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Forsmark site investigation

Single-hole injection tests in borehole KFM03B

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November 2004

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Abstract

Borehole KFM03B is core-drilled within the site investigations in the Forsmark area. KFM03B, which is drilled adjacent to the c 1,000 m deep cored borehole KFM03A at drilling site DS3, is sub-vertical, about 100 m deep and cased to about 5 m depth. The borehole diameter is approximately 77 mm in the interval 5–100 m.

This report presents injection tests performed with the pipe string system PSS3 in borehole KFM03B and the test results.

The main aim of the injection tests in KFM03B was to characterize hydraulic conditions in the rock adjacent to the borehole regarding hydrogeological properties. Hydraulic parameters such as transmissivity, conductivity, dominating flow regime and possible outer hydraulic boundaries were determined using analysis methods for stationary as well as transient conditions.

The highest transmissivity was found in the section 62–67 m ($T = 2.1 \times 10^{-5}$ m^2/s). Other sections of increased transmissivity were 32–37 m ($T = 7.1 \times 10^{-6}$ m^2/s) and 37–42 m ($T = 8.0 \times 10^{-6}$ m^2/s). During most of the tests, a certain period with pseudo-radial flow could be identified from the injection period, making a standard transient evaluation possible. However, the recovery period for some tests was strongly affected by wellbore storage effects, making a unique transient evaluation of this period more difficult. In addition, the recovery periods from several borehole sections indicated pseudo-spherical or even pseudo-stationary flow regimes.

The injection tests provide a database for statistical analysis of the hydraulic conductivity distribution along the borehole. Basic statistical parameters are presented in this report.

Sammanfattning

Borrhål KFM03B är ett kärnborrhål som borrats inom platsundersökningarna i Forsmarksområdet. KFM03B, som ligger i anslutning till det ca 1 000 m djupa kärnborrhålet KFM03A, är sub-vertikalt, ca 100 m djupt och försett med foderrör till ca 5 m djup. Borrhålsdiametern är c:a 77 mm i intervallet 5–100 m.

Föreliggande rapport beskriver genomförda injektionstester med rörgångssystemet PSS3 i borrhål KFM03B samt resultaten från desamma.

Huvudsyftet med injektionstesterna var att karaktärisera berggrundsakviféren runt borrhålet med avseende på hydrogeologiska egenskaper. Hydrauliska parametrar såsom transmissivitet, konduktivitet, dominerande flödesregim och eventuella yttre hydrauliska randvillkor bestämdes med hjälp av analysmetoder för såväl stationära som transienta förhållanden.

Den högsta transmissiviteten fanns i sektionen 62–67 m ($T = 2.1 \times 10^{-5}$ m^2/s). Andra sektioner med förhöjd transmissivitet var 32–37 m ($T = 7.1 \times 10^{-6}$ m^2/s) och 37–42 m ($T = 8.0 \times 10^{-6}$ m^2/s). Under de flesta tester kunde en viss period med pseudo-radiellt flöde identifieras från injektionsperioden, vilket möjliggjorde en standardmässig transient utvärdering. Återhämtningsperioden för några tester var däremot starkt påverkad av brunnsmagasinseffekter, vilket gjorde en unik transient utvärdering av denna period svårare. Dessutom uppvisade flera av testernas återhämtningskurvor tecken på pseudo-sfäriskt och ibland pseudo-stationärt flöde.

Resultaten från injektionstesterna utgör en databas för statistisk analys av den hydrauliska konduktivitetens fördelning längs borrhålet. Viss statistisk analys har utförts inom ramen för denna aktivitet och grundläggande statistiska parametrar presenteras i rapporten.

Contents

1 Introduction

The injection tests in borehole KFM03B at Forsmark, Sweden, were carried out during July and August 2004 by Geosigma AB. The borehole KFM03B was core drilled within the on-going site investigation in the Forsmark area and is situated adjacent to the deep core drilled borehole KFM03A. KFM03B is sub-vertical, c 100 m deep and cased to c 5 m depth. The borehole diameter is c 77 mm in the interval 5.14–101.54 m. The location of the borehole is shown in Figure 1-1.

This document reports the results obtained from the injection tests in borehole KFM03B. The activity is performed within the Forsmark site investigation. The work was carried out in compliance with the SKB internal controlling documents, presented in Table 1-1. Data and results were delivered to the SKB site characterization database SICADA under field note no Forsmark 353.

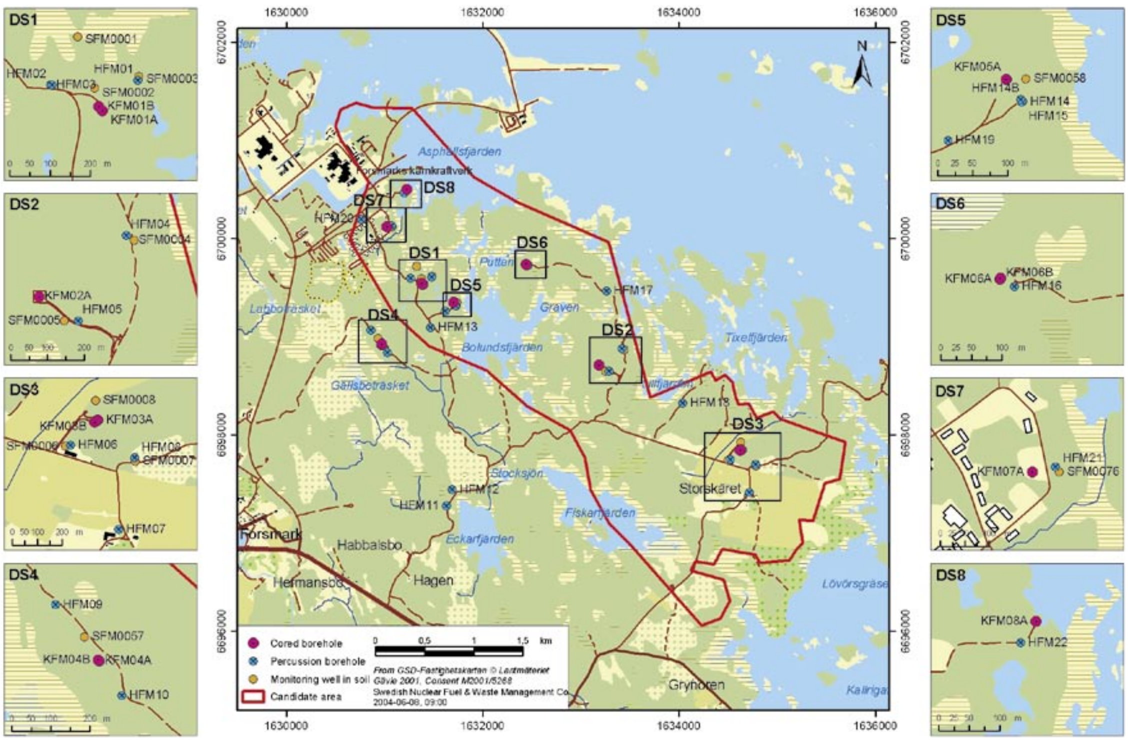


__Figure 1-1.__ The investigation area at Forsmark including the candidate area selected for more detailed investigations. Borehole KFM03B is situated at drilling site DS3.

Table 1-1. SKB internal controlling documents for performance of the activity.

Activity Plan	Number	Version
Hydraulic injection tests in borehole KFM03A with PSS3	AP PF 400-04-26	1.0
Method descriptions and instructions	**Number**	**Version**
Mätsystembeskrivning (MSB) – Allmän del. Pipe String System (PSS3).	SKB MD 345.100	1.0
Mätsystembeskrivning för: Kalibrering, PSS3.	SKB MD 345.122	1.0
Mätsystembeskrivning för: Skötsel, service, serviceprotokoll, PSS3.	SKB MD 345.124	1.0
Metodbeskrivning för hydrauliska injektionstester	SKB MD 323.001	1.0
Instruktion för analys av injektions- och enhålspumptester	SKB MD 320.004	1.0
Instruktion för rengöring av borrhåls-utrustning och viss markbaserad utrustning	SKB MD 600.004	1.0

2 Objectives

The main aim of the injection tests in borehole KFM03B was to characterize the hydraulic properties of the rock adjacent to the borehole. The primary parameter to be determined was hydraulic transmissivity from which hydraulic conductivity can be derived. The results of the injection tests provide a database which can be used for statistical analyses of the hydraulic conductivity distribution along the borehole. Basic statistical analyses are presented in this report.

Other hydraulic parameters of interest were flow regimes and outer hydraulic boundaries. These parameters were analysed using transient evaluation of the test responses during the injection- and recovery periods.

3 Scope

3.1 Boreholes

Technical data of the tested borehole are shown in Table 3-1 and in Appendix 4. The reference point of the boreholes is defined as the centre of top of casing (ToC), given as "Elevation" in the table below. The Swedish National coordinate system (RT90) is used for the horizontal coordinates together with RHB70 for the elevation. "Northing" and "Easting" refer to the top of the boreholes.

Table 3-1. Technical data of the borehole KFM03B (printout from SKB database, SICADA).

Borehole length (m)	**101.540**				
Drilling period	**From date**	**To date**	**Secup (m)**	**Seclow (m)**	**Drilling type**
	2003-06-29	2003-07-02	0.000	101.540	Core drilling
Starting point coordinate	**Length (m)**	**Northing (m)**	**Easting (m)**	**Elevation**	**Coord system**
	0.000	6697844.200	1634618.681	8.468	RT90-RHB70
Angles	**Length (m)**	**Bearing**	**Inclination (– = down)**		
	0.000	264.486	–85.303		
Borehole diameter	**Secup (m)**	**Seclow (m)**	**Hole diam (m)**		
	0.000	0.780	0.116		
	0.780	5.000	0.101		
	5.000	5.140	0.086		
	5.140	101.540	0.077		
Core diameter	**Secup (m)**	**Seclow (m)**	**Core diam (m)**		
	0.780	5.140	0.072		
	5.140	101.540	0.051		
Casing diameter	**Secup (m)**	**Seclow (m)**	**Case in (m)**	**Case out (m)**	
	0.000	5.150	0.078	0.090	

3.2 Tests performed

The injection tests in borehole KFM03B, performed according to Activity Plan AP PF 400-04-64 (SKB internal controlling document) are listed in Table 3-2. The injection tests were carried out with the Pipe String System (PSS3). The test procedure, together with the equipment, is described in the measurement system description for PSS (SKB MD 345.100, SKB internal controlling document) and in the corresponding method descriptions for hydraulic injection tests (SKB MD 323.001 Metodbeskrivning för

Hydrauliska injektionstester, SKB internal controlling document). In some of the test sections, the test was not performed as intended because the time required for achieving constant head in the test section was too long, or due to that equipment malfunctions caused pressure and/or flow rate disturbances. Whenever such disturbances were expected to affect data evaluation, the test was repeated. Test number (Test no in Table 3-2) refers to the number of tests performed in the actual section. For evaluation, data from the last test in each test section were used.

Table 3-2. Single-hole injection tests performed in borehole KFM03B.

Bore hole	Test section		Section length	Test type[1)]	Test no	Test start date, time	Test stop date, time
Bh ID	secup	seclow		(1–6)		YYYYMMDD hh:mm	YYYYMMDD hh:mm
KFM03B	7.00	12.00	5	3	2	20040802 10:48	20040802 13:39
KFM03B	12.00	17.00	5	3	1	20040712 11:41	20040712 14:09
KFM03B	17.00	22.00	5	3	2	20040721 14:25	20040721 16:00
KFM03B	22.00	27.00	5	3	1	20040712 16:30	20040712 18:01
KFM03B	27.00	32.00	5	3	1	20040713 09:04	20040713 10:35
KFM03B	32.00	37.00	5	3	1	20040713 11:41	20040713 12:34
KFM03B	37.00	42.00	5	3	1	20040713 13:18	20040713 14:55
KFM03B	42.00	47.00	5	3	1	20040713 15:14	20040713 16:40
KFM03B	47.00	52.00	5	3	1	20040713 16:57	20040713 18:24
KFM03B	52.00	57.00	5	3	1	20040714 08:33	20040714 09:59
KFM03B	57.00	62.00	5	3	1	20040714 10:19	20040714 11:50
KFM03B	62.00	67.00	5	3	1	20040714 12:00	20040714 14:02
KFM03B	67.00	72.00	5	3	1	20040714 14:14	20040714 15:11
KFM03B	72.00	77.00	5	3	1	20040714 15:24	20040714 16:50
KFM03B	77.00	82.00	5	3	2	20040721 11:42	20040721 13:11
KFM03B	82.00	87.00	5	3	1	20040716 11:16	20040716 12:47
KFM03B	87.00	92.00	5	3	1	20040716 13:04	20040716 15:05
KFM03B [2)]	92.00	97.00	5	3	1	20040716 15:18	20040716 15:39

[1)] 3: Injection test.

[2)] No injection was performed. Risk of packer failure due to pressure increase below test section.

3.3 Equipment checks

The PSS3 equipment was fully serviced, according to SKB internal controlling documents (SKB MD 345.124, service, and SKB MD 345.122, calibration), in February 2004. Some service and calibration was also made in April 2004.

Functioning checks were performed during the installation of the PSS equipment at the test site. In order to check the function of the pressure sensors, the air pressure was recorded and found to be as expected. While lowering, the sensors showed good agreement with the total head of water (p/ρg). The temperature sensor displayed expected values in both air and water.

Simple functioning checks of down-hole sensors were done at every change of test section interval. Checks were also done continuously while lowering the pipe string along the borehole.

4 Description of equipment

4.1 Overview

4.1.1 Measurement container

All of the equipment needed to perform the injection tests is located in a steel container (Figure 4-1). The container is divided into two compartments; a data-room and workshop. The container is placed on pallets in order to obtain a suitable working level in relation to the borehole casing.

The hoisting rig is of a hydraulic chain-feed type. The jaws, holding the pipe string, are opened hydraulically and closed mechanically by springs. The rig is equipped with a load transmitter and the load limit may be adjusted. The maximum load is 22 kN.

The packers and the test valve are operated hydraulically by water filled pressure vessels. Expansion and release of packers, as well as opening and closing of the test valve, is done using magnetic valves controlled by the software in the data acquisition system.

The injection system consists of a tank, a pump and a flow meter. The injection flow rate may be manually or automatically controlled. At small flow rates, a water filled pressure vessel connected to a nitrogen gas regulator is used instead of the pump.

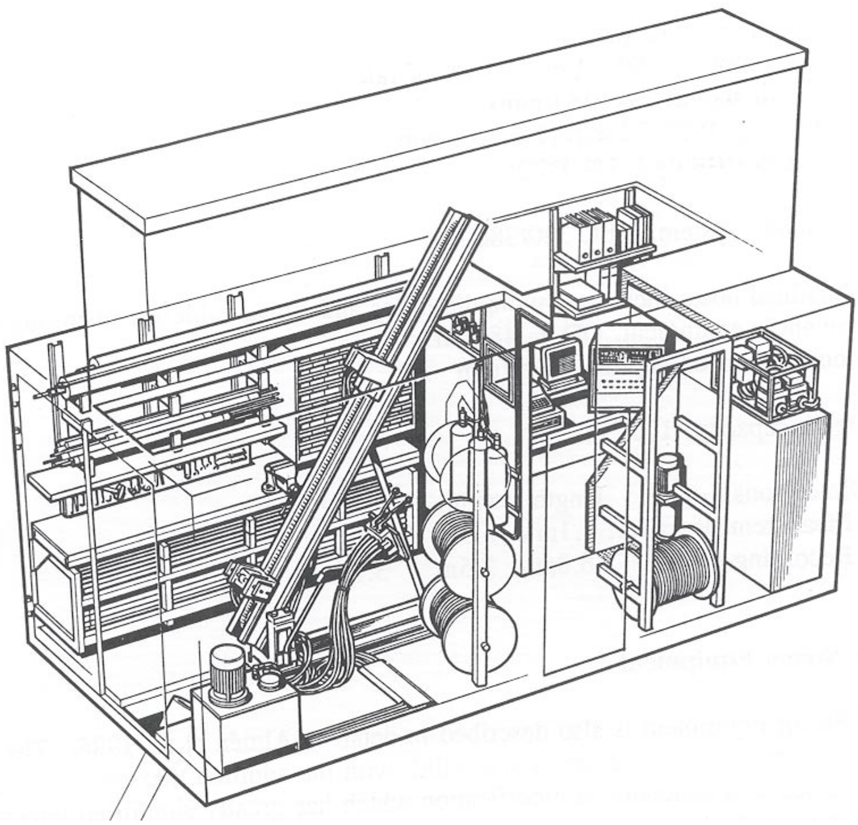


Figure 4-1. *Outline of the PSS3 container with equipment.*

4.1.2 Down-hole equipment

A schematic drawing of the down-hole equipment is shown in Figure 4-2. The pipe string consists of aluminium pipes of 3 m length, connected by stainless steel taps sealed with double o-rings. Pressure is measured above (Pa), within (P) and below (Pb) the test section, which is isolated by two packers. The groundwater temperature in the test section is also measured. The hydraulic connection between the pipe string and the test section can be closed or opened by a test valve operated by the measurement system.

At the lower end of the borehole equipment, a level indicator (caliper type) gives a signal as the reference depth marks along the borehole are passed.

The length of the test section may be varied (5, 20 or 100 metres).

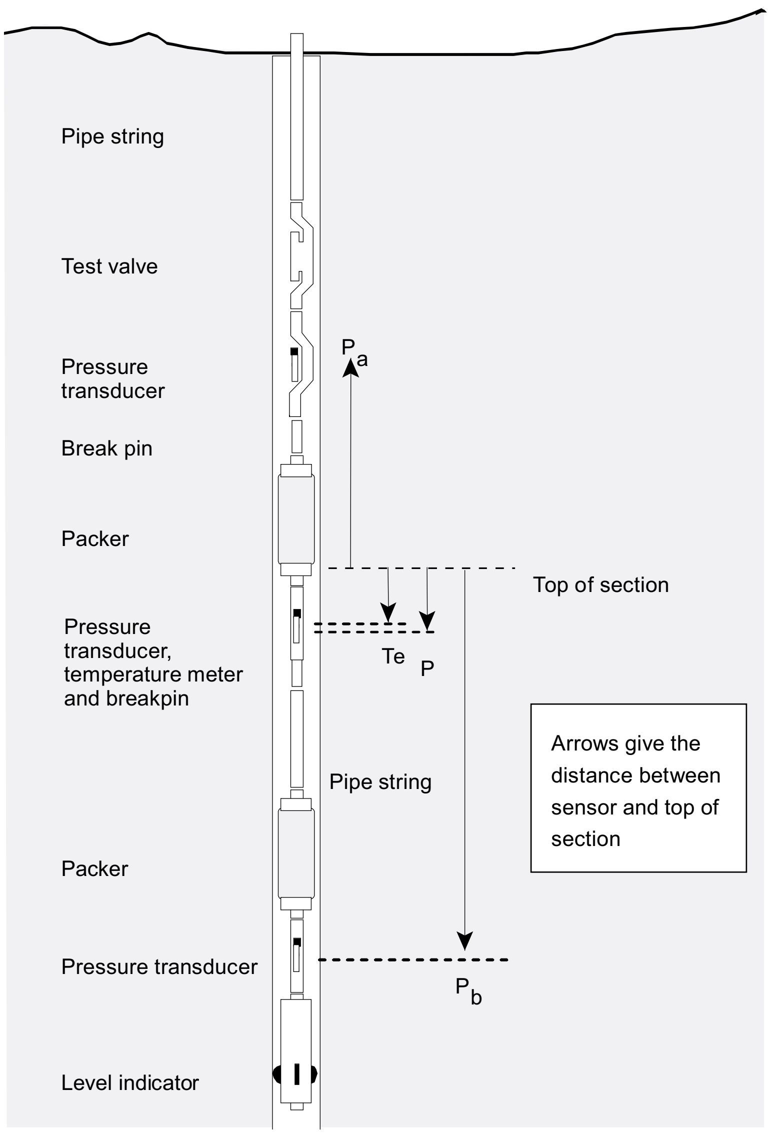


Figure 4-2. Schematic drawing of the down-hole equipment in the PSS3 system.

4.2 Measurement sensors

Technical data for the measurement sensors in the PSS system together with corresponding data of the system are shown in Table 4-1.

Table 4-1. Technical data for sensors together with estimated data for the PSS system (based on current experience).

Technical specification					
Parameter		**Unit**	**Sensor**	**PSS**	**Comments**
Absolute pressure	Output signal	mA	4–20		
	Meas range	MPa	0–13.5		
	Resolution	kPa	< 1.0		
	Accuracy[1)]	% F S	0.1		
Differential pressure, 200 kPa	Accuracy	kPa		< ± 5	Estimated value
Temperature	Output signal	mA	4–20		
	Meas range	°C	0–32		
	Resolution	°C	< 0.01		
	Accuracy	°C	± 0.1		
Flow Qbig	Output signal	mA	4–20		
	Meas range	m^3/s	1.67×10^{-5}–1.67×10^{-3}		
	Resolution	m^3/s	6.7×10^{-8}		
	Accuracy[2)]	% O R	0.15–3	0.2–1	The specific accuracy is depending on actual flow
Flow Qsmall	Output signal	mA	4–20		
	Meas range	m^3/s	1.67×10^{-8}–1.67×10^{-5}		
	Resolution	m^3/s	6.7×10^{-10}		
	Accuracy[2)]	% O R	0.4–10	0.4–20	The specific accuracy is depending on actual flow

[1)] 0.1% of Full Scale. Includes hysteresis, linearity and repeatability.

[2)] Maximum error in % of actual reading (% o r). The higher numbers correspond to the lower flow.

The sensor positions are fixed relative to the top of the test section. In Table 4-2, the position of the sensors is given with top of test section as reference (Figure 4-2).

Table 4-2. Position of sensors in the borehole and displacement volume of equipment in the test section.

Parameter	**Length of test section (m)**
	5
Equipment displacement volume in test section [1)]	3
Total volume of test section [2)]	23
Position for sensor P_a, pressure above test section, (m above secup) [3)]	1.88
Position for sensor P, pressure in test section, (m above secup) [3)]	–3.54
Position for sensor T_{sec}, Temperature in test section, (m above secup) [3)]	–4.10
Position for sensor P_b, pressure below test section, (m above secup) [3)]	–7.00

[1)] Displacement volume in test section due to pipe string, signal cable and packer ends (in litre).

[2)] Total volume of test section (V = section length*π*d²/4).

[3)] Position of sensor relative top of test section. A negative value indicates a position below top of test section, (secup).

4.3 Data acquisition system

The data acquisition system in the PSS equipment contains a standard office PC connected to an I/O-unit (Datascan 7320). Using the Orchestrator software, pumping and injection tests are monitored and borehole sensor data are collected. In addition to the borehole parameters, packer and atmospheric pressure, container air temperature and water temperature are logged. Test evaluation may be performed on-site after a conducted test. An external display enables monitoring of test parameters.

The data acquisition system may be used to start and stop the automatic control system (computer and servo motors). These are connected as shown in Figure 4-3. The control system monitors the flow regulator and uses differential pressure across the regulating valve together with pressure in test section as input signals.

