.28E–08	1.89	–7.72	5.43E–09	4.29E–10	–	
KAV01	450.7	1.0	0.1	–2.28E–07	1.60E–06	1.90	–7.72	1.88E–07	4.29E–10	0.70	
KAV01	460.0	1.0	0.1	–	3.06E–08	1.90	–7.70	3.15E–09	4.29E–10	–	Uncertain
KAV01	460.7	1.0	0.1	–	4.44E–08	1.90	–7.70	4.58E–09	4.29E–10	–	Uncertain
KAV01	461.8	1.0	0.1	–	4.44E–08	1.91	–7.70	4.58E–09	4.29E–10	–	
KAV01	462.1	1.0	0.1	–	5.56E–08	1.92	–7.70	5.72E–09	4.29E–10	–	

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KAV01	463.9	1.0	0.1	–5.56E–08	2.92E–07	1.92	–7.70	3.57E–08	4.28E–10	0.38	
KAV01	476.8	1.0	0.1	–	1.53E–08	1.95	–7.64	1.58E–09	4.30E–10	–	
KAV01	478.5	1.0	0.1	–5.56E–08	4.72E–07	1.96	–7.63	5.44E–08	4.30E–10	0.95	
KAV01	485.3	1.0	0.1	–	1.39E–08	1.98	–7.61	1.43E–09	4.30E–10	–	
KAV01	497.2	1.0	0.1	–	4.17E–08	2.07	–7.57	4.27E–09	4.27E–10	–	
KAV01	497.9	1.0	0.1	–4.31E–07	3.89E–06	2.07	–7.57	4.43E–07	4.28E–10	1.11	
KAV01	499.7	1.0	0.1	–	4.17E–08	2.07	–7.58	4.27E–09	4.27E–10	–	
KAV01	501.7	1.0	0.1	–	1.03E–06	2.07	–7.57	1.05E–07	4.27E–10	–	
KAV01	502.7	1.0	0.1	–3.06E–07	1.69E–06	2.03	–7.58	2.06E–07	4.29E–10	0.56	
KAV01	504.4	1.0	0.1	–	7.50E–09	2.07	–7.58	7.69E–10	4.27E–10	–	Uncertain
KAV01	517.1	1.0	0.1	–	5.56E–09	2.11	–7.56	5.69E–10	4.26E–10	–	Uncertain
KAV01	519.0	1.0	0.1	–	5.56E–09	2.10	–7.56	5.68E–10	4.26E–10	–	Uncertain
KAV01	523.8	1.0	0.1	–	2.50E–08	2.10	–7.57	2.56E–09	4.26E–10	–	
KAV01	527.5	1.0	0.1	–	2.00E–05	2.09	–7.58	2.05E–06	4.26E–10	–	
KAV01	528.9	1.0	0.1	–	9.44E–07	2.11	–7.59	9.63E–08	4.25E–10	–	
KAV01	530.3	1.0	0.1	–	2.08E–06	2.11	–7.59	2.12E–07	4.25E–10	–	Uncertain
KAV01	530.7	1.0	0.1	–	4.17E–06	2.10	–7.59	4.25E–07	4.25E–10	–	
KAV01	531.0	1.0	0.1	–	3.50E–07	2.09	–7.59	3.57E–08	4.26E–10	–	Uncertain
KAV01	534.6	1.0	0.1	–1.94E–08	9.72E–08	2.11	–7.60	1.19E–08	4.25E–10	0.49	
KAV01	539.6	1.0	0.1	–	4.17E–09	2.13	–7.59	4.24E–10	4.24E–10	–	Uncertain
KAV01	541.1	1.0	0.1	–	1.31E–07	2.13	–7.60	1.33E–08	4.24E–10	–	
KAV01	541.8	1.0	0.1	–	4.72E–08	2.15	–7.59	4.80E–09	4.23E–10	–	
KAV01	544.1	1.0	0.1	–	7.78E–09	2.14	–7.60	7.90E–10	3.67E–10	–	Uncertain
KAV01	550.4	1.0	0.1	–1.72E–07	5.14E–07	2.16	–7.54	6.99E–08	2.83E–10	–0.27	
KAV01	551.2	1.0	0.1	–	2.08E–08	2.17	–7.54	2.12E–09	2.83E–10	–	
KAV01	553.3	1.0	0.1	–2.78E–08	6.94E–08	2.18	–7.53	9.91E–09	2.83E–10	–0.60	
KAV01	556.1	1.0	0.1	–	2.78E–09	2.18	–7.53	2.83E–10	2.83E–10	–	Uncertain
KAV01	559.6	1.0	0.1	–	1.47E–07	2.22	–7.53	1.49E–08	4.23E–10	–	
KAV01	560.4	1.0	0.1	–	5.28E–06	2.23	–7.52	5.36E–07	4.23E–10	–	
KAV01	565.0	1.0	0.1	–	8.33E–08	2.23	–7.52	8.46E–09	4.23E–10	–	
KAV01	621.8	1.0	0.1	–	1.94E–08	2.46	–7.19	1.99E–09	1.85E–09	–	Uncertain
KAV01	651.3	1.0	0.1	–	1.67E–07	2.61	–6.93	1.73E–08	8.64E–09	–	

EXPLANATIONS

Header	Unit	Explanations
Borehole		ID for borehole
Secup	m	Length along the borehole for the upper limit of the test section (based on corrected length L)
Seclow	m	Length along the borehole for the lower limit of the test section (based on corrected length L)
L	m	Corrected length along borehole based on SKB procedures for length correction.