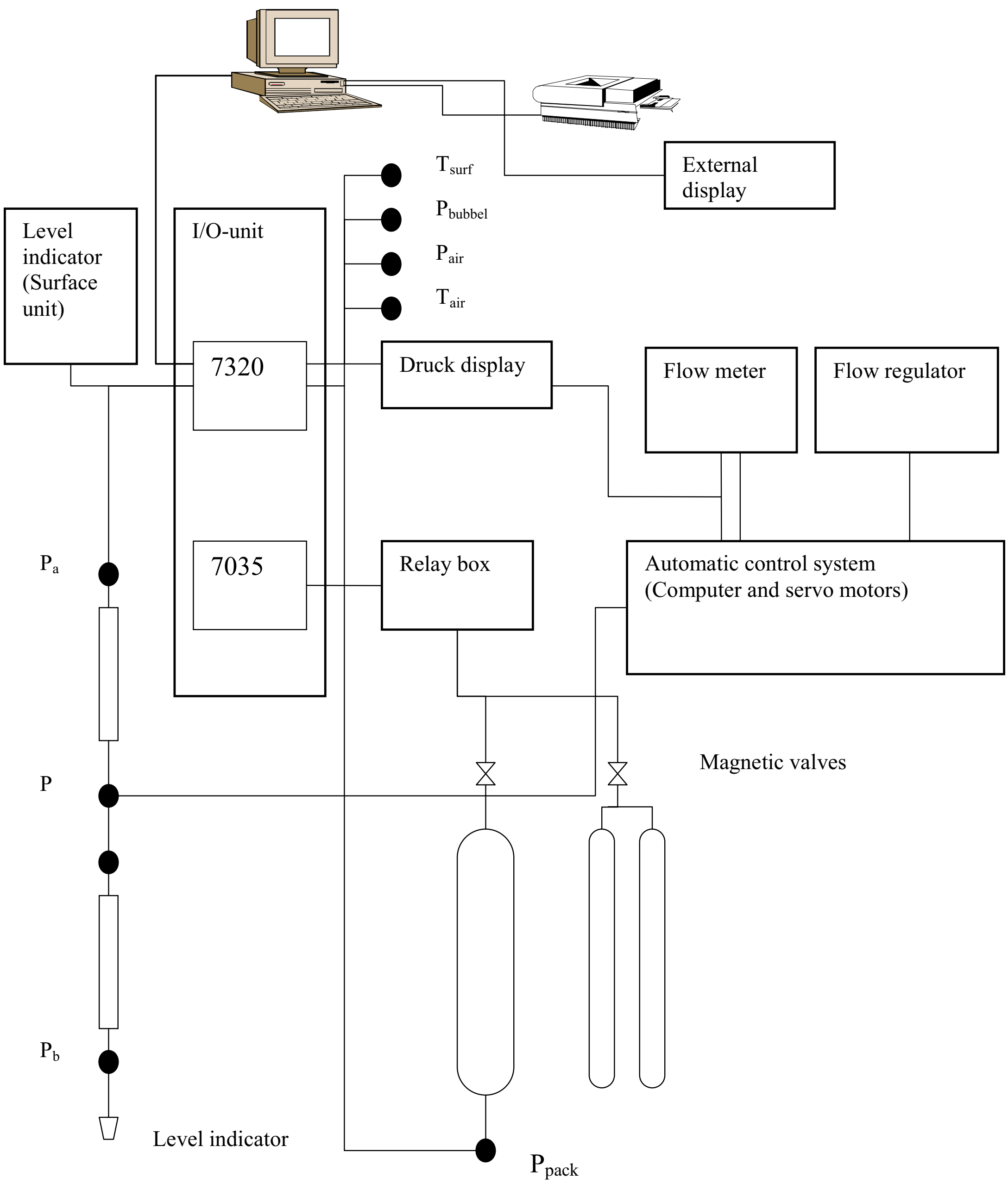


Figure 4-3. *Schematic drawing of the data acquisition system and the automatic control system in PSS.*

5 Execution

5.1 Preparation

5.1.1 Calibration

All sensors included in PSS are calibrated at the Geosigma engineering service station in Uppsala. Calibration is generally performed prior to each measurement campaign. Results from calibration, e.g. calibration constants, of sensors are kept in a document folder in PSS. If a sensor is replaced at the test site, calibration constants are altered as well. If a new, un-calibrated, sensor is to be used, calibration may be performed afterwards and data re-calculated.

5.1.2 Functioning checks

Equipment functioning checks were performed during the establishment of PSS at the test site. Simple function checks of down-hole sensors were done at every change of test section length, as well as while lowering the pipe string along the borehole.

5.1.3 Cleaning of equipment

Cleaning of the borehole equipmentis performed according to the cleaning instruction (SKB MD 600.004, Instruktion för rengöring av borrhålsutrustning och viss markbaserad utrustning), level 1.

5.2 Test performance

5.2.1 Test principle

The injection tests in KFM03B were generally carried out while maintaining a constant head of 200 kPa (20 m) in the test section. Before start of the injection period, approximately steady-state pressure conditions prevailed in the test section. After the injection period, the pressure recovery was measured.

For injection tests, the injection phase was interrupted if the injection flow was apparently below the measurement limit. Thereafter, the recovery was measured for at least 5 minutes to verify the low conductivity of the section.

5.2.2 Test procedure

Generally, the tests were performed according to the Activity Plan AP PF 400-04-64. Exceptions to this are presented in Section 5.5.

A test cycle includes the following phases: 1) Transfer of down-hole equipment to the next section, 2) Packer inflation, 3) Pressure stabilisation, 4) Injection, 5) Pressure recovery and 6) Packer deflation. The estimated time for each phase is presented in Table 5-1.

Table 5-1. Packer inflation time, pressure stabilisation time and test time used for the injection tests in KFM03B.

Test section length (m)	Packer inflation time (min)	Time for pressure stabilisation (min)	Injection period (min)	Recovery period (min)	Total time/test (min)[1)]
5	25	5	20	20	70

[1)] Exclusive of trip times in the borehole

5.3 Data handling

With the PSS system, primary data are handled using the Orchestrator software (Version 2.3.8). During a test, data are continuously logged in *.odl-files. After the test is finished, a report file (*.ht2) with space separated data is generated. The *.ht2-file (mio-format) contains logged parameters as well as test-specific information, such as calibration constants and background data. The parameters are presented as percentage of sensor measurement range and not in engineering units. The report file in ASCII-format is the raw data file delivered to the data base SICADA.

The *.ht2-files are automatically named with borehole id, top of test section and date and time of test start (as for example __KFM03B_0012.00_200407121141.ht2). The name differs slightly from the convention stated in Instructions for analysis of injection and single-borehole pump test, SKB MD 320.004.

Using the IPPLOT software (Version 2.0), the *.ht2-files are converted to parameter files suitable for plotting using the code SKB-plot and analysis with the AQTESOLV software.

A backup of data files was created on a regular basis by CD-storage and by sending the files to the Geosigma office in Uppsala by a file transfer protocol. A file description table is presented in Appendix 1.

5.4 Analyses and interpretation

5.4.1 Single-hole injection tests

As descibed in Section 5.2.1, the injection tests in KFM03B were performed as transient constant head tests followed by a pressure recovery period. The routine data processing of the measured data was done according to the Instruction for analysis of injection- and single-hole pumping tests (SKB MD 320.004). From the injection period, the (reciprocal) flow rate versus time was plotted in log-log and lin-log diagrams together with the corresponding derivative. From the recovery period, the pressure and pressure change were plotted versus Agarwal equivalent time in lin-log and log-log diagrams, respectively, together with the corresponding derivatives.

Initially, a qualitative evaluation of actual flow regimes, e.g. wellbore storage (WBS), pseudo-radial flow regime (PRF), pseudo-spherical flow regime (PSF) and pseudo-stationary flow regime (PSS), respectively, was performed. In addition, indications of outer boundary conditions during the tests were identified. The qualitative evaluation was mainly made from the log-log diagrams of the responses during the flow and recovery periods. In particular, time intervals with pseudo-radial flow, reflected by a constant (horizontal) derivative in the test diagrams, were identified. Apparent no-flow (NFB) and constant head boundaries (CHB) or equivalent boundary conditions of fractures are reflected by an increase/decrease of the derivative. In addition, a preliminary steady-state analysis of transmissivity according to Moye's formula (denoted T_M) was made for the injection period for all tests.

From the results of the qualitative evaluation, appropriate interpretation methods for the quantitative evaluation of the tests were selected. If possible, transient analysis was made on both the flow and recovery periods of the tests. Several of the responses during the recovery period were strongly influenced by wellbore storage effects. In addition, for some tests, the recovery period only indicated pseudo-stationary flow. Thus, for approximately half or the tests pseudo-radial flow was not reached during this period. On the other hand, during the injection period, a certain time interval with pseudo-radial flow could, in most tests, be identified. Consequently, standard methods for single-hole tests with wellbore storage and skin effects were used for routine evaluation of the tests.

The transient analysis was performed using a special version of the test analysis software AQTESOLV, which enables both visual and automatic type curve matching. The quantitative transient evaluation is generally carried out as an iterative process of manual type curve matching and automatic matching. For the injection period, a model presented by Hurst, Clark and Brauer, 1969 /1/ is used for estimating transmissivity and skin factor. The storativity was set to a fixed value of 10^{-6}, according to the instruction SKB MD 320.004. The model uses the effective wellbore radius concept to account for non-zero skin factors.

For evaluating transient recovery data, the Dougherty-Babu, 1984 /2/ model was applied. This model also uses the effective wellbore radius concept to account for non-zero skin factors. The wellbore storage is treated as the water level change in a fictive stand pipe connected to the section. The wellbore storage can be calculated from the fictive radius of this pipe, denoted casing radius in AQTESOLV, see below. The nomenclature used in AQTESOLV is listed in Appendix 3. The model was used to estimate values of transmissivity, skin factor and the wellbore storage coefficient (represented by the fictive casing radius r(c)), cf Equation 5-2.

The different transient estimates of transmissivity, in general from the pseudo-radial flow regimes during flow and recovery period, respectively, were compared and examined. One of these was chosen as the best representative value of transient transmissivity of the formation adjacent to the test section. This value is denoted T_T. In cases with more than one pseudo-radial flow regime during the injection- or recovery period, the first one is assumed to be the most representative for the hydraulic conditions in the rock close to the tested section. In most cases, the transient estimates of transmissivity from the injection period were considered more representative than those from the recovery period. The recovery responses were sometimes strongly affected by wellbore storage and often no pseudo-radial flow regime was observed. In addition, pseudo-stationary flow sometimes occurred during the recovery period.

Finally, a representative value of transmissivity of the section, T_R, was chosen from T_T and T_M. For tests approaching a pseudo-spherical or pseudo-stationary flow by the end of the test, the steady-state evaluation (T_M) was in some cases considered the best estimate of transmissivity, (i.e. $T_R = T_M$). Whenever the flow rate by the end of the injection period (Q_p) was not defined, and thus neither T_T nor T_M could be estimated, the most representative value of transmissivity for the test section was considered to be the estimated lower measurement limit for Q/s (i.e. T_R = Q/s-measl-L).

Estimated values of the borehole storage coefficient, C, based on actual borehole geometrical data and assumed fluid properties are shown in Table 5-2. The net water volume in the test section, V_w, has in Table 5-2 been calculated by subtracting the volume of equipment in the test section (pipes and thin hoses) from the total volume of the test section. For an isolated test section, the wellbore storage coefficient, C, may be calculated as /3/:

$$C = V_w \times c_w = L_w \times \pi \times r_w^2 \times c_w \qquad (5\text{-}1)$$

V_w = water volume in test section (m^3)

r_w = nominal borehole radius (m)

L_w = section length (m)

c_w = compressibility of water (Pa^{-1})

Table 5-2. Calculated net values of the wellbore storage coefficient C for injection tests with 5 m section length, based on the actual geometrical properties of the borehole and equipment configuration in the test section.

Borehole	r_w (m)	L_w (m)	Volume of test section (m^3)	Volume of equipment in section (m^3)	V_w (m^3)	C (m^3/Pa)
KFM03B	0.0385	5	0.023	0.003	0.020	9.3×10^{-12}

When appropriate, estimation of the actual borehole storage coefficient, C, in the test sections was also made from the recovery period, based on the early borehole response with 1:1 slope in the log-log diagrams. The coefficient C was calculated only for tests with a well-defined line of slope 1:1 in the beginning of the recovery period. In the most conductive sections, this period occurred during very short periods at early test times. The latter values may be compared with the net values of C based on geometry (Table 5-2).

Furthermore, when using the model by Dougherty-Babu, 1984 /2/, a fictive casing radius, r(c), is obtained from the parameter estimation. This value can then be used for calculating C as /3/:

$$C = \frac{\pi \cdot r(c)^2}{\rho \cdot g} \qquad (5\text{-}2)$$

Although this calculation was not done regularly and the results are not presented in this report, the calculations corresponded in most cases well to the value of C obtained from the line of slope 1:1 in the beginning of the recovery period.

The estimated values of C from the tests may differ from the net values in Table 5-2 based on geometry. For example, the effective compressibility for an isolated test section may sometimes be higher than the water compressibility due to e.g. packer compliance, resulting in increased C-values.

5.5 Nonconformities

The test program in KFM03B was carried out according to the Activity Plan AP PF 400-04-64, with the following exception:

- The temperature sensor in the injection water at the ground surface was out of order during most injection tests in KFM03B.

6 Results

6.1 Nomenclature and symbols

The nomenclature and symbols used for the results of the injection tests in KFM03B are in accordance with the Instruction for analysis of injection and single-hole pumping tests (SKB MD 320.004). Additional symbols used are explained in the text and in Appendix 5. Symbols used by the AQTESOLV software are explained in Appendix 3.

6.2 Routine evaluation of the single-hole injection tests

6.2.1 General test data

General test data with selected pressure and flow data from all tests are listed in Appendix 2.1 and 2.2, respectively.

6.2.2 Measurement limit for flow rate and specific flow rate

The estimated standard lower measurement limit for the flow rate for injection tests with PSS is c 1 mL/min (1.7×10^{-8} m^3/s). However, if the flow rate for a test was close to, or below, the standard lower measurement limit, a test-specific estimate of the lower measurement limit was used. The test-specific lower limit was based on the measurement noise before and after the injection period. The decisive factor for the varying lower measurement limit is not identified but it might be of both technical and hydraulic character. For two of the injections tests in KFM03B, the actual lower measurement limit of the flow rate was estimated and ranged from 6×10^{-9} m^3/s to 1.7×10^{-8} m^3/s.

The lower measurement limit for transmissivity is defined in terms of the specific flow rate (Q/s). The minimum specific flow rate corresponds to the estimated lower measurement limit for the flow rate together with the actual injection pressure during the test, see Table 6-1. The intention during this test campaign was to use a standard injection pressure of 200 kPa (20 m water column). However, for some test sections, the actual injection pressure was considerably different. A higher injection pressure is often a result of the test section being of low hydraulic conductivity. However, only one of the tests was carried out with an injection pressure above 300 kPa. A low injection pressure is often due to a highly conductive section, which was the case for one of the tests in KFM03B. A test section of low conductivity may also entail in a low injection pressure due to pressure increase, caused by packer expansion, before the injection start. The estimated lower measurement limit for the specific flow rate in KFM03B ranged from 2.0×10^{-10} m^2/s to 8.2×10^{-10} m^2/s, except for the test in the most conductive section which had a considerably higher limit (1.6×10^{-9} m^2/s) due to a low injection pressure (~ 102 kPa).

When the final flow rate (Q_p) was not defined (i.e. not clearly above the measurement noise before and after the injection period), the estimated lower measurement limit for specific flow rate was based on the estimated lower measurement limit for the specific test and a standard injection pressure of 20 m. This is done in order to avoid excessively high estimates of the specific flow rate for these low conductivity sections, which would have been the result if the actual injection pressure had been used (since the actual pressure sometimes was significantly less than 20 m, see above).

The lower measurement limits for the flow rate correspond to different values of steady-state transmissivity, T_M, depending on the section lengths used in the factor C in Moye's formula, as described in the Instruction for analysis of injection and single-hole pumping tests (SKB MD 320.004). In this case, only 5 m section length was applied, see Table 6-1.

Table 6-1. Estimated lower measurement limit for specific capacity Q/s and steady-state transmissivity for different injection pressures and estimated lower measurement limits for flow rate for the injection tests in borehole KFM03B.

Borehole	r_w (m)	L_w (m)	Q-measl-L (m^3/s)	Injection pressure (kPa)	Q/s-measl-L (m^2/s)	Factor C in Moye's formula	T_M-measl-L (m^2/s)
KFM03B	0.0385	5	1.7E–08	100	1.6E–09	0.82	1.3E–09
KFM03B	0.0385	5	1.7E–08	200	8.2E–10	0.82	6.7E–10
KFM03B	0.0385	5	1.7E–08	300	5.5E–10	0.82	4.5E–10
KFM03B	0.0385	5	1.2E–08	100	1.1E–09	0.82	9.4E–10
KFM03B	0.0385	5	1.2E–08	200	5.7E–10	0.82	4.7E–10
KFM03B	0.0385	5	1.2E–08	300	3.8E–10	0.82	3.1E–10
KFM03B	0.0385	5	5.0E–09	100	4.9E–10	0.82	4.0E–10
KFM03B	0.0385	5	5.0E–09	200	2.5E–10	0.82	2.0E–10
KFM03B	0.0385	5	5.0E–09	300	1.6E–10	0.82	1.3E–10

6.2.3 Length correction

No reference marks are milled into the borehole wall of KFM03B and therefore no length corrections are performed.

6.2.4 General results

A summary of the results of the routine evaluation of the injection tests in KFM03B is presented, test by test, in Table 6-2. Selected test diagrams are presented in Appendix 3. In general, one linear diagram showing the entire test sequence together with lin-log and log-log diagrams from the injection- and recovery periods, respectively, are presented. The quantitative analysis was performed from such diagrams using the AQTESOLV software. From tests with a flow rate below the estimated lower measurement limit for the specific test, only the linear diagram is presented.

The dominating transient flow regimes during the injection and recovery periods, respectively, as interpreted from the qualitative test evaluation, are listed in Table 6-2 and further commented on in Section 6.2.5.

For tests showing only wellbore storage and tests approaching pseudo-stationary flow, no unique transient evaluation is possible. In such cases, no type curve matching was done.

In the quantitative evaluation, the steady-state transmissivity (T_M) was calculated by Moye's formula. Transient evaluation was conducted, whenever possible, both on the injection- and recovery periods (T_f and T_s, respectively). Transient evaluation was performed for all tests for which a significant flow rate, Q_p, could be identified, see Section 6.2.2.

The value judged as the most reliable from the transient evaluation of the tests was selected as T_T. The associated value for the skin factor is listed in Table 6-2. Since a fairly well-defined time interval with pseudo-radial flow in most cases could be identified from the injection period, the transmissivity calculated from this period is in most cases considered as the most reliable transient analysis for the injection tests in KFM03B. In addition, the transient evaluation of transmissivity from the injection period was for most of the tests also judged to be the most representative estimate of transmissivity, T_R. The approximate start and stop times used for the transient evaluation are also listed in Table 6-2. For those tests where transient evaluation was not possible or not considered as representative, T_M was chosen as the representative transmissivity value, T_R. If Q_p was below the actual estimated measurement limit, the representative transmissivity value, T_R, was assumed to be less than the estimated Q/s-measl-L, see Section 6.2.2.

In some cases, two transmissivity values could be calculated from the tests, at early and at later times, respectively. It is then assumed that the first transmissivity value represents a region close to the borehole, whereas the later value may represent a larger volume of the rock.

The results of the routine evaluation of the injection tests in borehole KFM03B are also compiled in appropriate tables in Appendix 5, to be stored in the SICADA database.

For the evaluation of the test data, no corrections of the measured flow rate and absolute pressure data (e.g. due to barometric pressure variations or tidal fluctuations) have been made. For short-time single-hole tests, such corrections are generally not needed, unless very small pressure changes are applied. No subtraction of the barometric pressure from the measured absolute pressure has been made, since the length of the test periods are short relative to the time scale for barometric pressure changes. In addition, pressure differences rather than the pressure magnitudes are used by the evaluation.

Drilling records were checked in order to identify possible interference with test data from drilling in nearby boreholes. These records showed that drilling of KFM06A was in progress during the last injection test in KFM03B. However, the injection test is assumed to be unaffected by this activity due to the long distance between the boreholes.

In Figure 6-1, a comparison of calculated transmissivities in 5 m sections from steady-state evaluation (T_M) and transmissivity values from the transient evaluation (T_T) is shown. The agreement between the two populations is considered good. The lower measurement limit of transmissivity in 5 m sections for a flow rate of 1 mL/min and an injection pressure of 200 kPa is indicated in the figure.

The wellbore storage coefficient, C, was calculated from the straight line with a unit slope in the log-log diagrams from the recovery period, see Table 6-3. The coefficient C was only calculated for tests with a well-defined line of unit slope in the beginning of the recovery period. In the most conductive sections, this period occurred during very short intervals at very early times and is not visible in the diagrams. In sections with a very low transmissivity, the estimates of C may be uncertain due to difficulties in defining an accurate time for the start of the recovery period. The values of C presented in Table 6-2 may be compared with the net value of C in Table 5-2 (based on geometry).

The number of tests with a well defined line of unit slope for which it was possible to calculate C was 6 out of 16. Table 6-2 shows that there is, in general, a good agreement between the calculated C values from the tests and the value listed in Table 5-2, although the calculated values from the tests tend to be higher. When constructing 95% confidence intervals (using a t-distribution), the value of C listed in Table 5-2 is lower than the lower confidence interval limit for the tests.

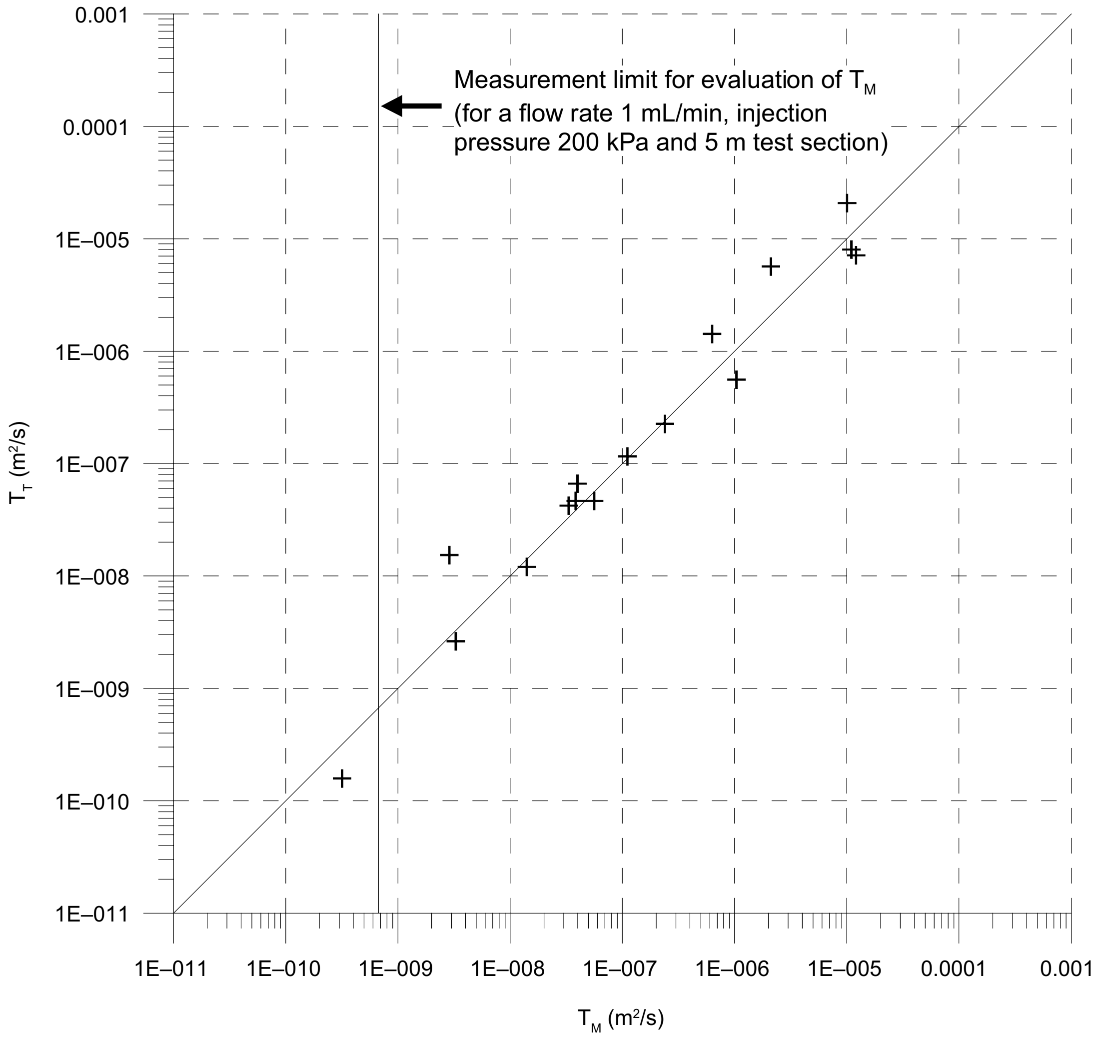


Figure 6-1. *Estimated transmissivities in 5 m sections from steady-state (T_M) and transient (T_T) evaluation.*

Table 6-2. Summary of the routine evaluation of the single-hole injection tests in borehole KFM03B.

Secup	Seclow	Test start	b	Flow regime [1]		Q/s-measl-L	Q/s	T_M	T_f	T_s	T_T	T_R [2]	ξ	dt_1	dt_2	C
(m)	(m)	YYYYMMDD hh:mm	(m)	Injection	Recovery	(m^2/s)	(m^2/s)	(m^2/s)	(m^2/s)	(m^2/s)	(m^2/s)	(m^2/s)	(–)	(s)	(s)	(m^3/Pa)
7.00	12.00	20040802 10:48	5.00	PRF	PRF	7.1E–10	1.26E–06	1.04E–06	3.31E–07	5.57E–07	5.57E–07	5.57E–07	–4.4	10	700	
12.00	17.00	20040712 11:41	5.00	PRF1 –> PRF2	PRF1 –> PRF2	8.1E–10	1.71E–08	1.40E–08	1.20E–08	2.01E–08	1.20E–08	1.20E–08	–1.0	80	500	4.45E–11
17.00	22.00	20040721 14:25	5.00	PRF –> NFB	WBS –> PRF?	6.8E–10	3.49E–09	2.87E–09	1.53E–08	1.49E–08	1.53E–08	1.53E–08	0.0	10	40	2.92E–11
22.00	27.00	20040712 16:30	5.00	PRF	PRF?	8.2E–10	6.83E–08	5.62E–08	4.64E–08	3.21E–07	4.64E–08	4.64E–08	–1.6	130	1,200	8.34E–11
27.00	32.00	20040713 09:04	5.00	PRF	PRF/PSF –> PSS	8.1E–10	4.03E–08	3.32E–08	4.21E–08	9.20E–08	4.21E–08	4.21E–08	0.7	150	1,200	5.61E–11
32.00	37.00	20040713 11:41	5.00	PRF –> PSF	PSF	8.0E–10	1.47E–05	1.21E–05	7.12E–06	4.49E–05	7.12E–06	7.12E–06	–4.1	20	70	
37.00	42.00	20040713 13:18	5.00	PRF –> PSF	PSF	7.7E–10	1.33E–05	1.10E–05	7.99E–06	2.91E–05	7.99E–06	7.99E–06	–3.9	20	200	
42.00	47.00	20040713 15:14	5.00	PRF	PSF/PSS	8.1E–10	2.90E–07	2.39E–07	2.25E–07	–	2.25E–07	2.25E–07	–1.7	50	1,200	
47.00	52.00	20040713 16:57	5.00	PSF	PSF	6.9E–10	2.56E–06	2.11E–06	5.66E–06	7.36E–06	5.66E–06	2.11E–06	5.6	400	1,200	
52.00	57.00	20040714 08:33	5.00	PRF	PRF –> PSF/ PSS	8.2E–10	7.65E–07	6.30E–07	1.42E–06	1.60E–06	1.42E–06	1.42E–06	4.2	100	1,200	
57.00	62.00	20040714 10:19	5.00	PRF1 –> PRF2	PSF –> PSS	8.2E–10	4.66E–08	3.84E–08	4.64E–08	–	4.64E–08	4.64E–08	0.1	20	500	
62.00	67.00	20040714 12:00	5.00	PRF/PSF	PLF –> PSF	1.6E–09	1.22E–05	1.01E–05	2.07E–05	2.08E–05	2.07E–05	2.07E–05	1.8	300	1,200	
67.00	72.00	20040714 14:14	5.00			3.0E–10						3.00E–10				
72.00	77.00	20040714 15:24	5.00	PSF	WBS –>	7.2E–10	3.98E–09	3.28E–09	5.71E–09	2.62E–09	2.62E–09	2.62E–09	0.7	3	300	3.14E–11
77.00	82.00	20040721 11:42	5.00	PRF	PRF/PSF	8.2E–10	4.83E–08	3.98E–08	6.61E–08	1.00E–07	6.61E–08	6.61E–08	2.7	50	1,221	
82.00	87.00	20040716 11:16	5.00	PRF1 –> PRF2	PRF	8.2E–10	1.35E–07	1.11E–07	1.16E–07	2.18E–07	1.16E–07	1.16E–07	–1.1	30	400	
87.00	92.00	20040716 13:04	5.00	PRF	WBS	2.0E–10	3.86E–10	3.18E–10	1.58E–10	2.71E–11	1.58E–10	1.58E–10	–0.4	100	1,200	1.83E–11

[1] The acronyms in the column "Flow regime" are as fol
flow (PSS) and apparent no-flow boundary (NFB). The flow regime definitions are further discussed in Section 6.2.6 below.

[2] For the tests were Q_p was not detected, T_R was assumed equal to the estimated Q/s-measl-L.

The transmissivity values considered most representative, T_R, from the injection tests in the tested sections of 5 m length are shown in Figure 6.2. The highest transmissivity value is found in the interval 62–67 m ($T_R = 2.1 \times 10^{-5}$ m²/s). Other intervals with relatively high transmissivity values are 32–42 m ($T_R = 7–8 \times 10^{-6}$ m²/s) and 47–57 m ($T_R = 1–2 \times 10^{-6}$ m²/s).

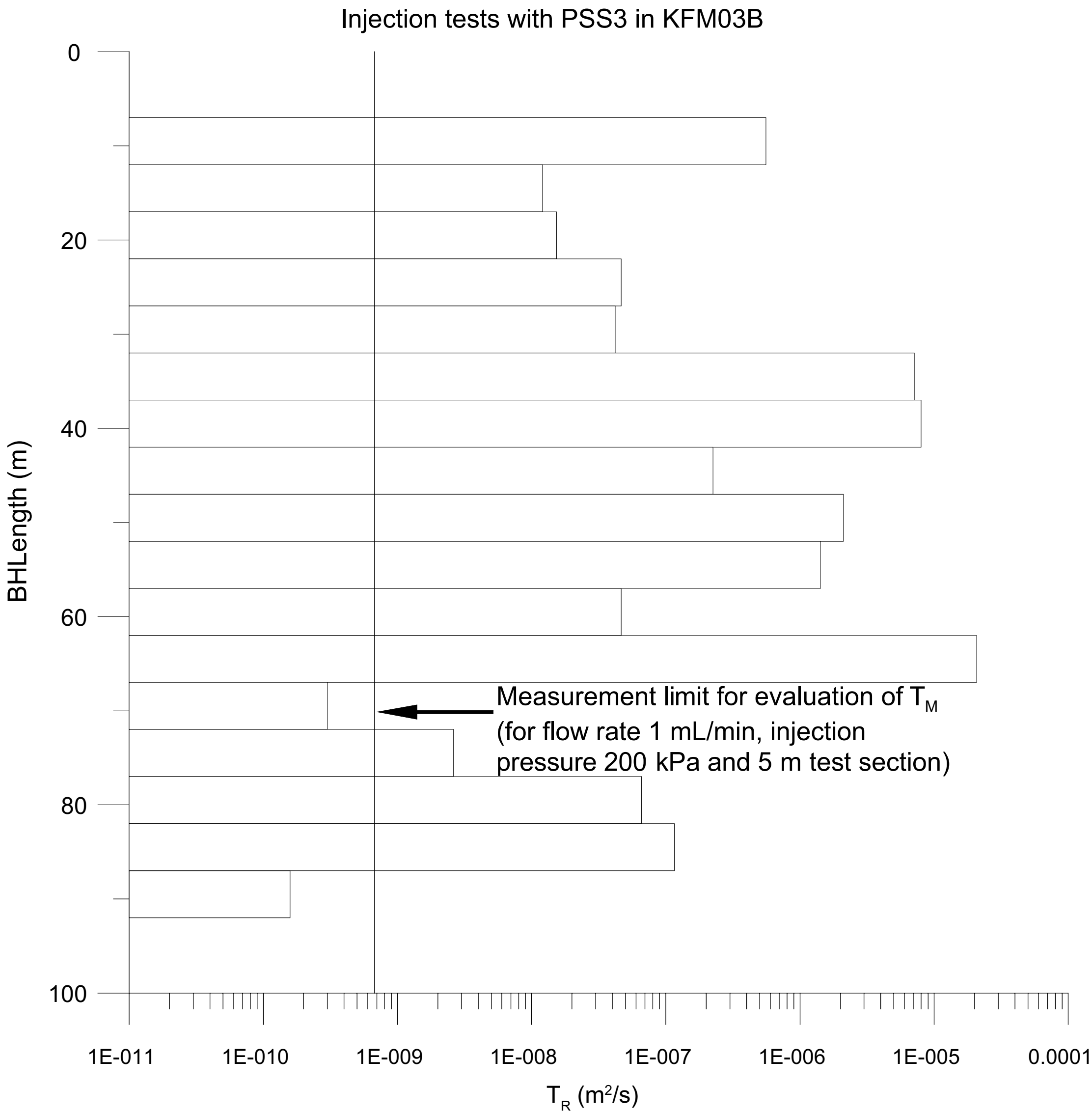


Figure 6-2. *Estimated best representative transmissivity values (T_R) for sections of 5 m length in borehole KFM03B. Estimated transmissivity values for the lower measurement limit from stationary evaluation (T_M-measl-L) (flow rate 1.7×10^{-8} m³/s and injection pressure 200 kPa) are also shown.*

6.2.5 Comments on the tests

Short comments on each test follow below. Flow regimes and hydraulic boundaries are in the text referred to as:

WBS = Wellbore storage

PRF = Pseudo-radial flow regime

PLF = Pseudo-linear flow regime

PSF = Pseudo-spherical flow regime

PSS = Pseudo-stationary flow regime

NFB = No-flow boundary

As discussed in Section 5.4, the flow regimes were mainly interpreted from the log-log plots of flow rate and pressure together with the corresponding derivatives. WBS is identified as a straight line of unit slope. PRF corresponds to a certain period of a horizontal derivative. PLF may at the beginning of the tests be reflected by a straight line of slope 0.5 or less in the log-log diagrams, both for the measured parameter (flow rate or pressure) and the derivative. PSF is reflected by a straight line with a slope of –0.5 for the derivative. However, other slopes may indicate transitions to PSF or PSS. The PSS corresponds to almost stationary conditions with a derivative approaching zero. Due to the limited resolution of the flow meter and pressure sensor, the derivative may at some times erroneously indicate a horizontal line by the end of periods with PSS.

7–12 m

The ground water level was located in the test section before the start of the test. Due to this fact, air was contained in c 1 metre length of the test section at the start of the injection period which strongly affected the response during the beginning of the injection period of the first test. Therefore, the test was repeated. During the injection period of the latter test, two separate periods with PRF are weakly indicated. However, these could be due to air in the test section. The first PRF period is considered to be the most representative one. After 980 s of the injection period, the water reached the pressure sensor, Pa, above the test section. During recovery, a well-defined PRF is indicated. A slight leakage flow is indicated by the end of the recovery.

12–17 m

Two periods with PRF are indicated during both the injection and the recovery period. The pressure in the section above the test section increased during the entire test.

17–22 m

The pressure in the test section increased by c 3 kPa during the injection period. Despite this, a short PRF is indicated early in the injection period which is transitioning to a NFB. During the recovery period, WBS, possibly transitioning to a PRF is indicated.

22–27 m

A well defined PRF during the injection phase is indicated. After a transition period, an apparent PRF is indicated during the recovery phase. The pressure above the section increased during the entire test. The pressure below the test section was much higher in the beginning of the test than later. The reason for this phenomenon is unclear.

27–32 m

A well defined PRF is indicated during the injection period. During the recovery period, PRF/PSF with transition to PSS is indicated and thus transient evaluation is uncertain. Pressure above the test section increased during the entire test, pressure below was relatively stable during the test.

32–37 m

During the injection period a short initial period with PRF transitioning to PSF is indicated, possibly due to hydraulic interaction with the section below. The transmissivity calculated from this period is chosen as the most representative for the test. A PSF dominated during the recovery period. The pressure below the test section increased c 24 kPa during the injection period and, of this pressure change, c 22 kPa recovered during the recovery period. Therefore, the T-value presented for this section may be slightly overestimated.

37–42 m

The disturbance in pressure and flow before the injection start, as seen on the overview plot, Appendix 3, Figure A3-30, is due to a miscalculation of flow. Hence, the injection was stopped and then re-started when the pressure had recovered. A PRF is indicated in the beginning of the injection period, transitioning to a PSF by the end of the injection period. A PSF is indicated during the recovery period. The pressure above the test section increased c 50 kPa during the injection period and, of this pressure change, c 46 kPa recovered during the recovery period. Therefore, the T-value presented for this section may be slightly overestimated.

42–47 m

A PRF is indicated during the injection period. The recovery was almost immediate and a PSF/PSS dominated the period.

47–52 m

During both the injection and recovery period a PSF is indicated. Thus, only an approximate transient evaluation can be made.

52–57 m

A PRF is indicated during the injection period. The recovery is almost immediate. However, a short PRF is indicated in the beginning of the recovery period, transitioning to a PSF or PSS.

57–62 m

Two periods with PRF are indicated during the injection period. There was an almost immediate recovery of pressure after the injection and no unique transient evaluation of the recovery period could be made.

62–67 m

A PRF is indicated by the end of the injection phase. A PLF is indicated in the beginning of the recovery period with transition to a PSF.

67–72 m

The test section has a low conductivity. Since the flow rate was not detectable, neither steady-state nor transient evaluation of transmissivity was possible. Hence, in accordance with AP PF 400-04-64, the injection time was shortened. As a result, Q/s-measl-L was considered to be the most representative transmissivity value for this section.

72–77 m

A PSF is indicated during the injection period. During the recovery period WBS is indicated with a transition period towards the end.

77–82 m

The injection period indicates a well-defined PRF. The recovery period indicates a PRF approaching PSF.

82–87 m

There is a well-defined first PRF during the injection period with a transition to a second PRF. A PRF is indicated during the recovery period.

87–92 m

Although the flow rate data are scattered, a PRF is weakly indicated towards the end of the injection period. During the recovery period only WBS effects are present.

92–97 m

No injection test was performed since the pressure below the test section increased during the packer expansion to higher pressures than the equipment is designed for due to low hydraulic conductivity below 98 m. Therefore, the test was interrupted. However, it is likely that a detectable flow could be found in the section 93–98 m since packer inflation caused a much smaller pressure build up below the section during the test in section 87–92 m than in test section 92–97 m.

6.2.6 Flow regimes

A summary of the frequency of identified flow regimes is presented in Table 6-3, which shows all identified flow regimes. I.e. if a certain test period indicates a pseudo-radial flow regime transition to a pseudo-spherical flow regime, this period contributes to one observation of pseudo-radial and one observation of pseudo-spherical flow. The numbers within parenthesis denote the number of tests where the actual flow regime is the only one present.

It should be noted that the interpretation of flow regimes is only tentative and based on visual inspection of the data curves. The number of tests with a pseudo-linear flow regime may be underestimated for the injection period due to the fact that a certain time is required to achieve a constant pressure in the beginning of the test.

Table 6-3. Interpreted flow regimes during the injection tests in KFM03B.

Section length (m)	Number of tests	Number of tests with definable Q_p	Injection period			Recovery period				
			PRF	PSF	NFB	WBS	PLF	PRF	PSF	PSS
5	17	16	14 (10)	5 (2)	1 (0)	3 (2)	1 (0)	8 (5)	9 (3)	4 (0)

Table 6-3 shows that a certain period of pseudo-radial flow could be identified during the injection period for 14 out of 16 of the tests with a definable final flow rate. For the recovery period, the corresponding result is only 8 out of 16. For a minor part of the tests, more than one flow regime could be identified. PRF is more common during the injection period than the recovery period, while the situation regarding PSF is the opposite.

6.3 Basic statistics of hydraulic conductivity distributions

Some basic statistical parameters were calculated for the steady-state hydraulic conductivity (K_M) from the injection tests in borehole KFM03B. The hydraulic conductivity is obtained by dividing the transmissivity by the section length, in this case T_M/L_w. Results from the tests where Q_p was below the estimated measurement limit was not included in the statistical analyses of K_M. Therefore, the same basic statistical parameters were derived for the hydraulic conductivity considered the most representative ($K_R = T_R/L_w$), including all tests. In the statistical analysis, the logarithm (base 10) of K_M and K_R was used. Selected results are shown in Table 6-4.

Table 6-4. Basic statistical parameters for steady-state hydraulic conductivity (K_M) and hydraulic conductivity considered most representative (K_R) in borehole KFM03B. L_w = section length, m = arithmetic mean, s = standard deviation.

Borehole	Parameter	Unit	L_w = 5 m
KFM03B	Measured borehole interval	M	7–92
KFM03B	Number of tests	–	17
KFM03B	N:o of tests below E.L.M.L.[1)]	–	1
KFM03B	m ($Log_{10}(K_M)$)	Log_{10} (m/s)	–7.59
KFM03B	s ($Log_{10}(K_M)$)	–	1.37
KFM03B	m ($Log_{10}(K_R)$)	Log_{10} (m/s)	–7.71
KFM03B	s ($Log_{10}(K_R)$)	–	1.47

[1)] Number of tests where Qp could not be defined (E.L.M.L. = estimated lower measurement limit)

7 References

/1/ **Hurst W, Clark J D, Brauer E B, 1969.** The skin effect in producing wells. J. Pet. Tech., Nov. 1969, pp 1,483–1,489.

/2/ **Dougherty D E, Babu D K, 1984.** Flow to a partially penetrating well in a double-porosity reservoir. Water Resour. Res., 20 (8), 1,116–1,122.

/3/ **Almén K-E, Andersson J-E, Carlsson L, Hansson K, Larsson N-Å, 1986.** Hydraulic testing in crystalline rock. A comparative study of single-hole test methods. SKB TR-86-27, Svensk Kärnbränslehantering AB.

Appendix 1

File description table

Bh id	Testsection		Test type	Test no	Test start	Test stop	Data files of raw and primary data	Parameters in file	Comments
					Date, time	Date, time			
idcode	(m)	(m)	(1–6)*		YYYYMMDD hh:mm	YYYYMMDD hh:mm	__Borehole id_secup_date and time of test start		
KFM03B	7	12	3	2	20040802 10:48	20040802 13:39	__KFM03B_0007.00_200408021048.ht2	P,Q,Te	
KFM03B	12	17	3	1	20040712 11:41	20040712 14:09	__KFM03B_0012.00_200407121141.ht2	P,Q,Te	
KFM03B	17	22	3	2	20040721 14:25	20040721 16:00	__KFM03B_0017.00_200407211425.ht2	P,Q,Te	
KFM03B	22	27	3	1	20040712 16:30	20040712 18:01	__KFM03B_0022.00_200407121630.ht2	P,Q,Te	
KFM03B	27	32	3	1	20040713 09:04	20040713 10:35	__KFM03B_0027.00_200407130904.ht2	P,Q,Te	
KFM03B	32	37	3	1	20040713 11:41	20040713 12:34	__KFM03B_0032.00_200407131141.ht2	P,Q,Te	
KFM03B	37	42	3	1	20040713 13:18	20040713 14:55	__KFM03B_0037.00_200407131318.ht2	P,Q,Te	
KFM03B	42	47	3	1	20040713 15:14	20040713 16:40	__KFM03B_0042.00_200407131514.ht2	P,Q,Te	
KFM03B	47	52	3	1	20040713 16:57	20040713 18:24	__KFM03B_0047.00_200407131657.ht2	P,Q,Te	
KFM03B	52	57	3	1	20040714 08:33	20040714 09:59	__KFM03B_0052.00_200407140833.ht2	P,Q,Te	
KFM03B	57	62	3	1	20040714 10:19	20040714 11:50	__KFM03B_0057.00_200407141019.ht2	P,Q,Te	
KFM03B	62	67	3	1	20040714 12:00	20040714 14:02	__KFM03B_0062.00_200407141200.ht2	P,Q,Te	
KFM03B	67	72	3	1	20040714 14:14	20040714 15:11	__KFM03B_0067.00_200407141414.ht2	P,Q,Te	
KFM03B	72	77	3	1	20040714 15:24	20040714 16:50	__KFM03B_0072.00_200407141524.ht2	P,Q,Te	
KFM03B	77	82	3	2	20040721 11:42	20040721 13:11	__KFM03B_0077.00_200407211142.ht2	P,Q,Te	
KFM03B	82	87	3	1	20040716 11:16	20040716 12:47	__KFM03B_0082.00_200407161116.ht2	P,Q,Te	
KFM03B	87	92	3	1	20040716 13:04	20040716 15:05	__KFM03B_0087.00_200407161304.ht2	P,Q,Te	
KFM03B	92	97	3	1	20040716 15:18	20040716 15:39	__KFM03B_0092.00_200407161518.ht2	P,Q,Te	No injection was performed. Risk of packer failure due to pressure increase below test section.

[1)] Test type 3 equals to injection test

General test data

Borehole:	KFM03B
Testtype:	CHir (Constant Head injection and recovery)
Field crew:	K Gokall-Norman, J Jönsson, T Svensson and Pirkka-Tapio Tammela
General comment:	

Test section secup (m)	Test section seclow (m)	Test start YYYYMMDD hh:mm	Start of flow period YYYYMMDD hh:mm:ss	Stop of flow period YYYYMMDD hh:mm:ss	Test stop YYYYMMDD hh:mm	Total flow time t_p (min)	Total recovery time t_F (min)
7	12	20040802 10:48	20040802 12:56:59	20040802 13:16:59	20040802 13:39	20	20
12	17	20040712 11:41	20040712 13:26:38	20040712 13:46:59	20040712 14:09	20	20
17	22	20040721 14:25	20040721 15:18:15	20040721 15:38:37	20040721 16:00	20	20
22	27	20040712 16:30	20040712 17:18:28	20040712 17:38:49	20040712 18:01	20	20
27	32	20040713 09:04	20040713 09:52:46	20040713 10:13:05	20040713 10:35	20	20
32	37	20040713 11:41	20040713 11:51:49	20040713 12:12:06	20040713 12:34	20	20
37	42	20040713 13:18	20040713 14:12:59	20040713 14:33:17	20040713 14:55	20	20
42	47	20040713 15:14	20040713 15:58:15	20040713 16:18:33	20040713 16:40	20	20
47	52	20040713 16:57	20040713 17:41:49	20040713 18:02:11	20040713 18:24	20	20
52	57	20040714 08:33	20040714 09:16:35	20040714 09:36:53	20040714 09:59	20	20
57	62	20040714 10:19	20040714 11:07:52	20040714 11:28:13	20040714 11:50	20	20
62	67	20040714 12:00	20040714 13:19:26	20040714 13:39:44	20040714 14:02	20	20
67	72	20040714 14:14	20040714 14:58:31	20040714 15:03:36	20040714 15:11	5	5
72	77	20040714 15:24	20040714 16:07:33	20040714 16:27:55	20040714 16:50	20	20
77	82	20040721 11:42	20040721 12:28:57	20040721 12:49:18	20040721 13:11	20	20
82	87	20040716 11:16	20040716 12:05:18	20040716 12:25:39	20040716 12:47	20	20
87	92	20040716 13:04	20040716 14:23:15	20040716 14:43:37	20040716 15:05	20	20
92 [1)]	97	20040716 15:18			20040716 15:39		

[1)] No injection was performed. Risk of packer failure due to pressure increase below test section.

Pressure and flow data

Summary of pressure and flow data for all tests in KFM03B

Test section		Pressure			Flow		
secup	seclow	p_i	p_p	p_F	Q_p [1]	Q_m [2]	V_p [2]
(m)	(m)	(kPa)	(kPa)	(kPa)	(m^3/s)	(m^3/s)	(m^3)
7	12	109.42	340.67	156.33	2.97E–05	4.38E–05	5.25E–02
12	17	160.75	361.63	183.37	3.49E–07	4.23E–07	5.16E–04
17	22	208.21	449.94	213.17	8.60E–08	1.95E–07	2.39E–04
22	27	254.84	454.90	257.32	1.39E–06	1.58E–06	1.93E–03
27	32	291.27	492.57	291.54	8.27E–07	9.27E–07	1.13E–03
32	37	345.08	549.97	345.63	3.07E–04	3.13E–04	3.81E–01
37	42	396.27	608.89	398.61	2.89E–04	3.01E–04	3.66E–01
42	47	444.42	645.30	444.42	5.94E–06	6.55E–06	7.98E–03
47	52	493.12	730.30	494.08	6.18E–05	6.88E–05	8.41E–02
52	57	540.44	740.65	541.00	1.56E–05	1.61E–05	1.96E–02
57	62	590.12	790.31	590.12	9.51E–07	1.09E–06	1.34E–03
62	67	638.69	740.23	639.79	1.26E–04	1.44E–04	1.76E–01
67	72	744.65	928.99	930.63			
72	77	747.96	975.62	741.34	9.23E–08	1.06E–07	1.30E–04
77	82	789.34	989.10	793.22	9.84E–07	1.05E–06	1.28E–03
82	87	826.46	1,026.12	830.19	2.74E–06	3.16E–06	3.86E–03
87	92	890.90	1,256.25	966.51	1.44E–08	3.56E–08	4.35E–05

1) No value indicates a flow below measurement limit (measurement limit is unique for each test but nominally 1.67E–8 m^3/s).