Length to flow anom.	m	Length along the borehole to inferred flow anomaly during overlapping flow logging
Test type (1–6)	(–)	1A: Pumping test – wire-line eq, 1B:Pumping test-submersible pump, 1C: Pumping test-airlift pumping, 2: Interference test, 3: Injection test, 4: Slug test, 5A: Difference flow logging -PFL-DIFF-Sequential, 5B: Difference flow logging -PFL-DIFF-Overlapping, 6: Flow logging-Impeller
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	^{o} 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	^{o} 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 100–1,000 (ml/h)	Number Of Fractures 1,000–1,0000 (ml/h)	Number Of Fractures 10,000–100,000 (ml/h)	Number Of Fractures 100,000–1,000,000 (ml/h)
727.26	732.26	0	0	0	0	0	0
722.26	727.26	0	0	0	0	0	0
717.26	722.26	0	0	0	0	0	0
712.26	717.26	0	0	0	0	0	0
707.26	712.26	0	0	0	0	0	0
702.26	707.26	0	0	0	0	0	0
697.27	702.27	0	0	0	0	0	0
692.27	697.27	0	0	0	0	0	0
687.28	692.28	0	0	0	0	0	0
682.28	687.28	0	0	0	0	0	0
677.29	682.29	0	0	0	0	0	0
672.29	677.29	0	0	0	0	0	0
667.30	672.30	0	0	0	0	0	0
662.30	667.30	0	0	0	0	0	0
657.31	662.31	0	0	0	0	0	0
652.31	657.31	0	0	0	0	0	0
647.29	652.29	1	0	1	0	0	0
642.26	647.26	0	0	0	0	0	0
637.24	642.24	0	0	0	0	0	0
632.21	637.21	0	0	0	0	0	0
627.19	632.19	0	0	0	0	0	0
622.17	627.17	0	0	0	0	0	0
617.16	622.16	1	1	0	0	0	0
612.15	617.15	0	0	0	0	0	0
607.14	612.14	0	0	0	0	0	0
602.14	607.14	0	0	0	0	0	0
597.13	602.13	0	0	0	0	0	0
592.12	597.12	0	0	0	0	0	0
587.11	592.11	0	0	0	0	0	0
582.10	587.10	0	0	0	0	0	0
577.10	582.10	0	0	0	0	0	0
572.09	577.09	0	0	0	0	0	0
567.08	572.08	0	0	0	0	0	0
562.07	567.07	1	0	1	0	0	0
557.06	562.06	2	0	1	0	1	0
552.05	557.05	2	0	1	0	0	0
547.03	552.03	2	1	0	1	0	0
542.01	547.01	1	1	0	0	0	0
536.99	541.99	3	1	2	0	0	0
531.98	536.98	1	0	1	0	0	0
526.95	531.95	5	0	0	3	2	0
521.93	526.93	1	1	0	0	0	0
516.91	521.91	2	2	0	0	0	0
511.90	516.90	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 100–1,000 (ml/h)	Number Of Fractures 1,000–10,000 (ml/h)	Number Of Fractures 10,000–100,000 (ml/h)	Number Of Fractures 100,000–1,000,000 (ml/h)
506.88	511.88	0	0	0	0	0	0
501.86	506.86	2	1	0	1	0	0
496.86	501.86	4	0	2	1	1	0
491.86	496.86	0	0	0	0	0	0
486.85	491.85	0	0	0	0	0	0
481.85	486.85	1	1	0	0	0	0
476.84	481.84	1	0	0	1	0	0
471.84	476.84	1	1	0	0	0	0
466.83	471.83	0	0	0	0	0	0