2) No value indicates that the parameter could not be calculated due to low and uncertain flow rates during a major part of flow period

p_i Pressure in test section before start of flow period

p_p Pressure in test section before stop of flow period

p_F Pressure in test section at the end of recovery period

Q_p Flow rate just before stop of flow period

Q_m Mean (arithmetic) flow rate during flow period

V_p Total volume injected during the flow period

Test diagrams – Injection tests

In the following pages is diagrams presented for all test sections. A linear diagram of pressure and flow rate is presented for each test. For most tests are lin-log and log-log diagrams presented, from injection and recovery period respectively.

Nomenclature for Aqtesolv:

T = transmissivity (m^2/s)

S = storativity (-)

K_Z/K_r = ratio of hydraulic conductivities in the vertical and radial direction (set to 1)

Sw = skin factor

r(w) = borehole radius (m)

r(c) = effective casing radius (m)

C = well loss constant (set to 0)

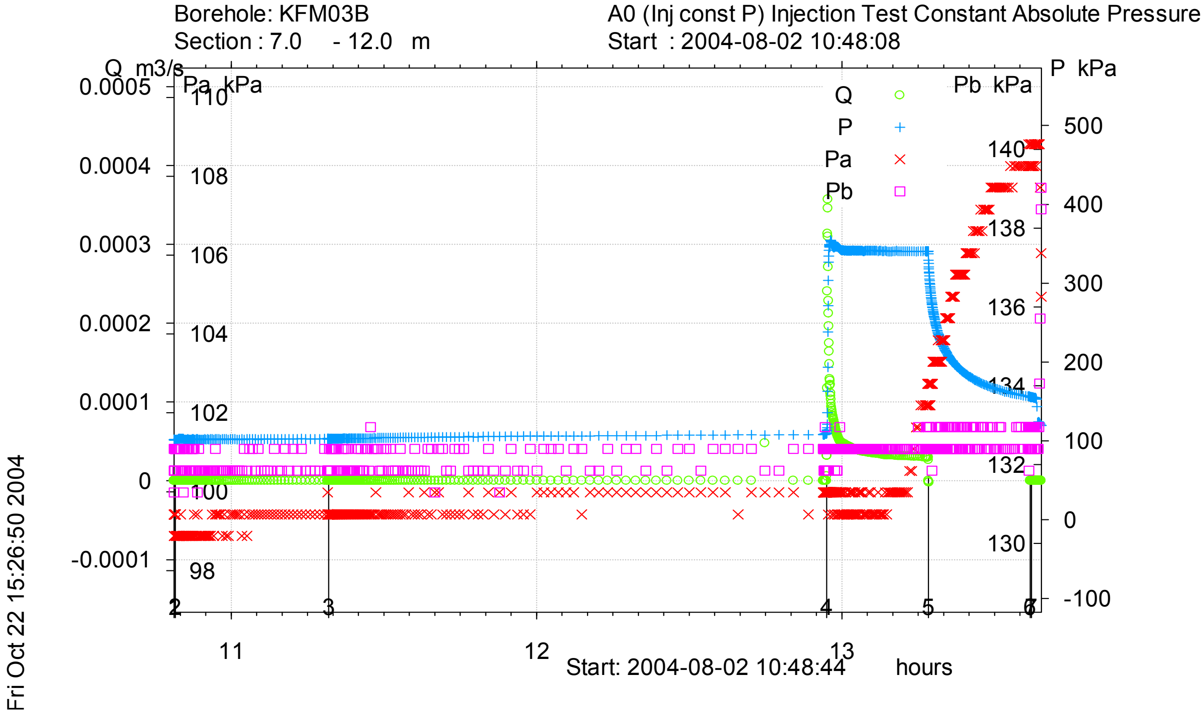


Figure A3-1. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 7–12 m in borehole KFM03B.

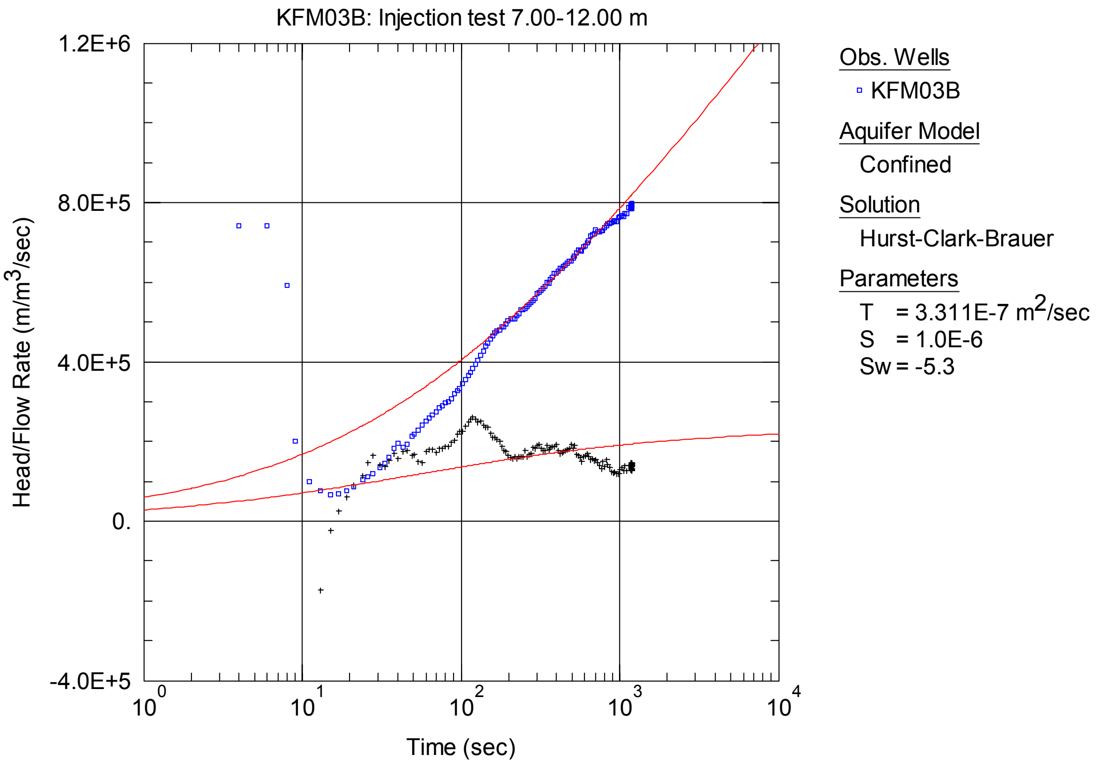


Figure A3-2. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 7–12 m in KFM03B.*

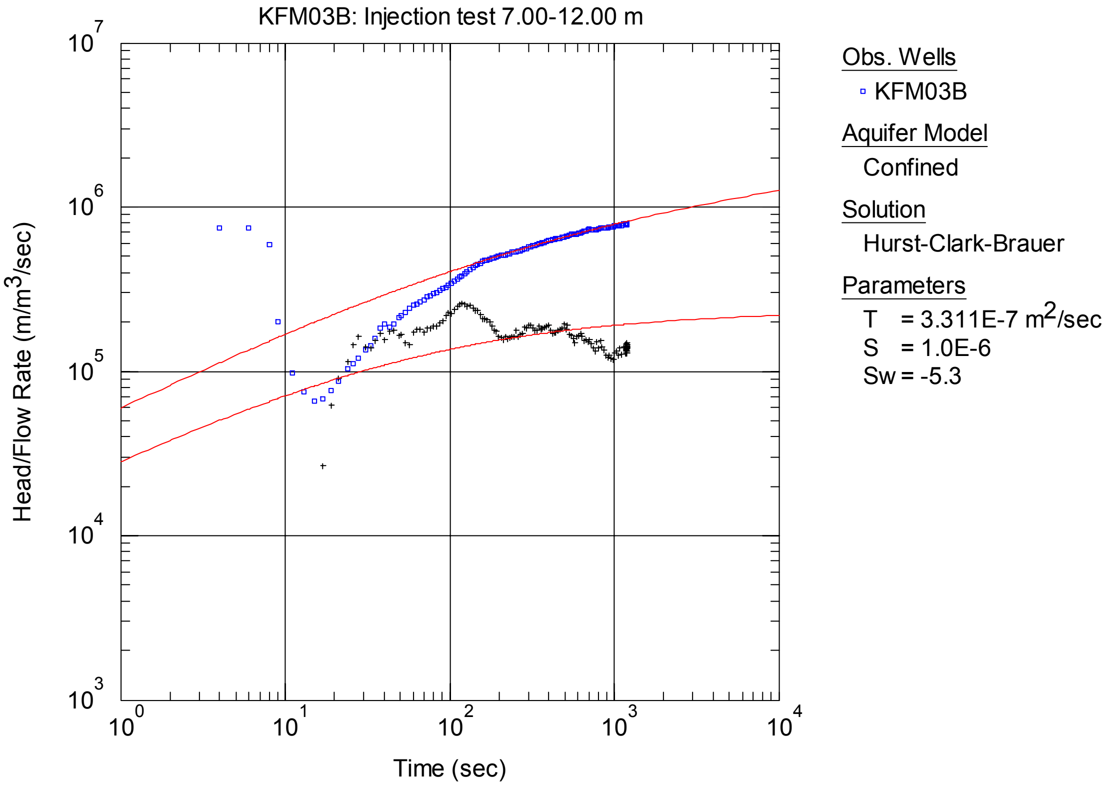


Figure A3-3. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 7–12 m in KFM03B.*

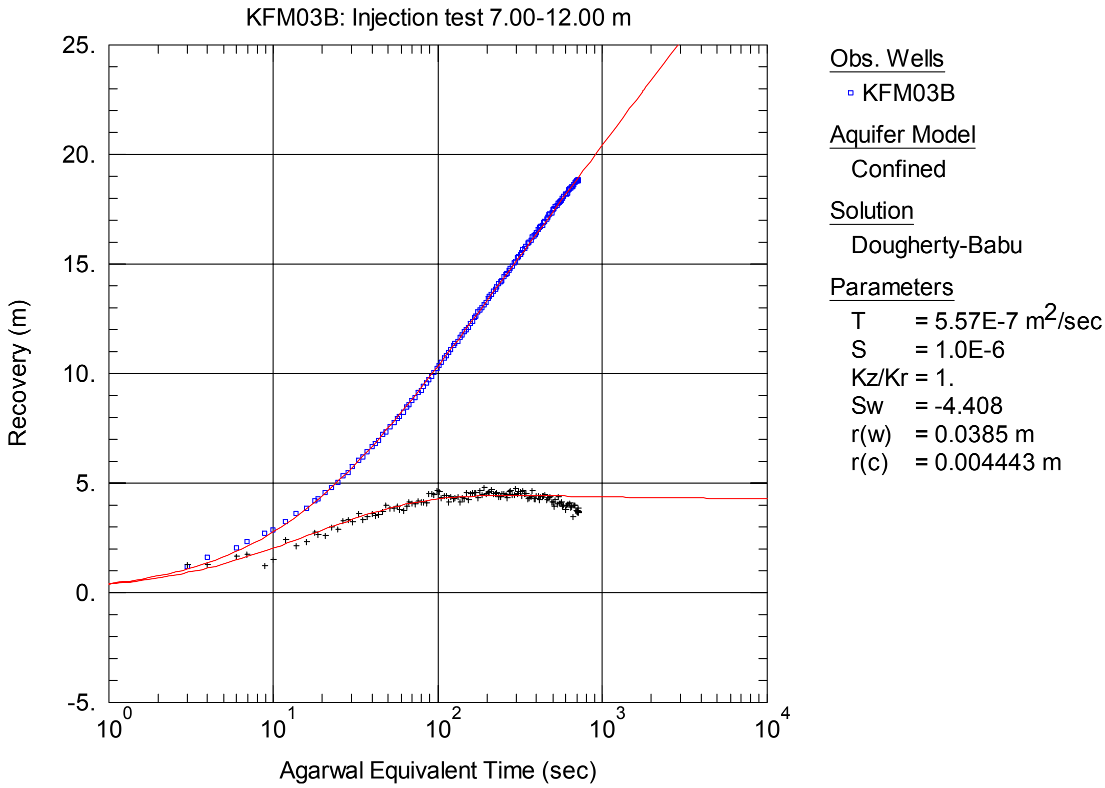


Figure A3-4. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 7–12 m in KFM03B.*

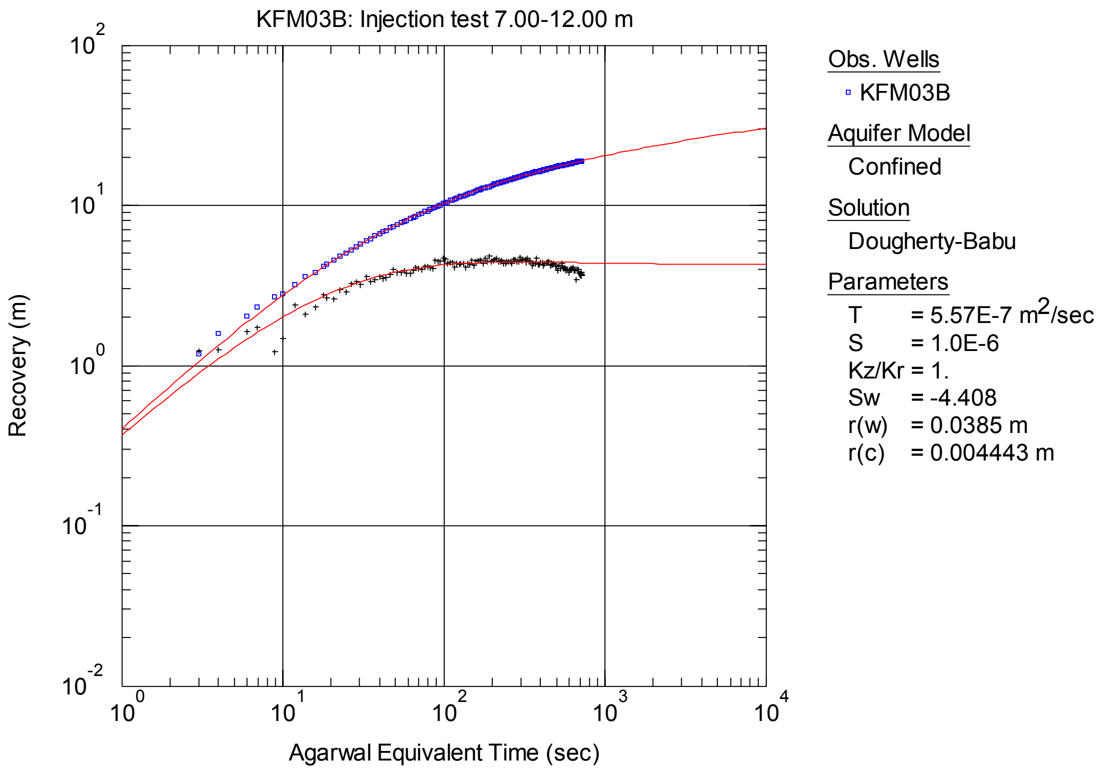


Figure A3-5. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 7–12 m in KFM03B.*

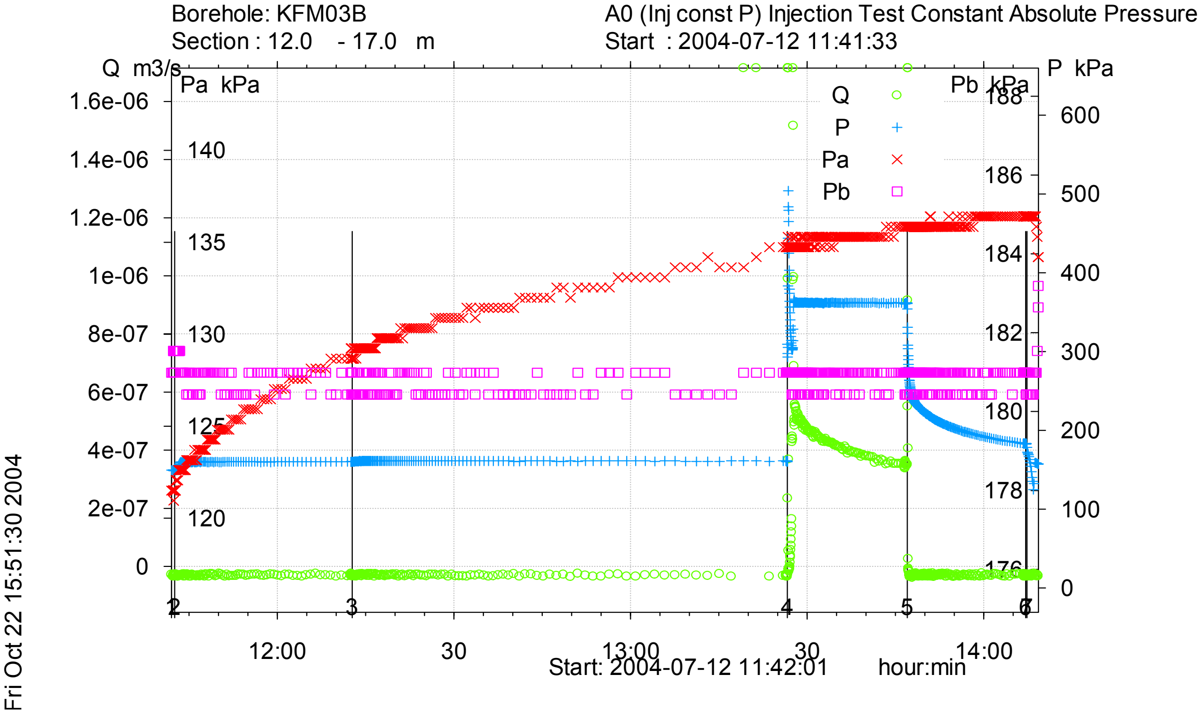


Figure A3-6. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 12–17 m in borehole KFM03B.*

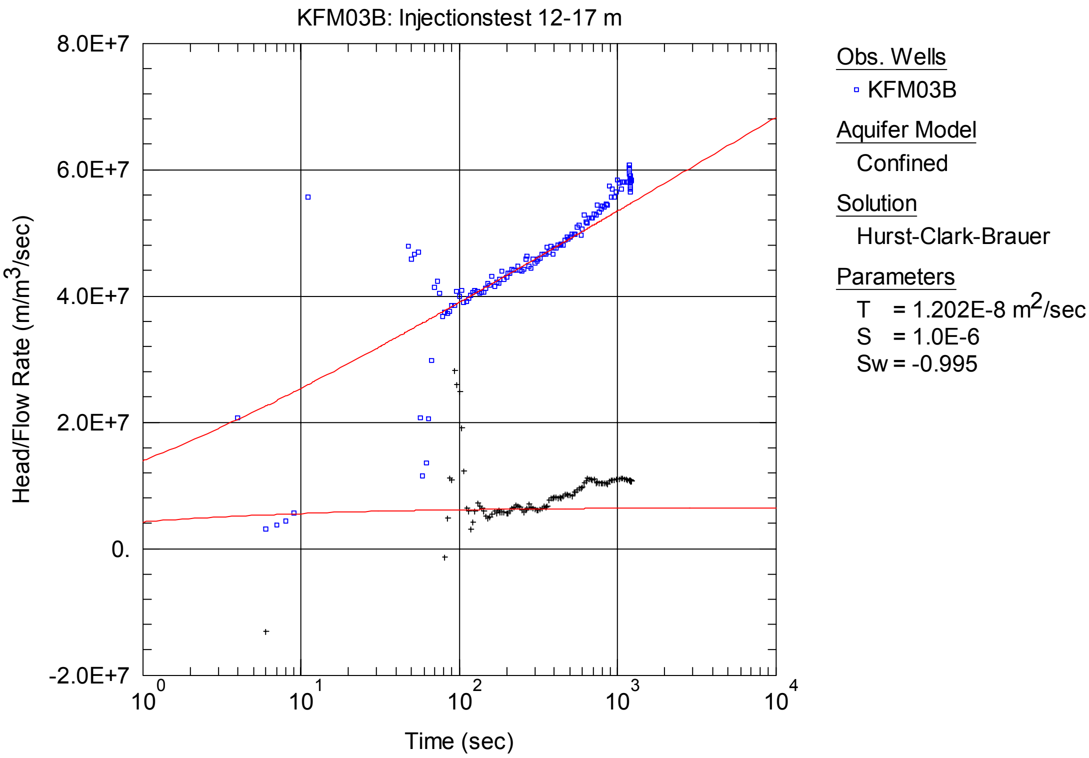


Figure A3-7. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 12–17 m in KFM03B. Showing type curve fit to early PRF.*

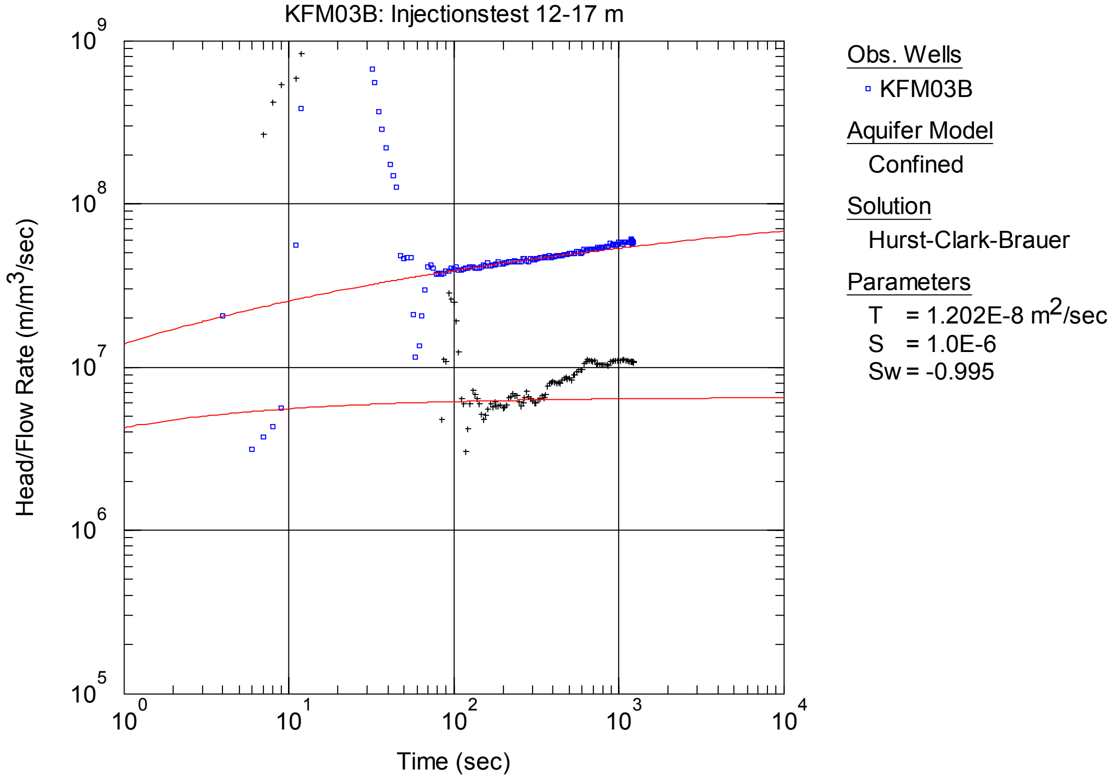


Figure A3-8. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 12–17 m in KFM03B. Showing type curve fit to early PRF.*

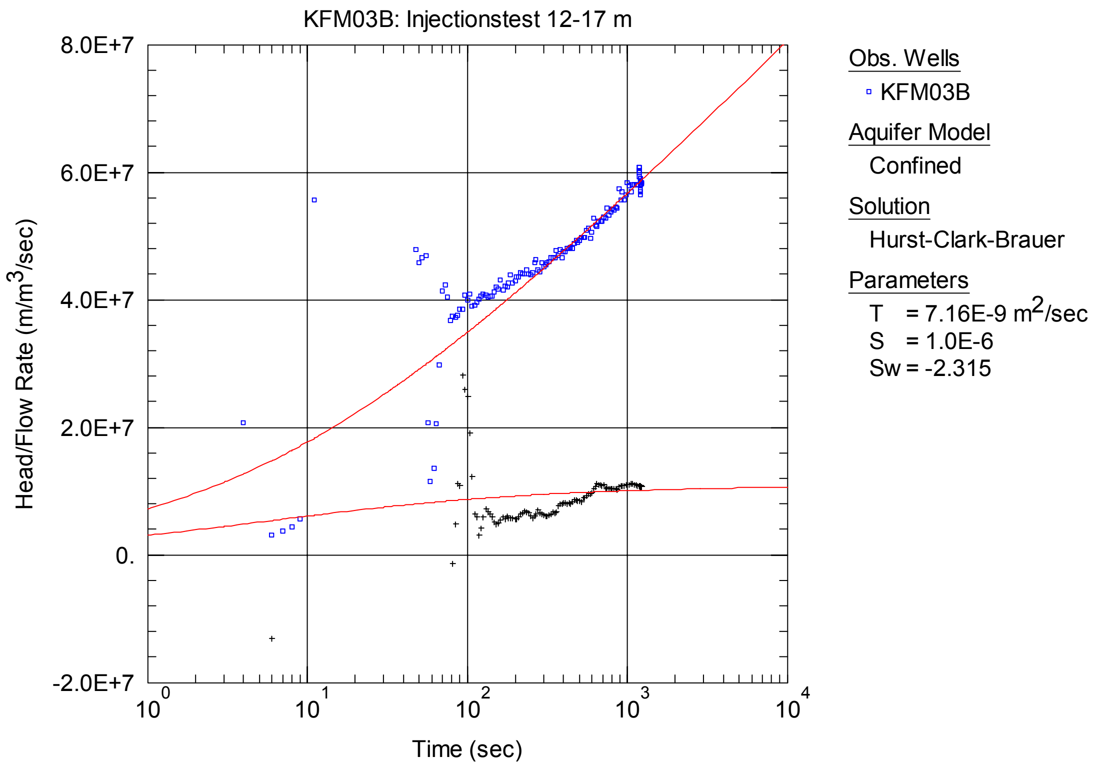


Figure A3-9. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 12–17 m in KFM03B. Showing type curve fit to late PRF.*

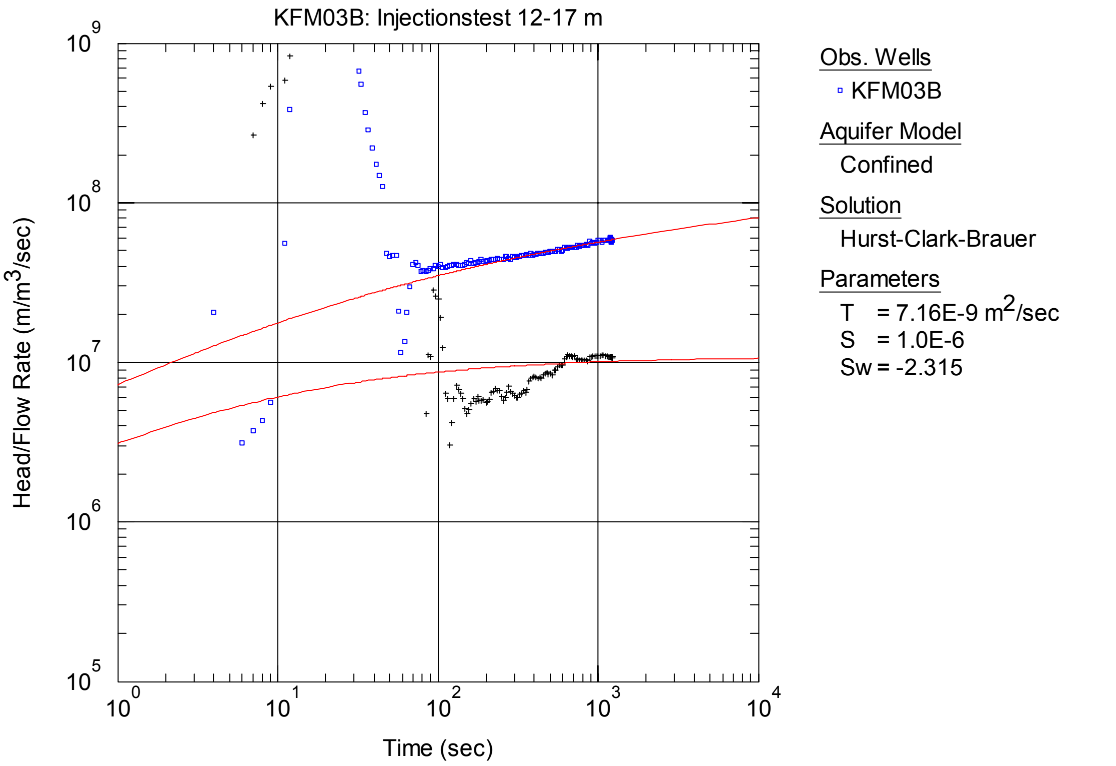


Figure A3-10. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 12–17 m in KFM03B. Showing type curve fit to late PRF.*

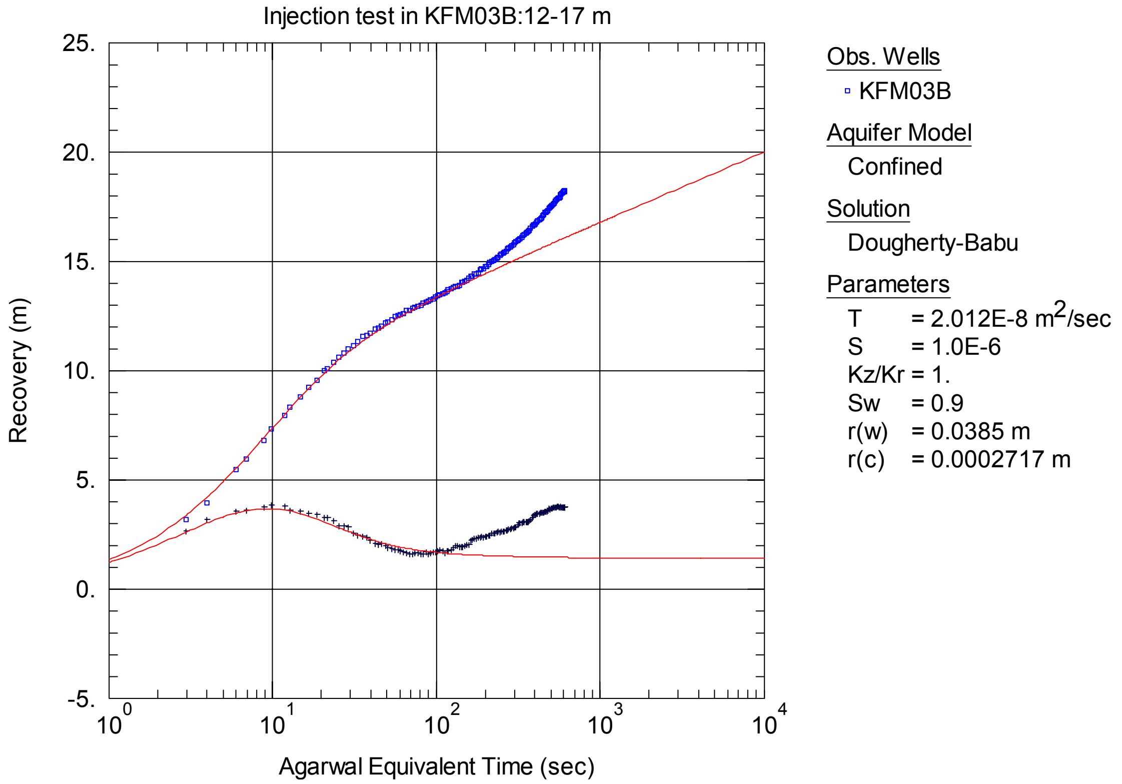


Figure A3-11. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 12–17 m in KFM03B. Showing type curve fit to early PRF.*

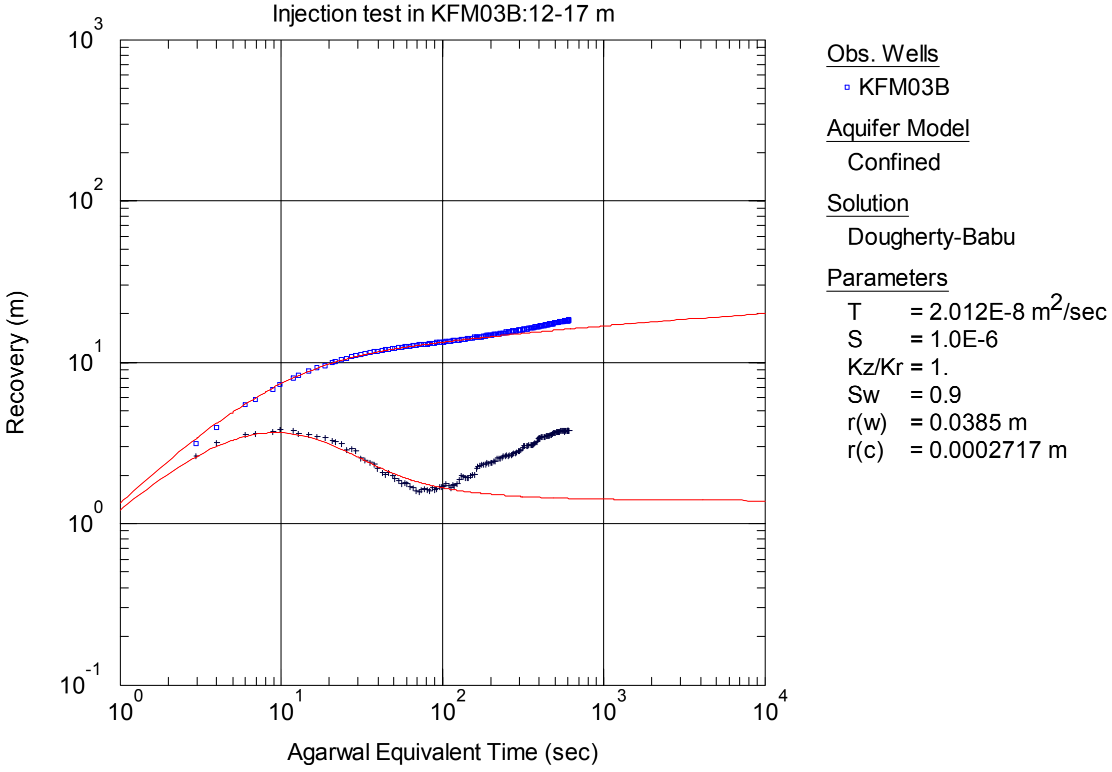


Figure A3-12. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 12–17 m in KFM03B. Showing type curve fit to early PRF.*

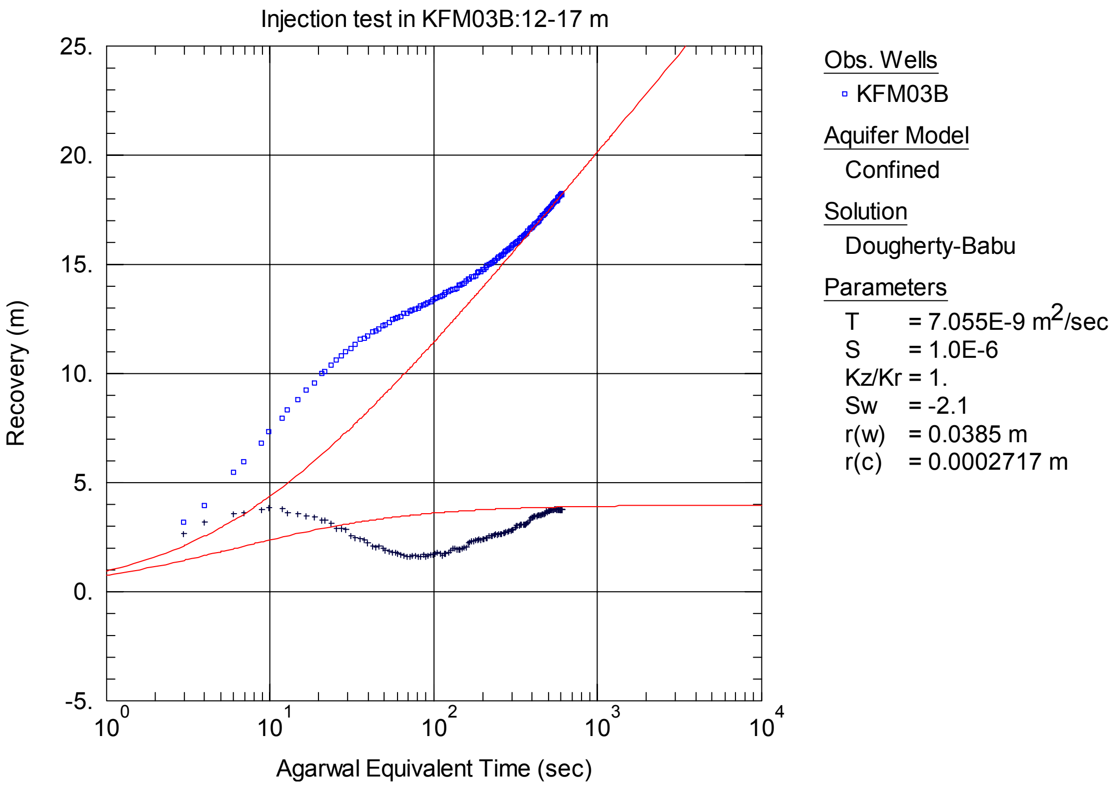


Figure A3-13. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 12–17 m in KFM03B. Showing type curve fit to late PRF.*

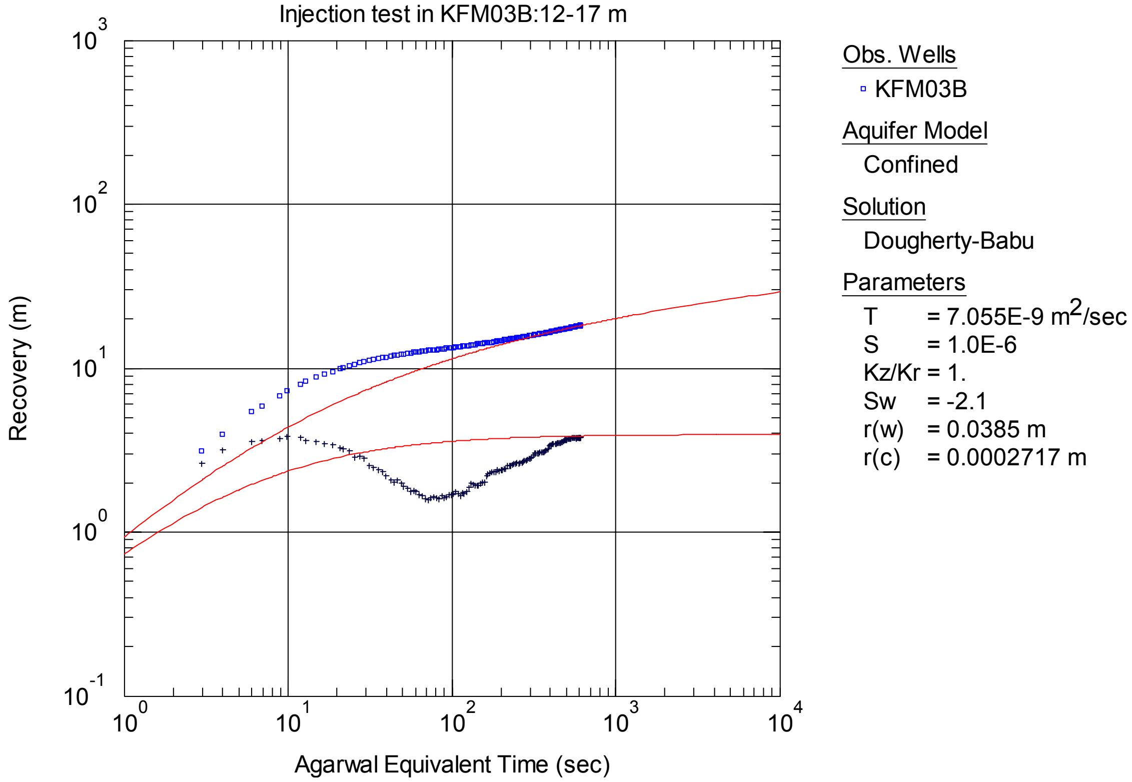


__Figure A3-14.__ Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 12–17 m in KFM03B. Showing type curve fit to late PRF.

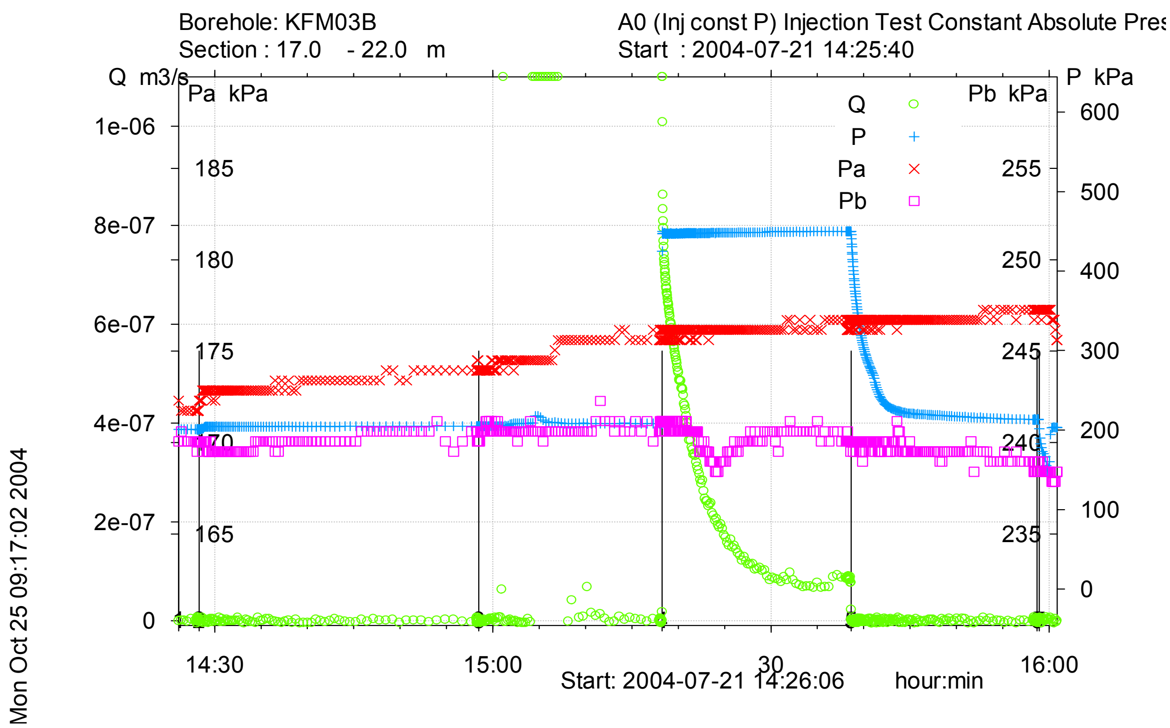


__Figure A3-15.__ Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 17–22 m in borehole KFM03B.

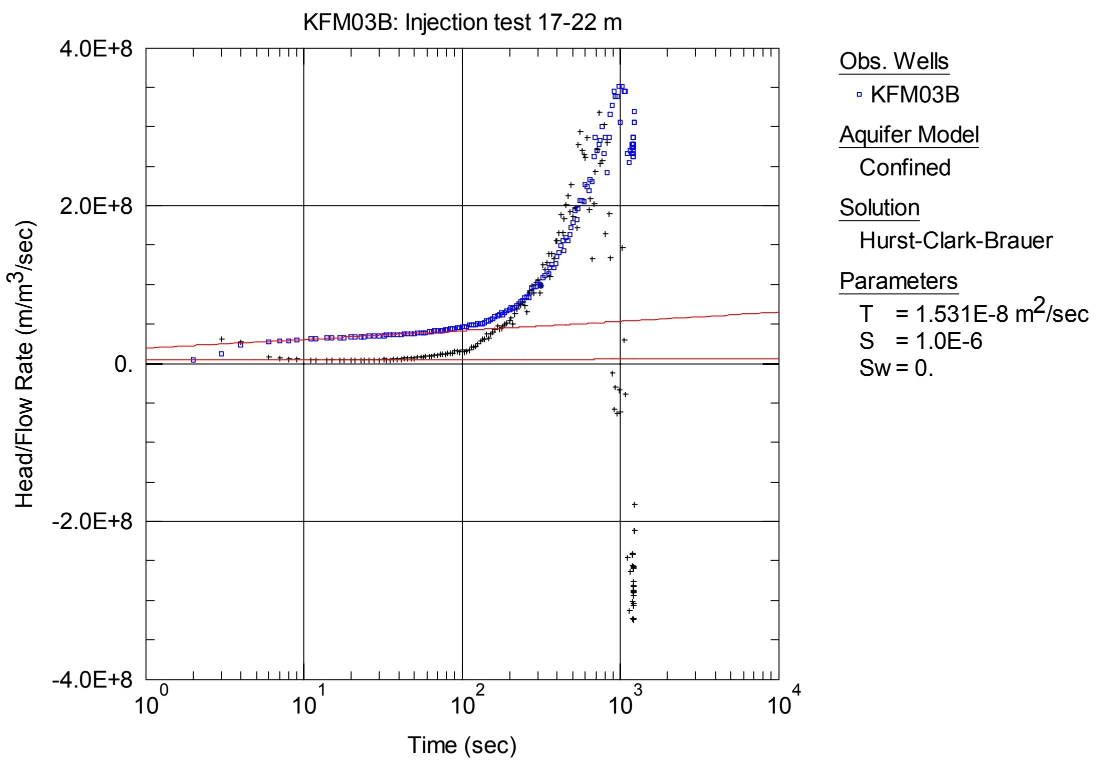


Figure A3-16. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 17–22 m in KFM03B.*

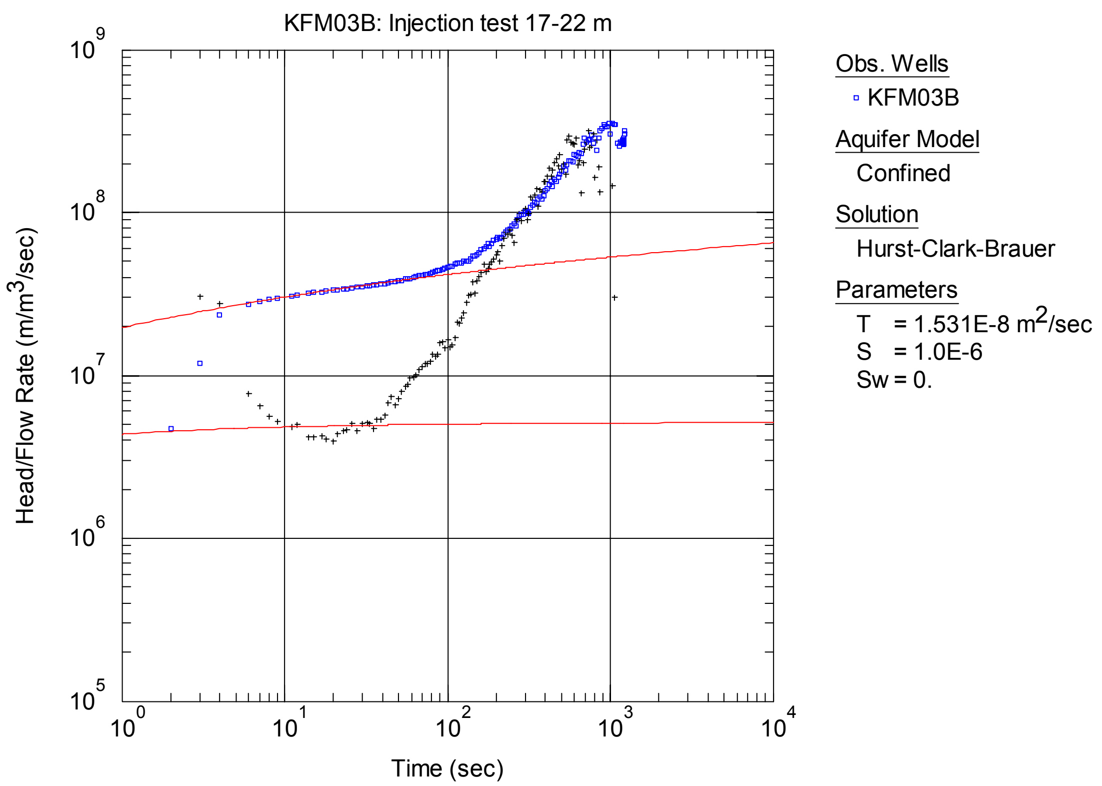


Figure A3-17. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 17–22 m in KFM03B.*