461.83	466.83	2	0	1	1	0	0
456.83	461.83	3	0	3	0	0	0
451.83	456.83	0	0	0	0	0	0
446.82	451.82	2	0	1	1	0	0
441.82	446.82	1	0	0	1	0	0
436.82	441.82	2	0	1	1	0	0
431.82	436.82	1	0	0	0	1	0
426.81	431.81	4	0	1	0	2	1
421.81	426.81	3	0	0	0	3	0
416.81	421.81	4	1	1	0	2	0
411.80	416.80	4	1	2	0	0	0
406.80	411.80	5	0	2	3	0	0
401.78	406.78	3	3	0	0	0	0
396.77	401.77	3	2	1	0	0	0
391.76	396.76	3	2	0	1	0	0
386.74	391.74	0	0	0	0	0	0
381.73	386.73	0	0	0	0	0	0
376.72	381.72	0	0	0	0	0	0
371.70	376.70	0	0	0	0	0	0
366.69	371.69	0	0	0	0	0	0
361.68	366.68	0	0	0	0	0	0
356.67	361.67	0	0	0	0	0	0
351.67	356.67	0	0	0	0	0	0
346.67	351.67	1	0	1	0	0	0
341.66	346.66	2	1	1	0	0	0
336.66	341.66	0	0	0	0	0	0
331.66	336.66	1	1	0	0	0	0
326.66	331.66	0	0	0	0	0	0
321.65	326.65	0	0	0	0	0	0
316.65	321.65	0	0	0	0	0	0
311.65	316.65	0	0	0	0	0	0
306.65	311.65	0	0	0	0	0	0
301.65	306.65	0	0	0	0	0	0
296.65	301.65	0	0	0	0	0	0
291.65	296.65	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 100–1,000 (ml/h)	Number Of Fractures 1,000–10,000 (ml/h)	Number Of Fractures 10,000–100,000 (ml/h)	Number Of Fractures 100,000–1,000,000 (ml/h)
286.65	291.65	1	1	0	0	0	0
281.65	286.65	1	0	1	0	0	0
276.65	281.65	2	2	0	0	0	0
271.65	276.65	0	0	0	0	0	0
266.65	271.65	2	1	1	0	0	0
261.65	266.65	1	1	0	0	0	0
256.65	261.65	1	0	1	0	0	0
251.64	256.64	1	0	0	1	0	0
246.63	251.63	1	0	1	0	0	0
241.62	246.62	4	0	2	2	0	0
236.61	241.61	2	1	1	0	0	0
231.60	236.60	2	1	0	1	0	0
226.58	231.58	4	1	2	1	0	0
221.57	226.57	2	0	1	0	0	0
216.56	221.56	4	0	3	0	1	0
211.55	216.55	5	0	2	3	0	0
206.54	211.54	5	1	4	0	0	0
201.54	206.54	0	0	0	0	0	0
196.54	201.54	1	1	0	0	0	0
191.54	196.54	4	1	1	2	0	0
186.54	191.54	1	0	0	0	1	0
181.54	186.54	2	2	0	0	0	0
176.54	181.54	2	1	0	1	0	0
171.54	176.54	5	0	2	3	0	0
166.54	171.54	4	1	2	1	0	0
161.55	166.55	2	1	1	0	0	0
156.55	161.55	4	2	2	0	0	0
151.55	156.55	1	0	1	0	0	0
146.54	151.54	2	2	0	0	0	0
141.53	146.53	2	1	1	0	0	0
136.52	141.52	3	0	1	1	1	0
131.51	136.51	3	0	1	2	0	0
126.51	131.51	4	0	2	2	0	0
121.50	126.50	0	0	0	0	0	0
116.49	121.49	3	2	0	1	0	0
111.48	116.48	3	1	2	0	0	0
106.47	111.47	3	1	2	0	0	0
101.46	106.46	1	1	0	0	0	0
96.45	101.45	1	0	1	0	0	0
91.44	96.44	0	0	0	0	0	0
86.43	91.43	1	1	0	0	0	0
81.42	86.42	4	0	2	1	1	0
76.41	81.41	6	1	1	3	0	1
71.40	76.40	5	0	0	2	2	0

Simpevarp, Borehole KAV01
Calculation of conductive fracture frequency