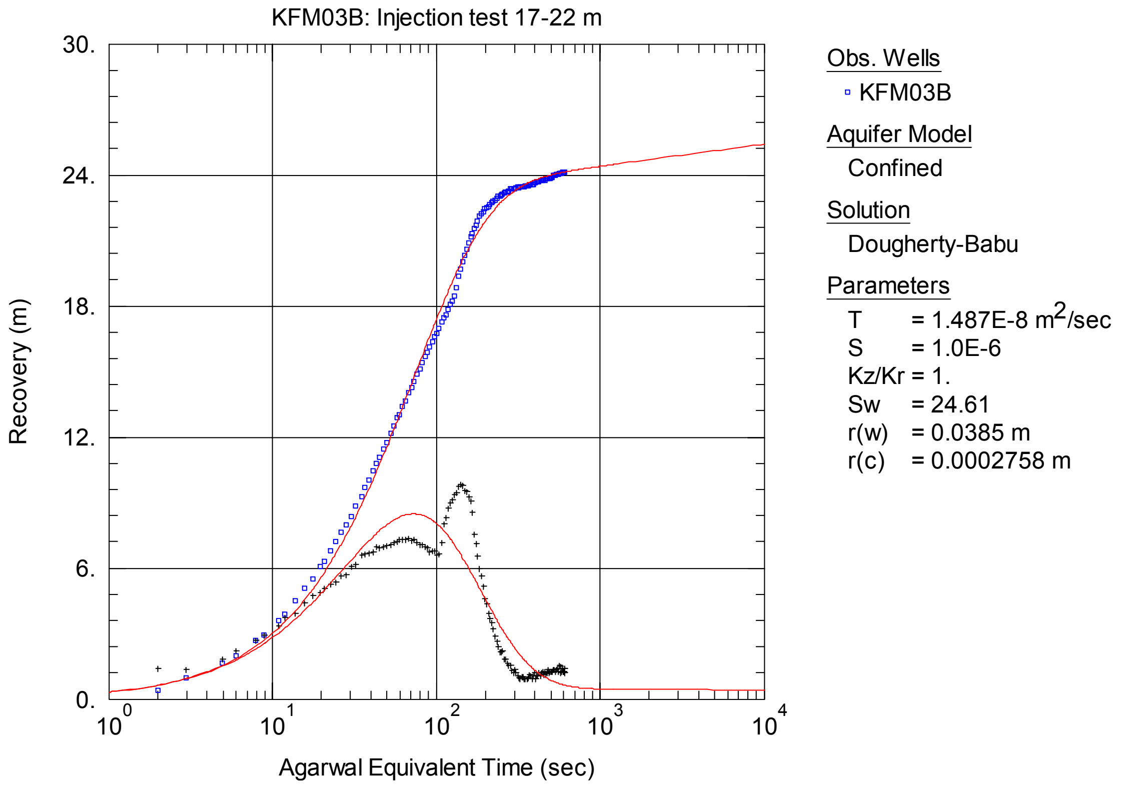


Figure A3-18. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 17–22 m in KFM03B.*

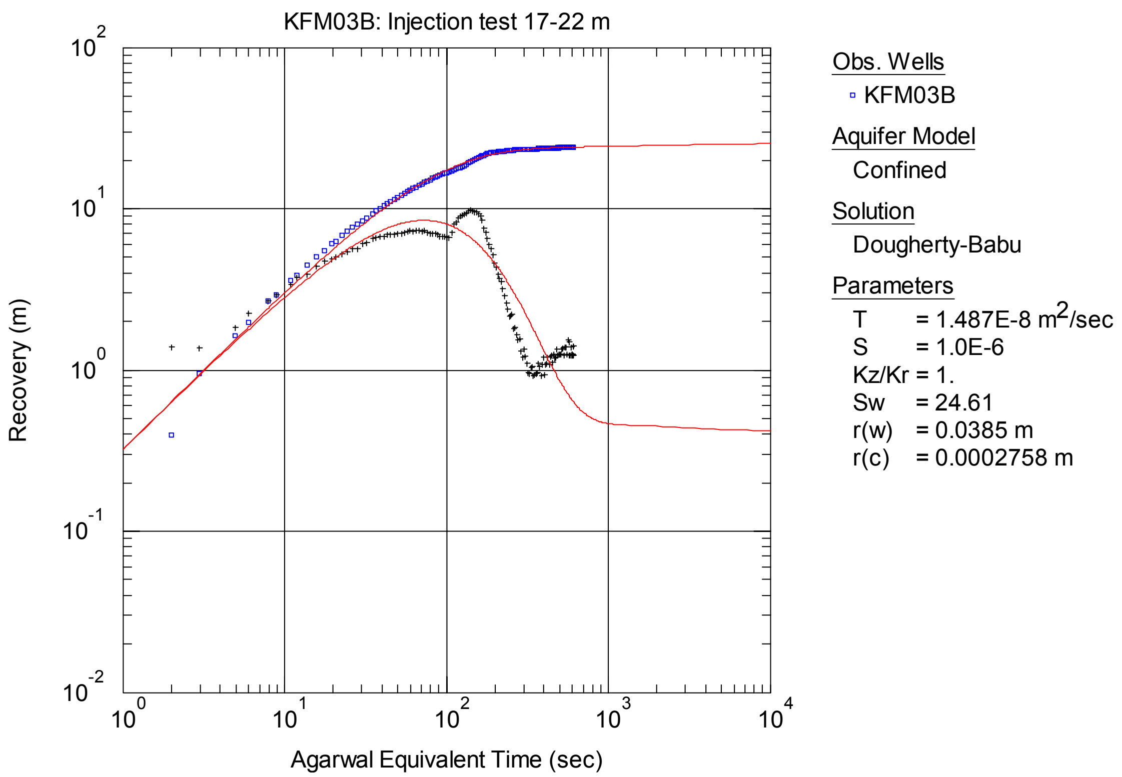


Figure A3-19. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 17–22 m in KFM03B.*

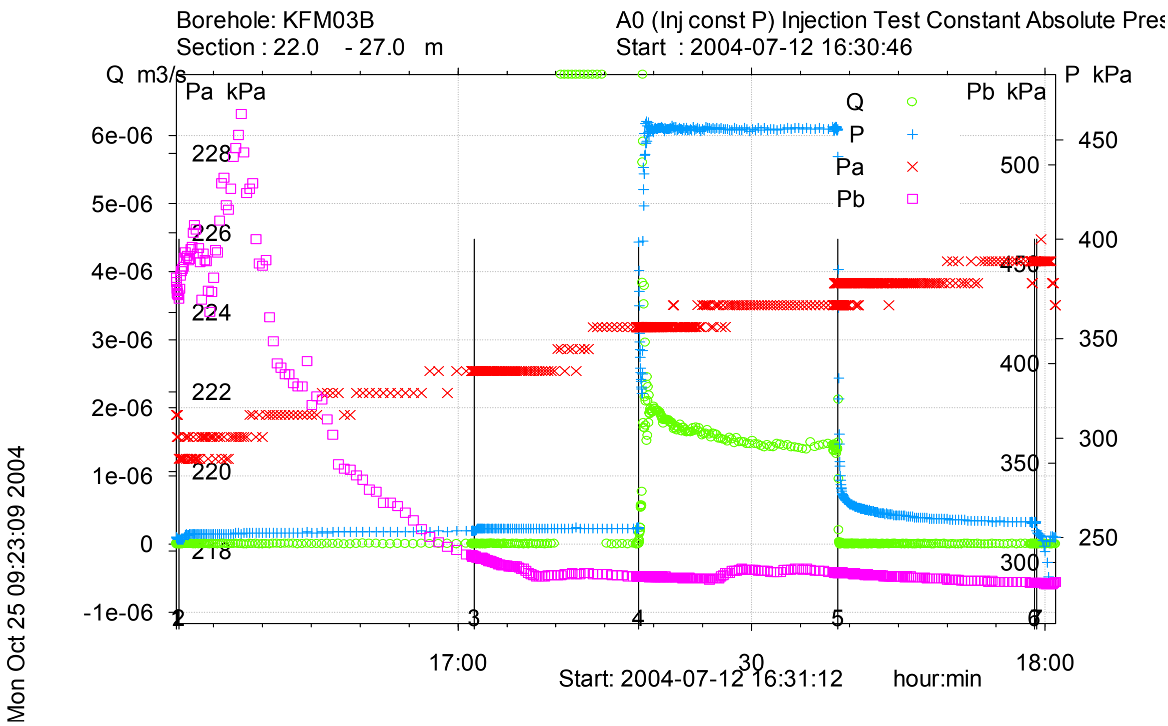


Figure A3-20. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 22–27 m in borehole KFM03B.*

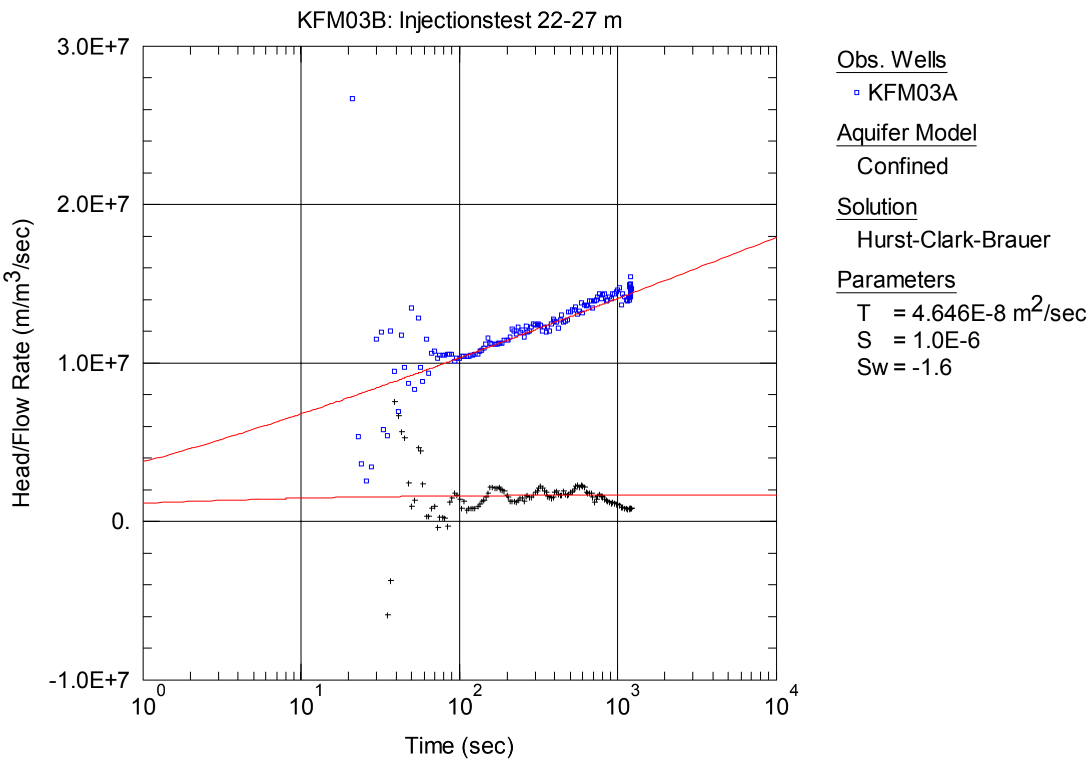


Figure A3-21. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 22–27 m in KFM03B.*

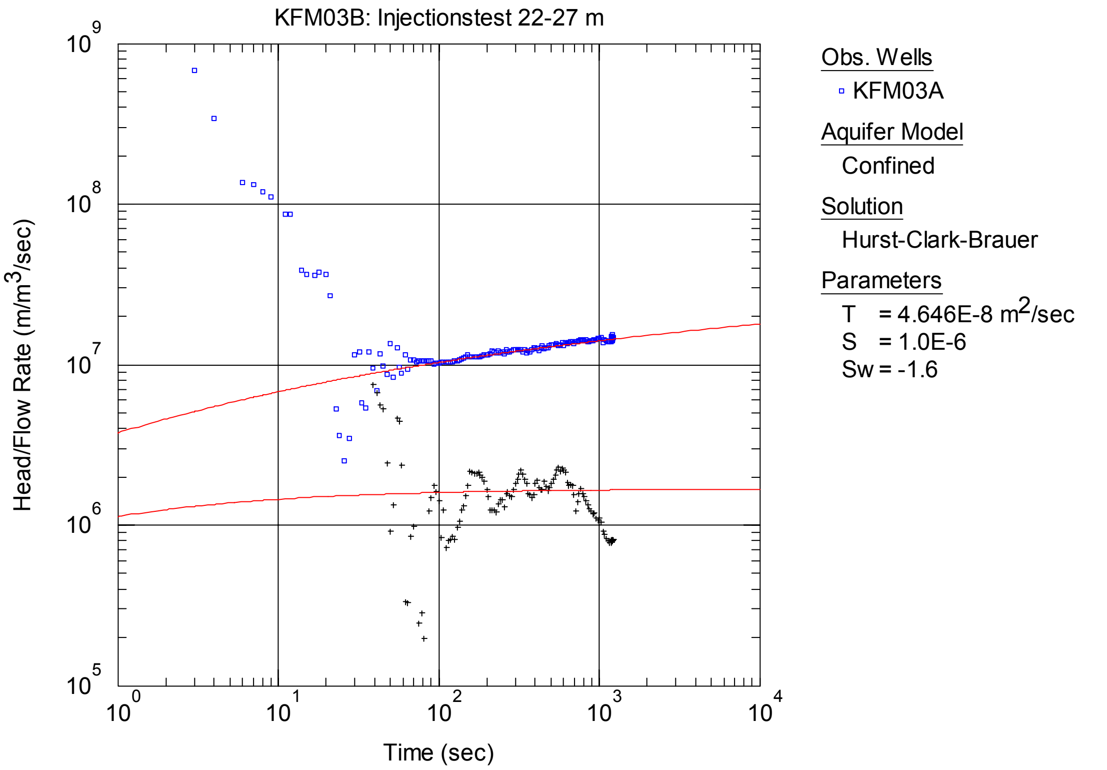


Figure A3-22. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 22–27 m in KFM03B.*

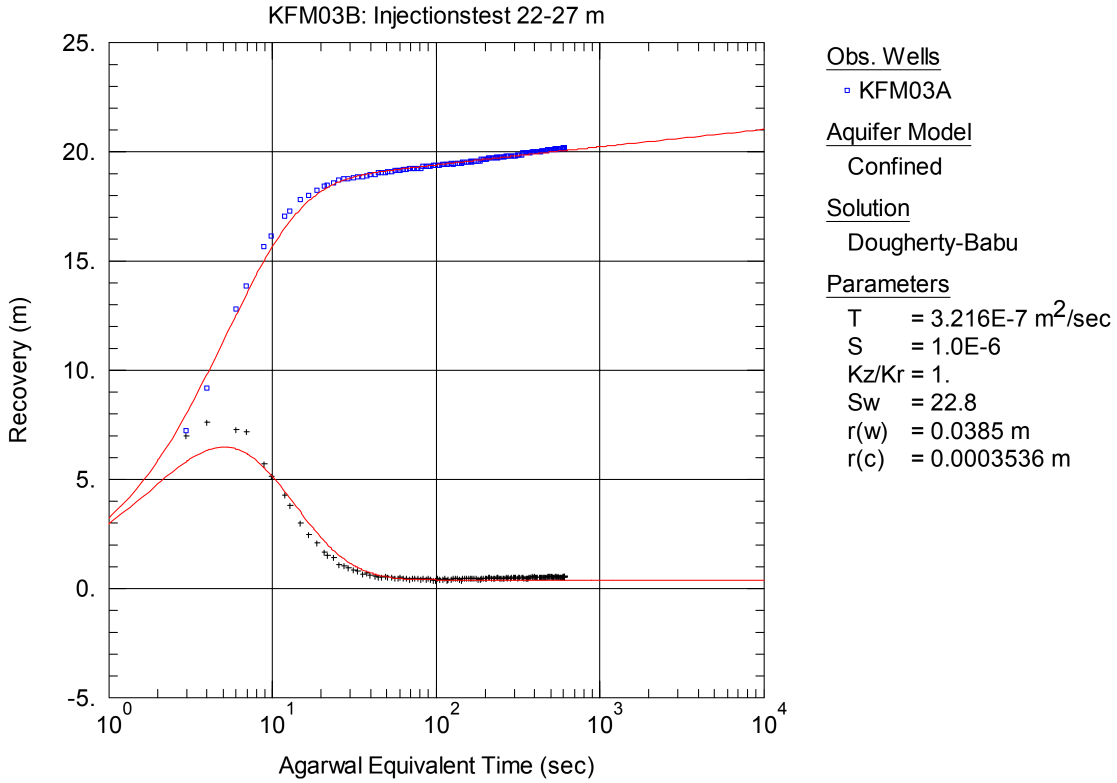


Figure A3-23. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 22–27 m in KFM03B.*

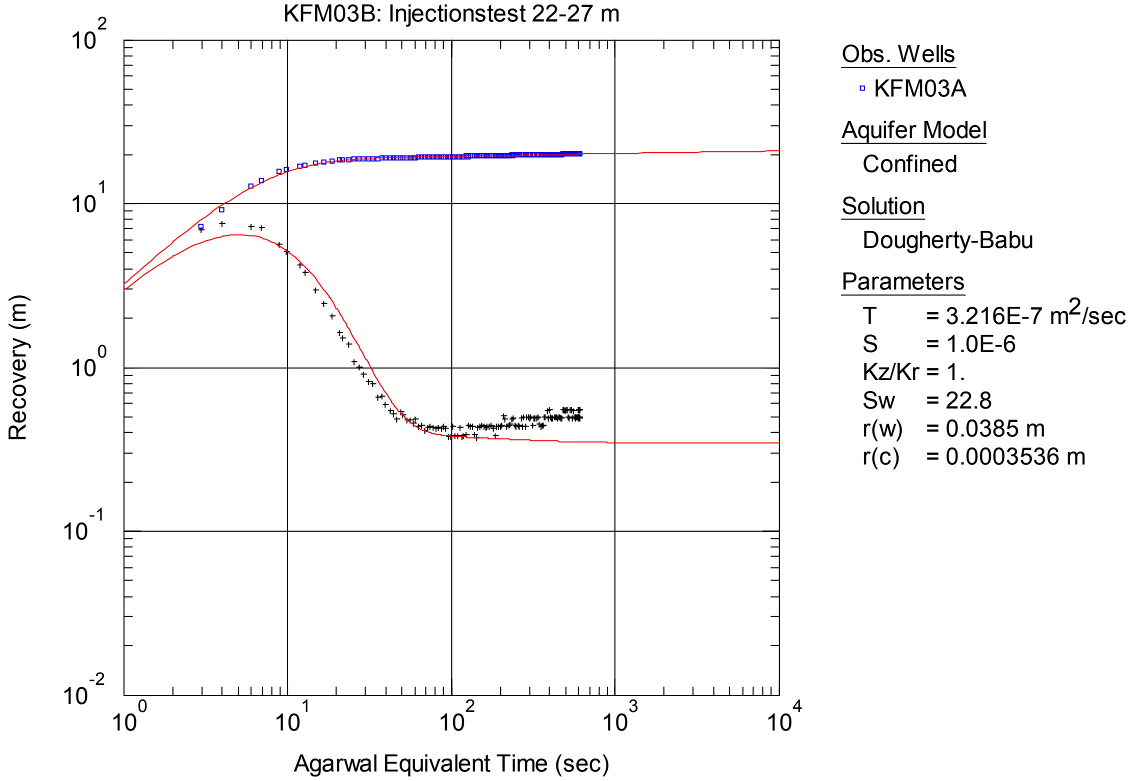


Figure A3-24. Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 22–27 m in KFM03B.

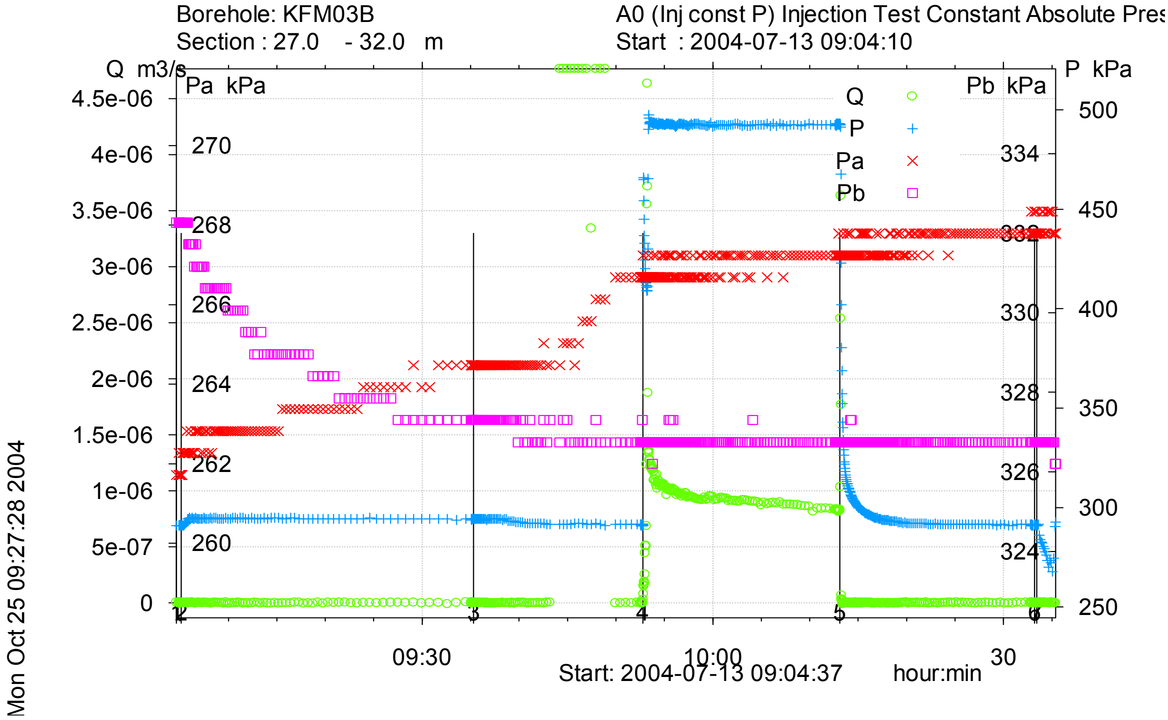


Figure A3-25. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 27–32 m in borehole KFM03B.

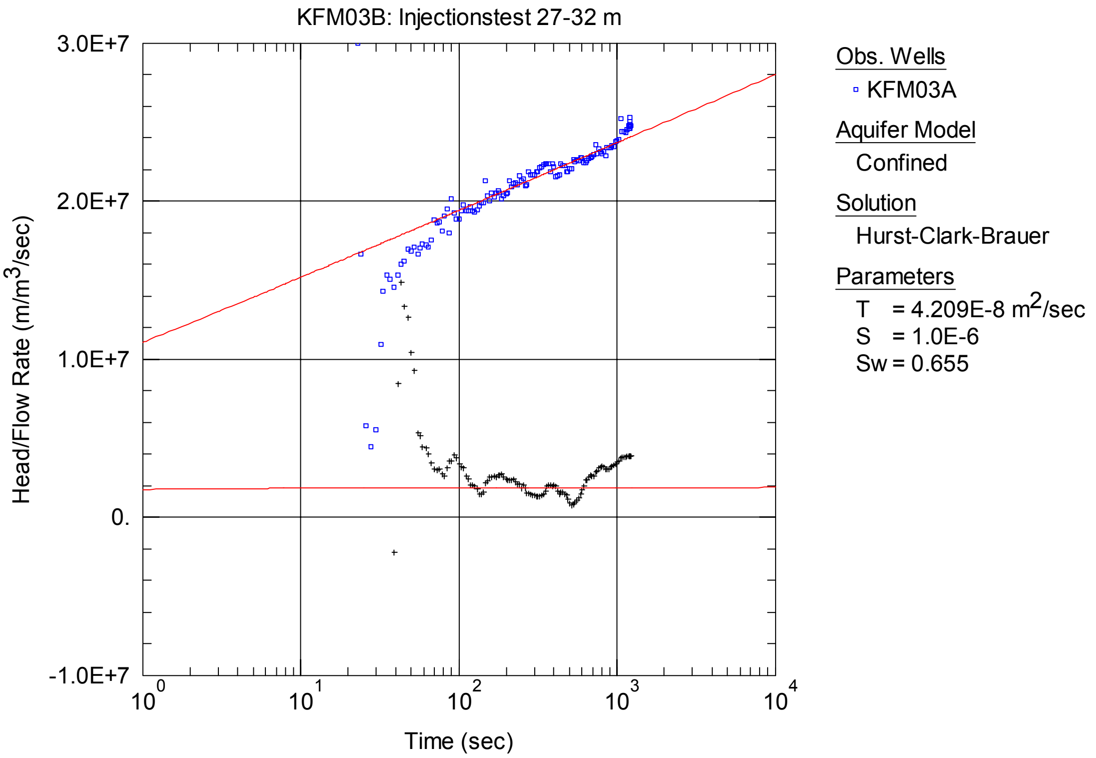


Figure A3-26. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 27–32 m in KFM03B.*

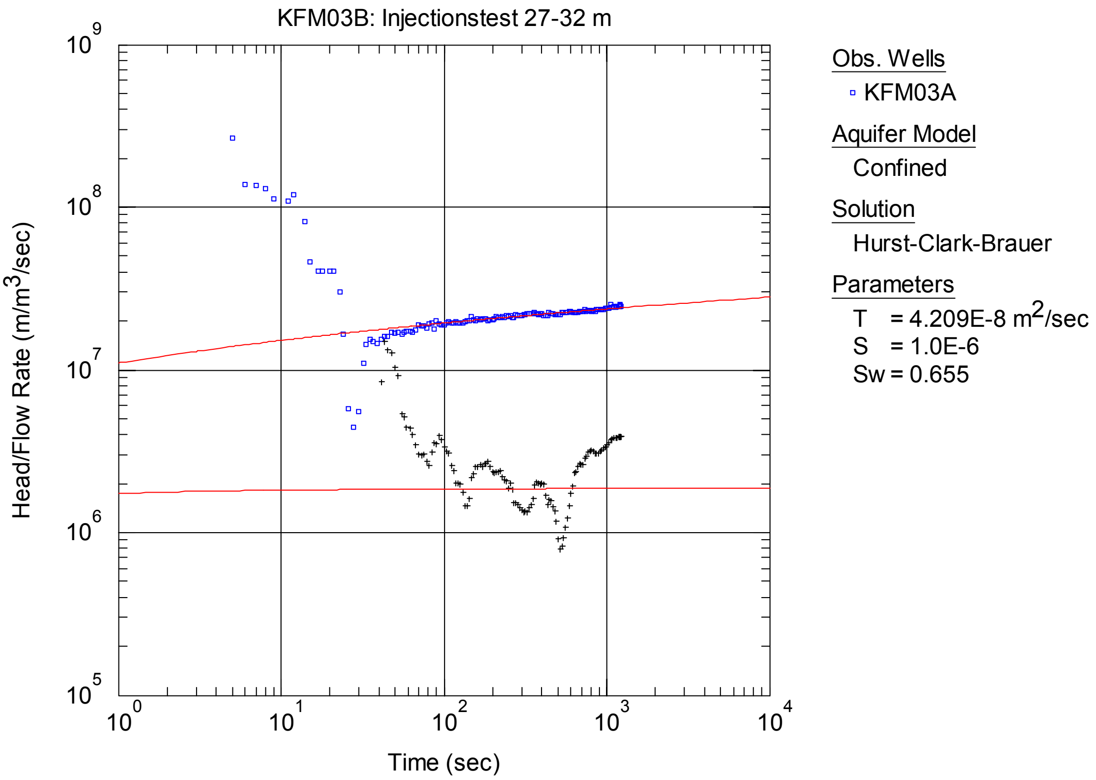


Figure A3-27. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 27–32 m in KFM03B.*

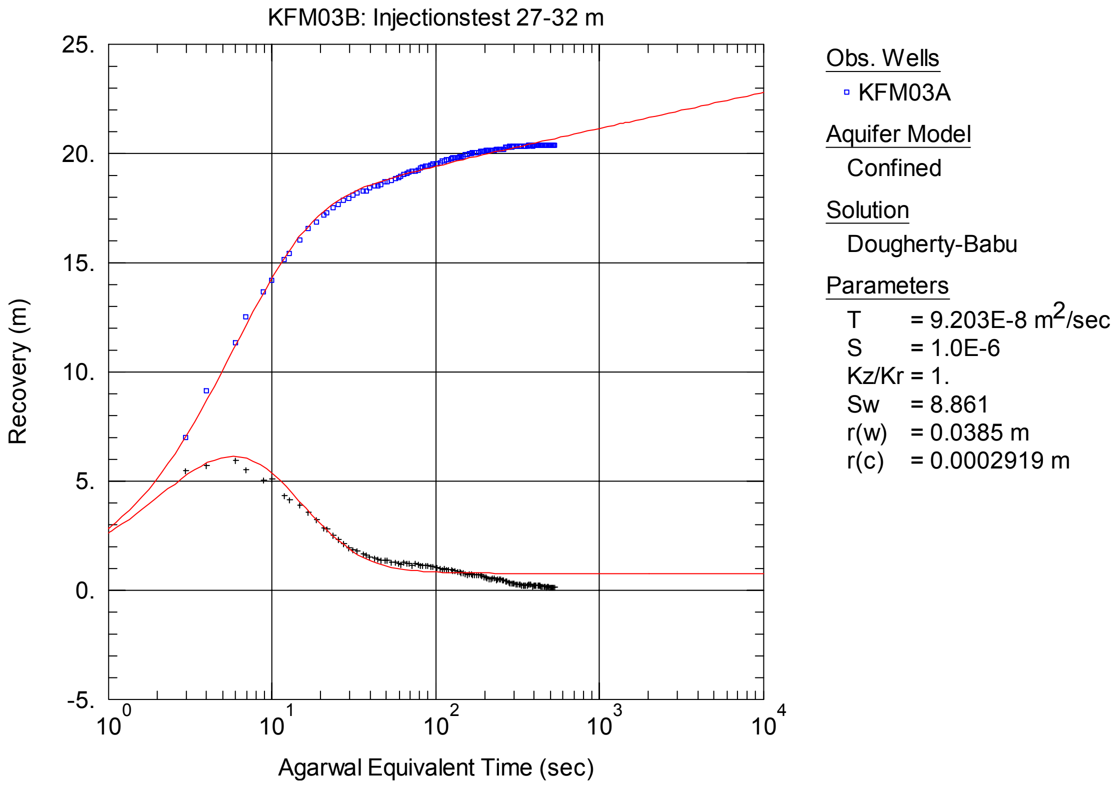


Figure A3-28. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 27–32 m in KFM03B.*

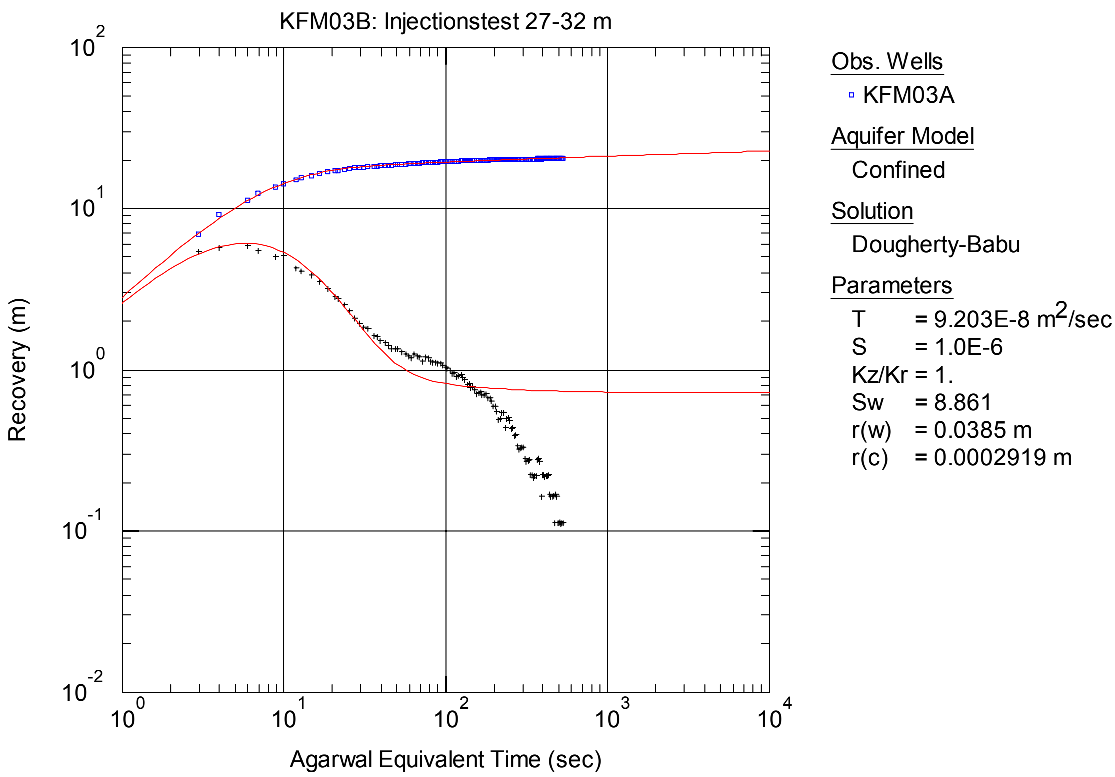


Figure A3-29. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 27–32 m in KFM03B.*

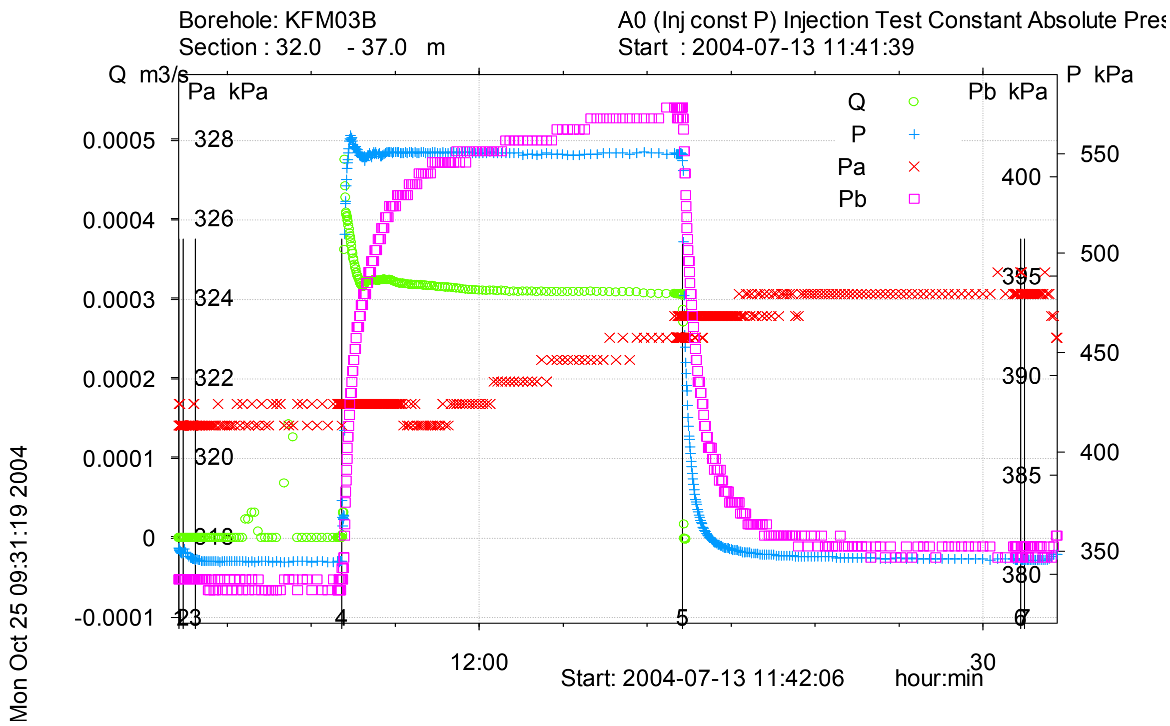


Figure A3-30. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 32–37 m in borehole KFM03B.*

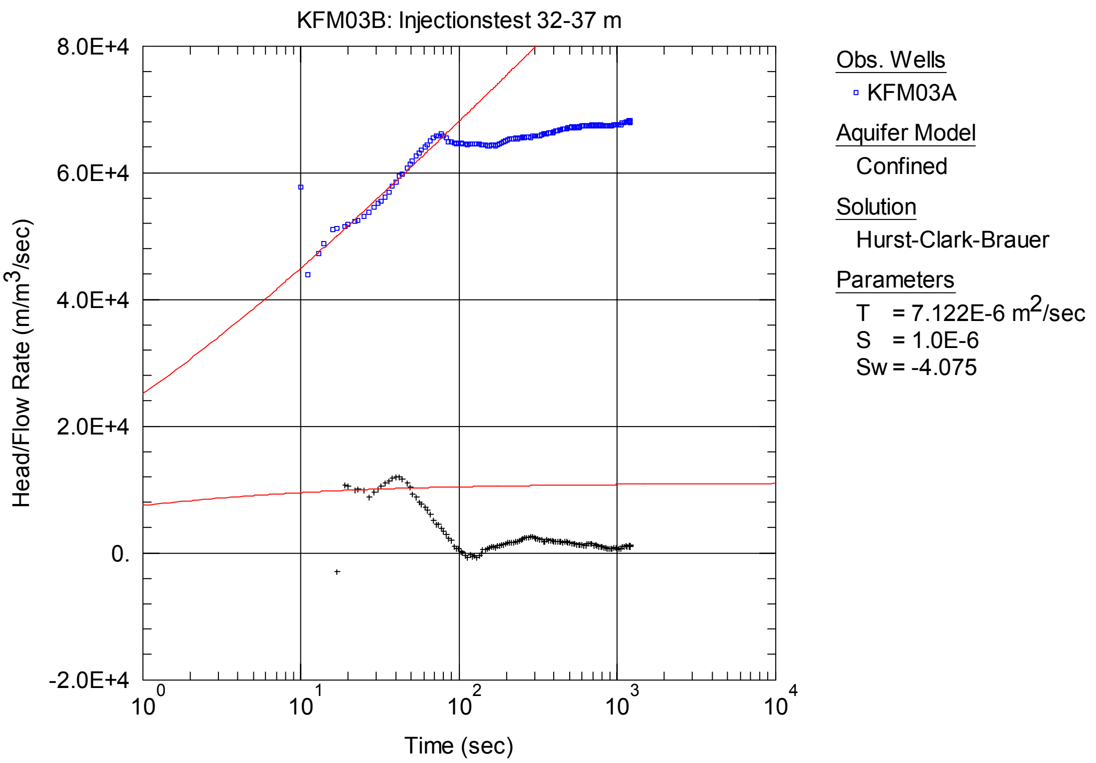


Figure A3-31. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 32–37 m in KFM03B.*

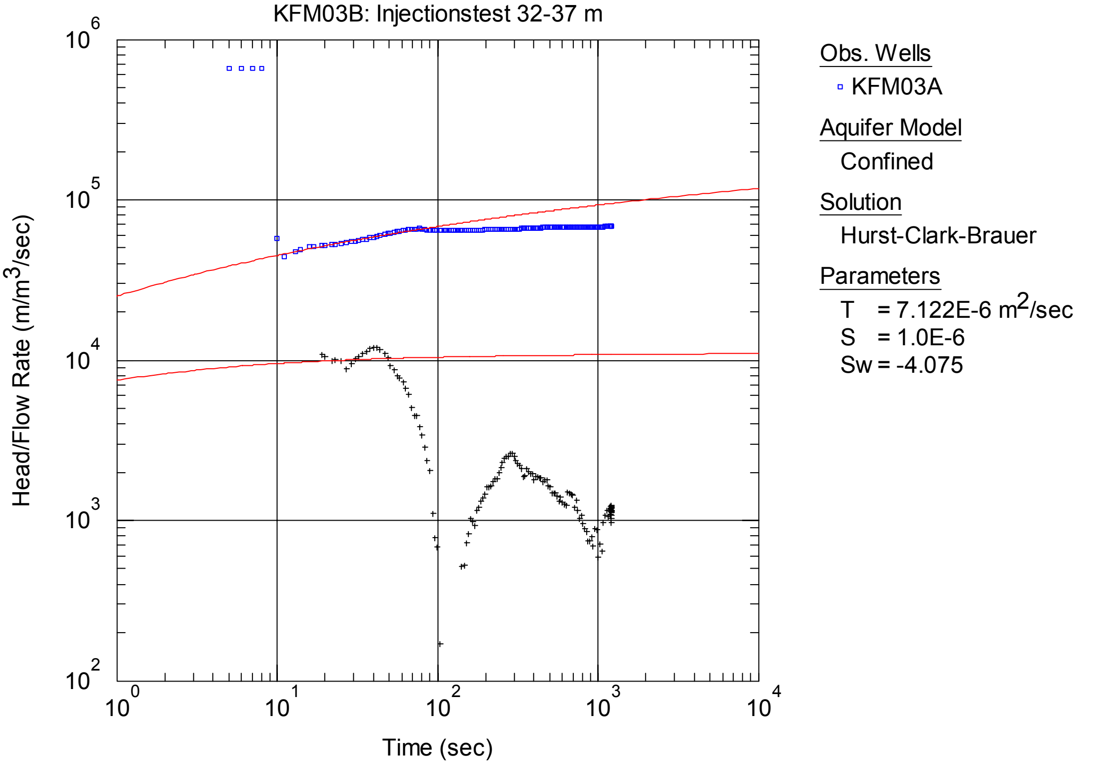


Figure A3-32. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 32–37 m in KFM03B.*

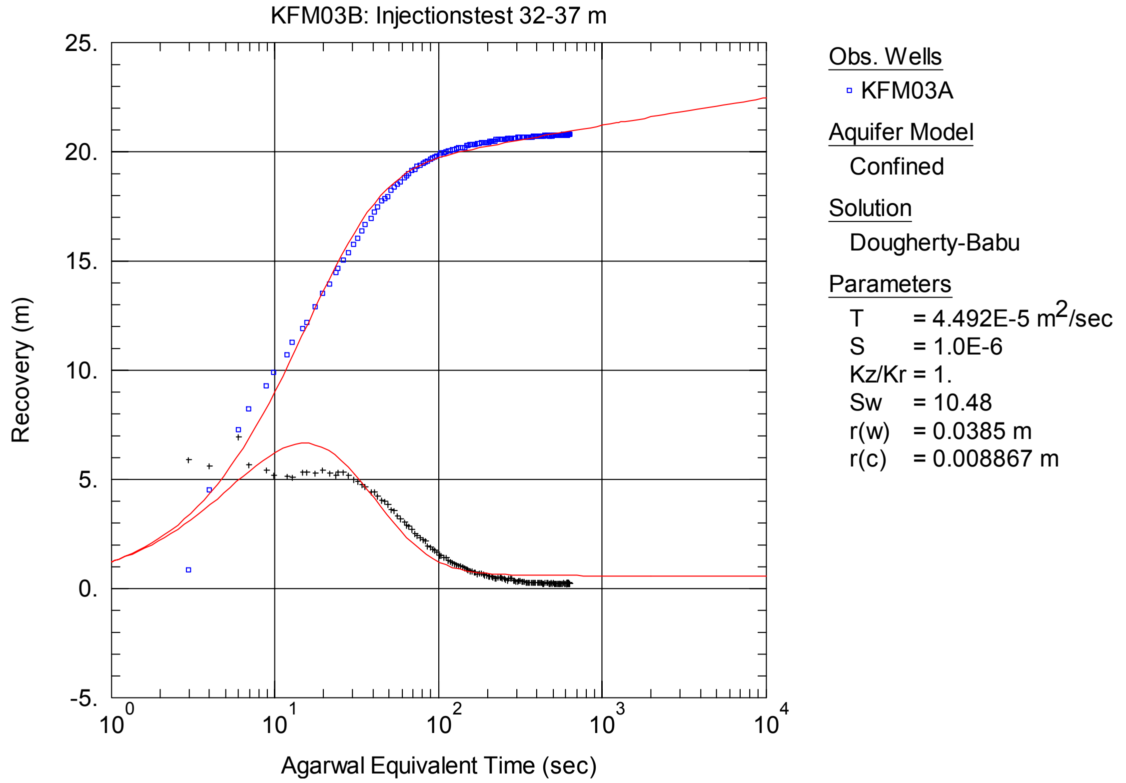


Figure A3-33. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 32–37 m in KFM03B.*

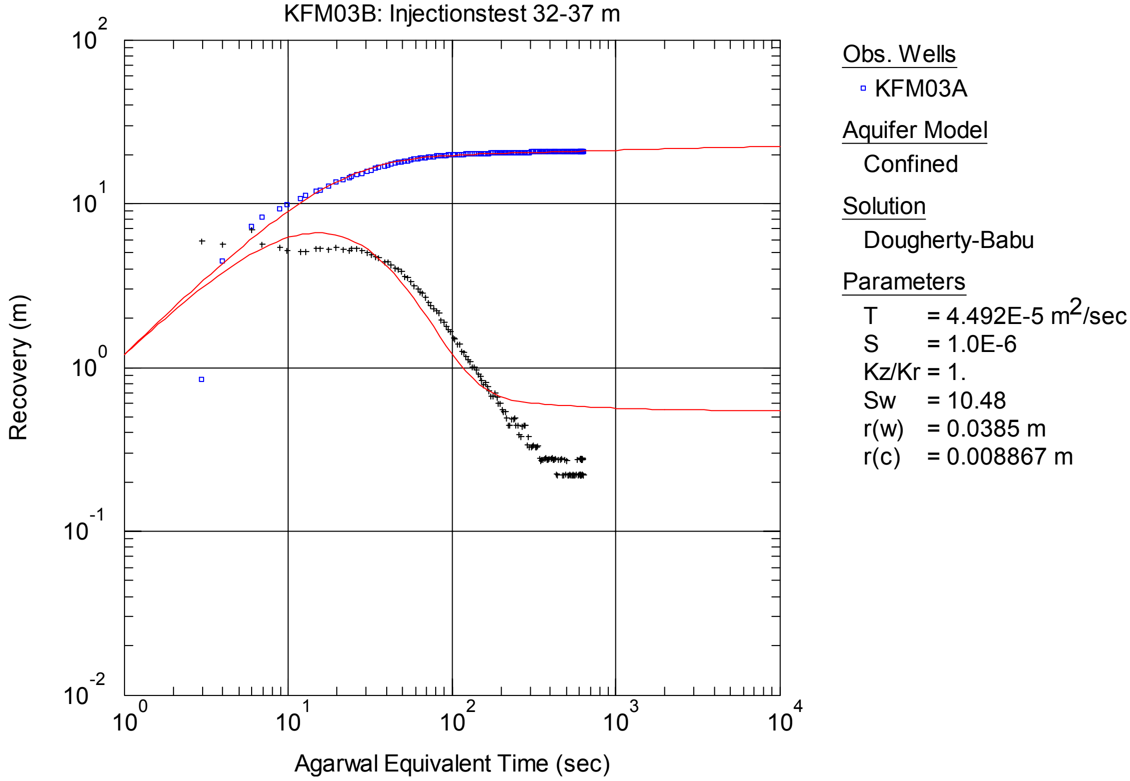


__Figure A3-34.__ Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 32–37 m in KFM03B.

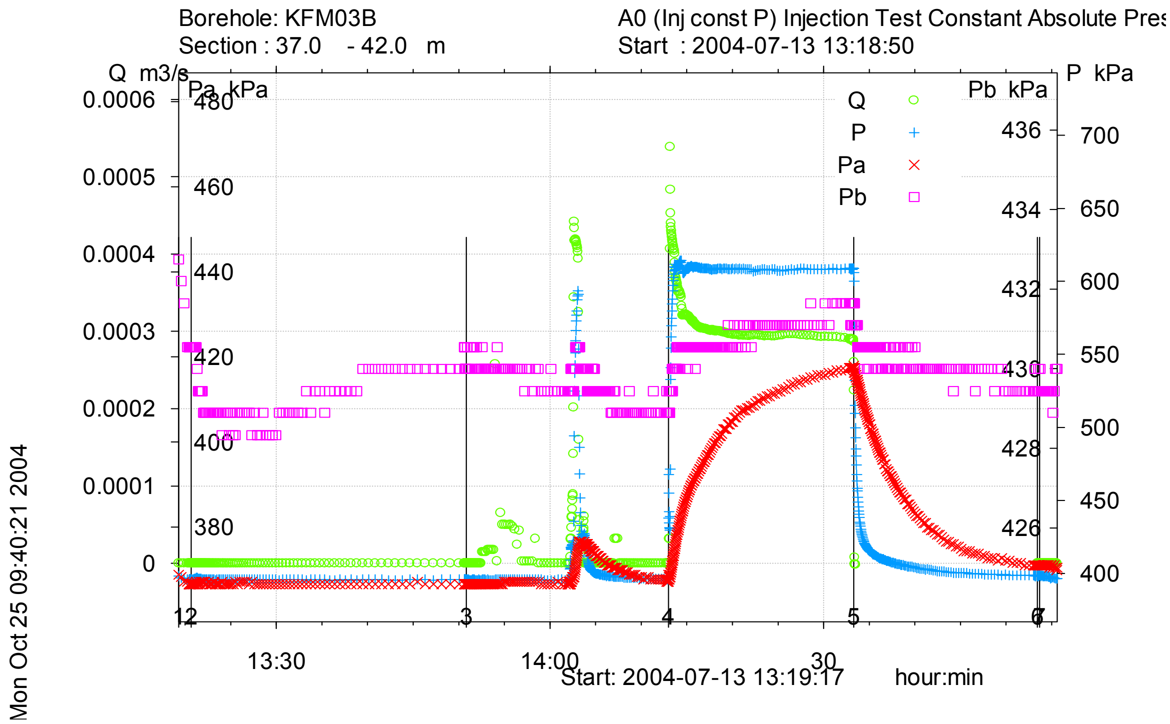


__Figure A3-35.__ Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 37–42 m in borehole KFM03B.

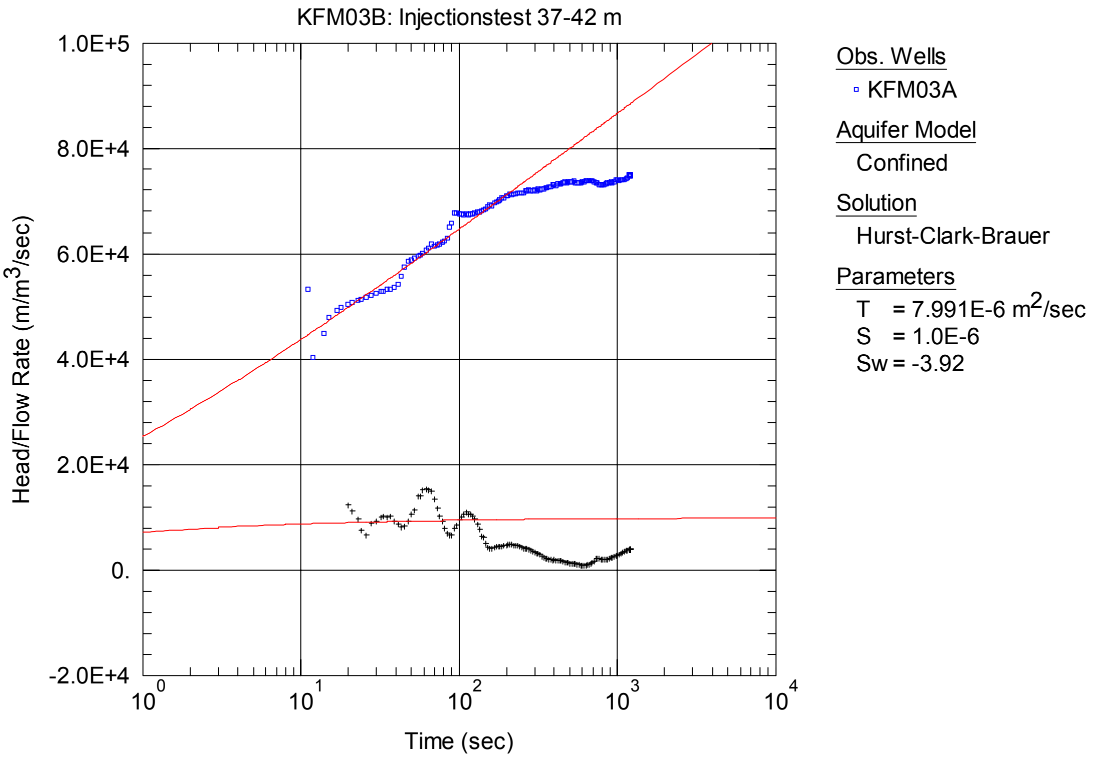


Figure A3-36. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 37–42 m in KFM03B.*

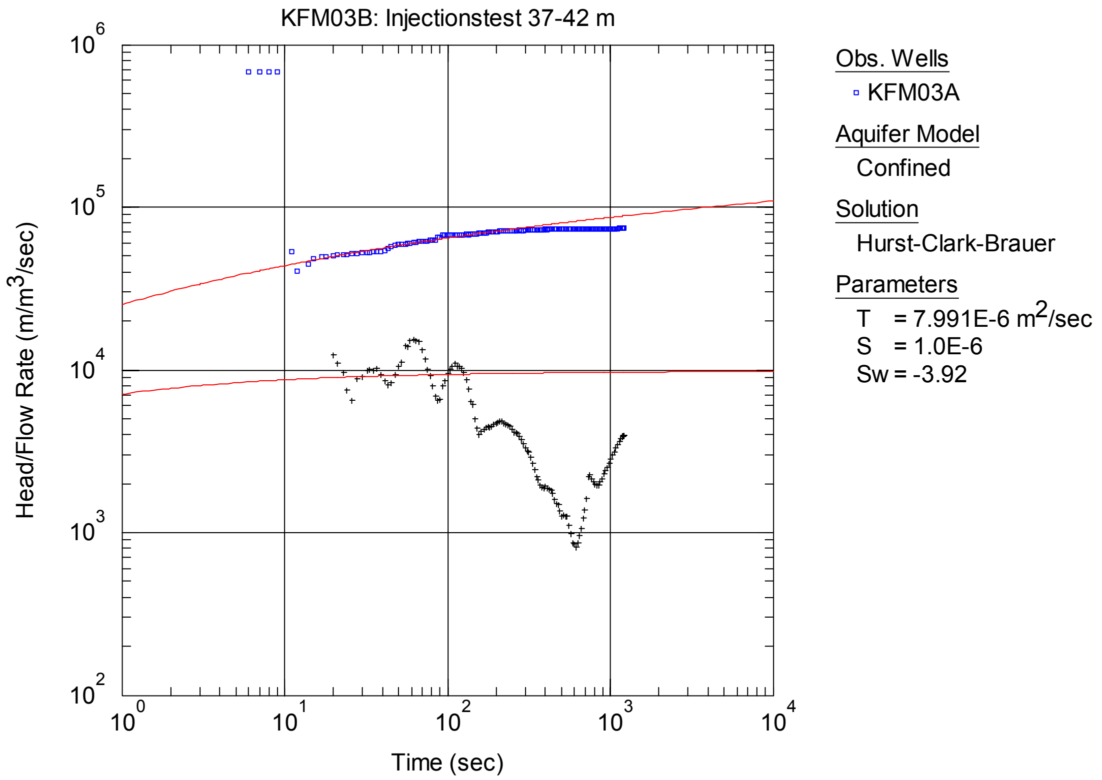


Figure A3-37. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 37–42 m in KFM03B.*

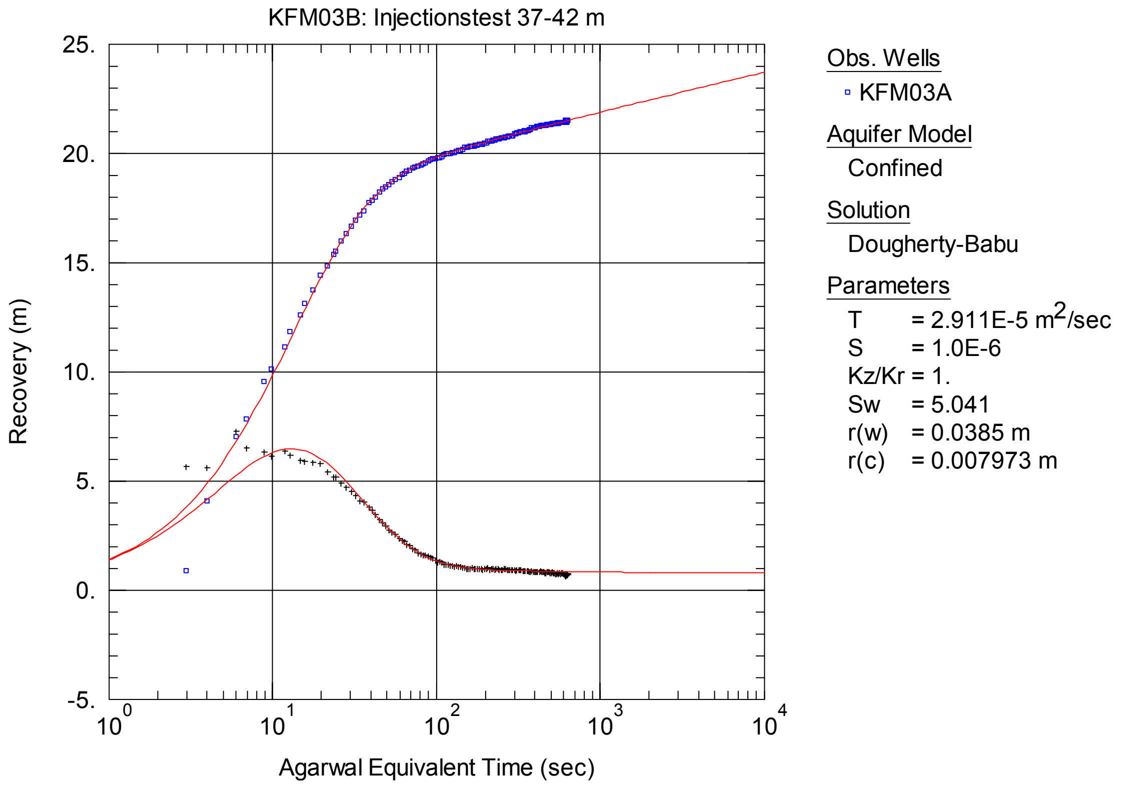


Figure A3-38. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 37–42 m in KFM03B.*

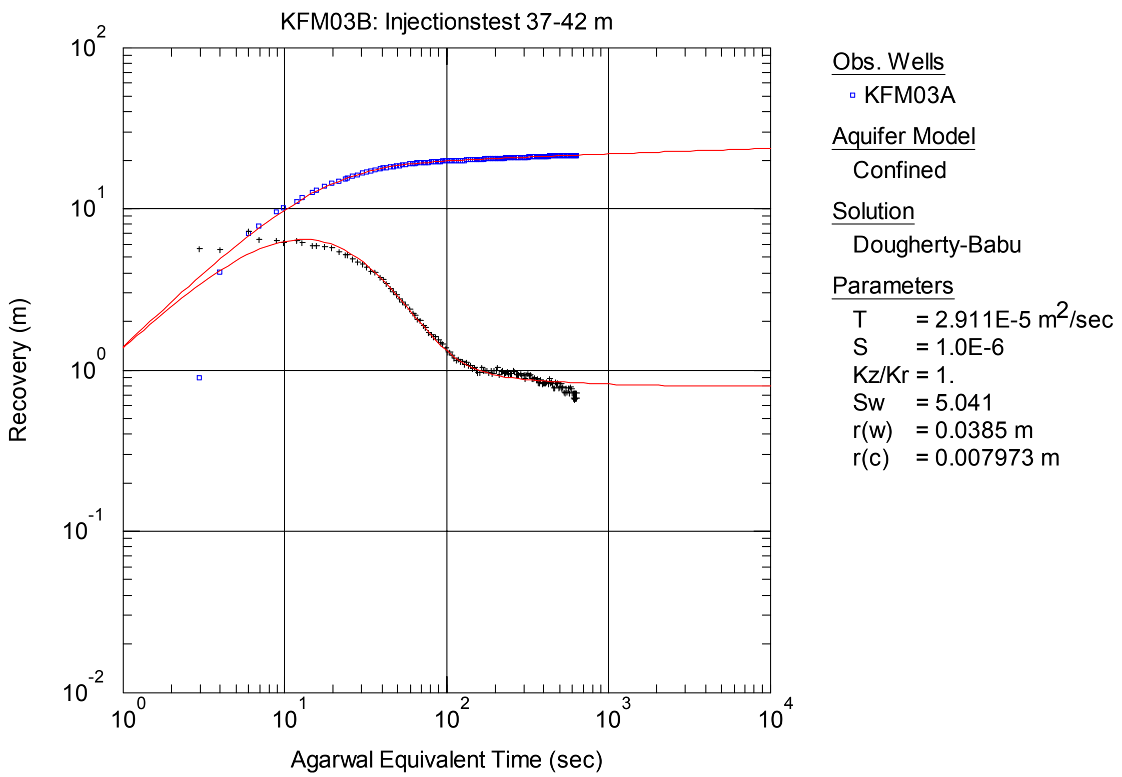


Figure A3-39. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 37–42 m in KFM03B.*

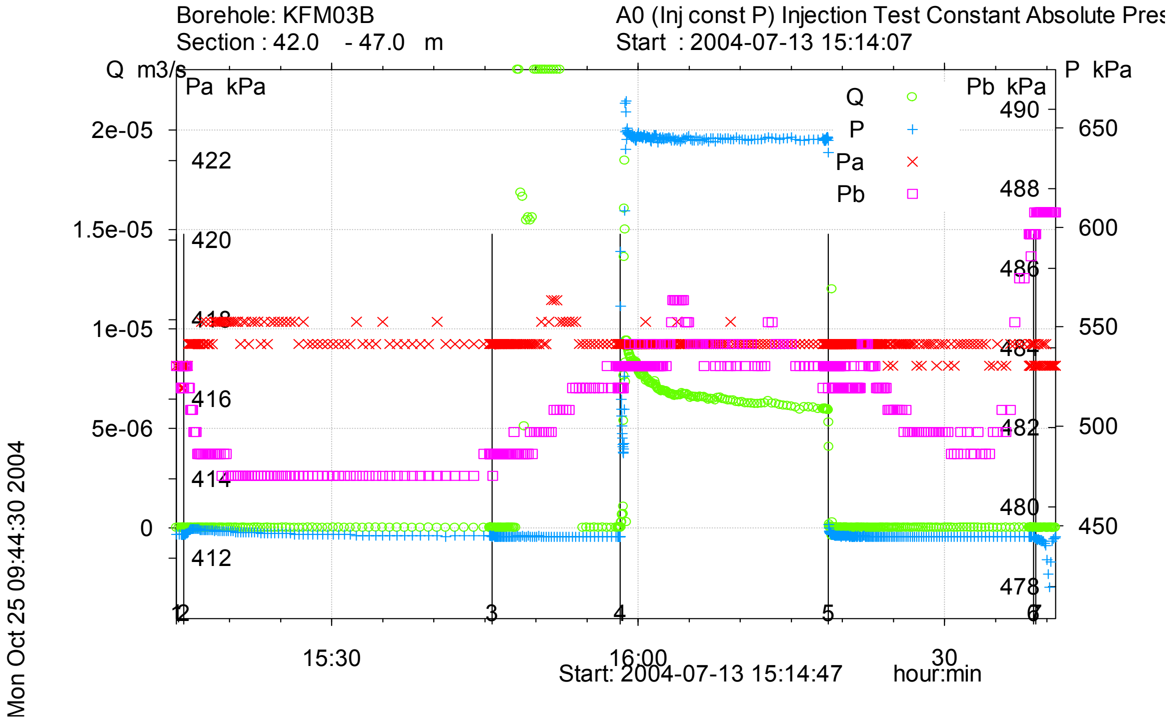


Figure A3-40. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 42–47 m in borehole KFM03B.*

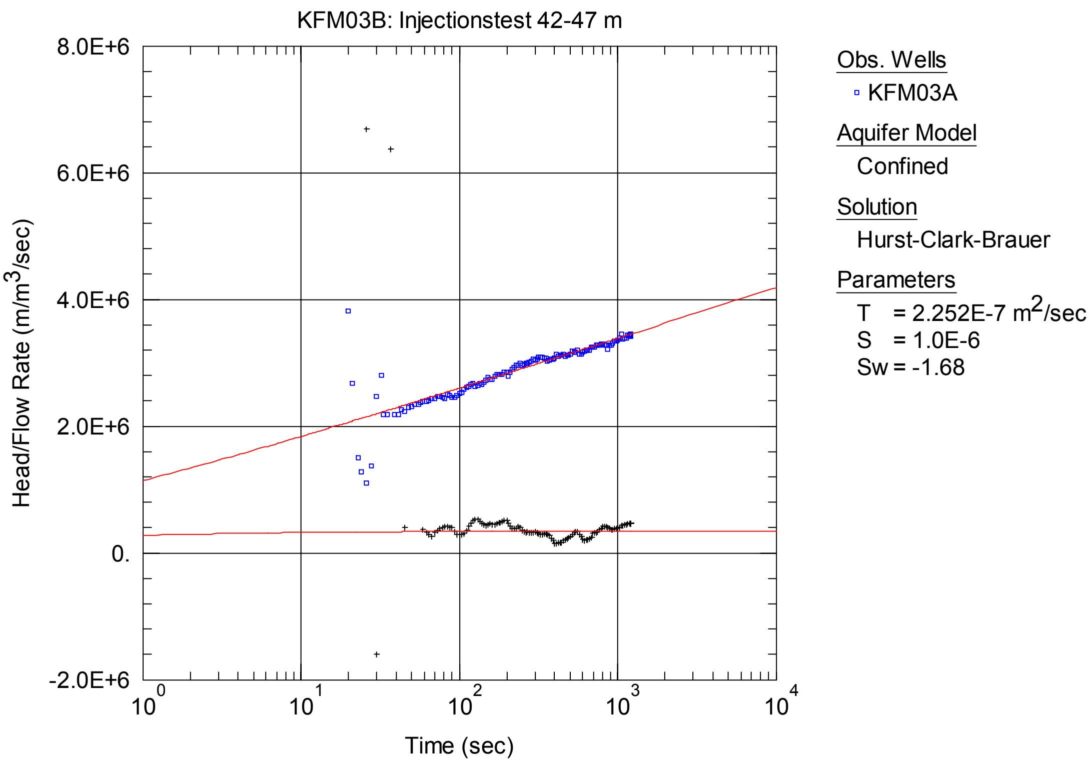


Figure A3-41. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 42–47 m in KFM03B.*

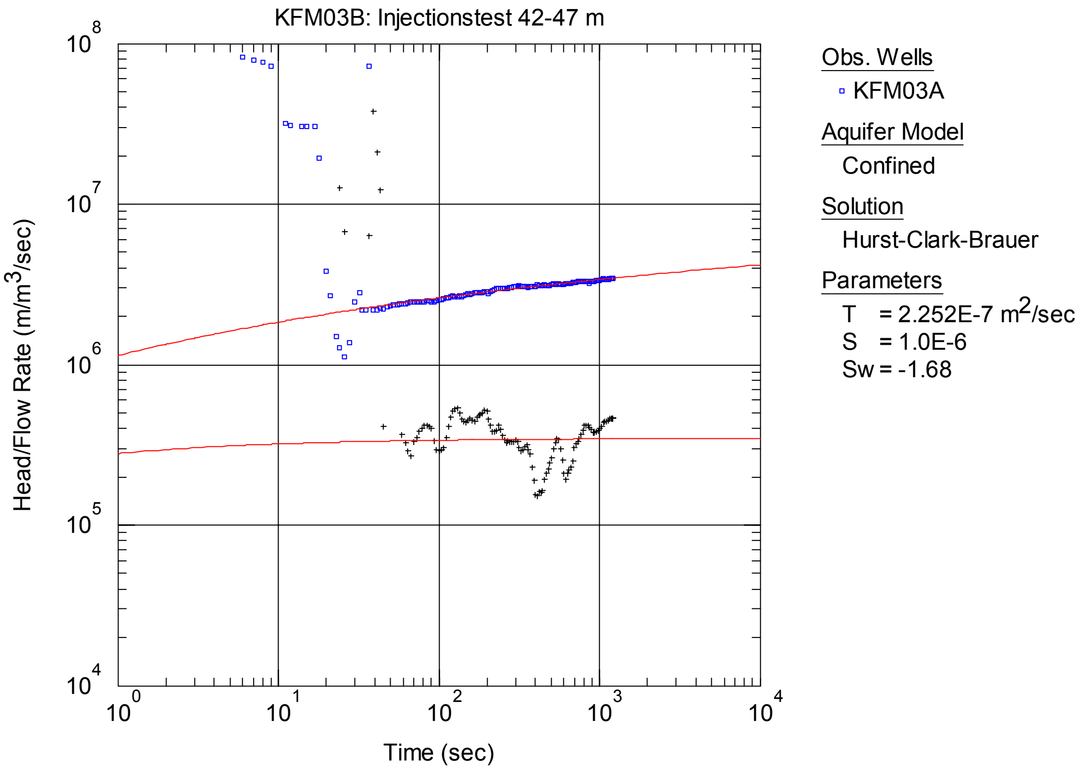


Figure A3-42. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 42–47 m in KFM03B.*

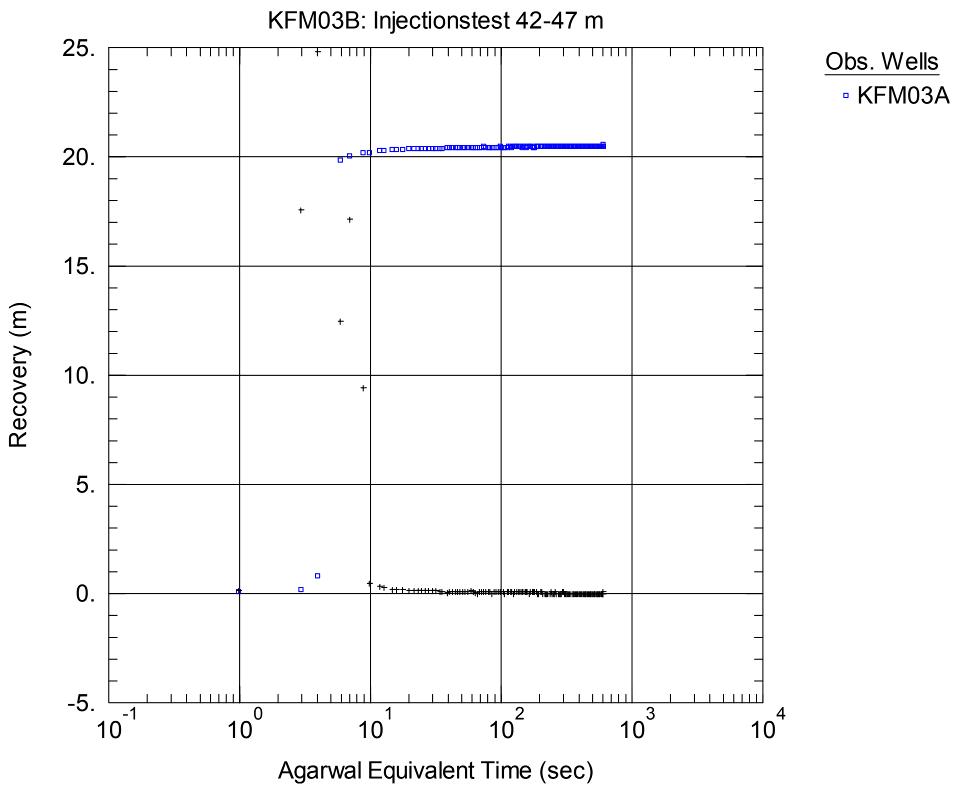


Figure A3-43. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 42–47 m in KFM03B.*

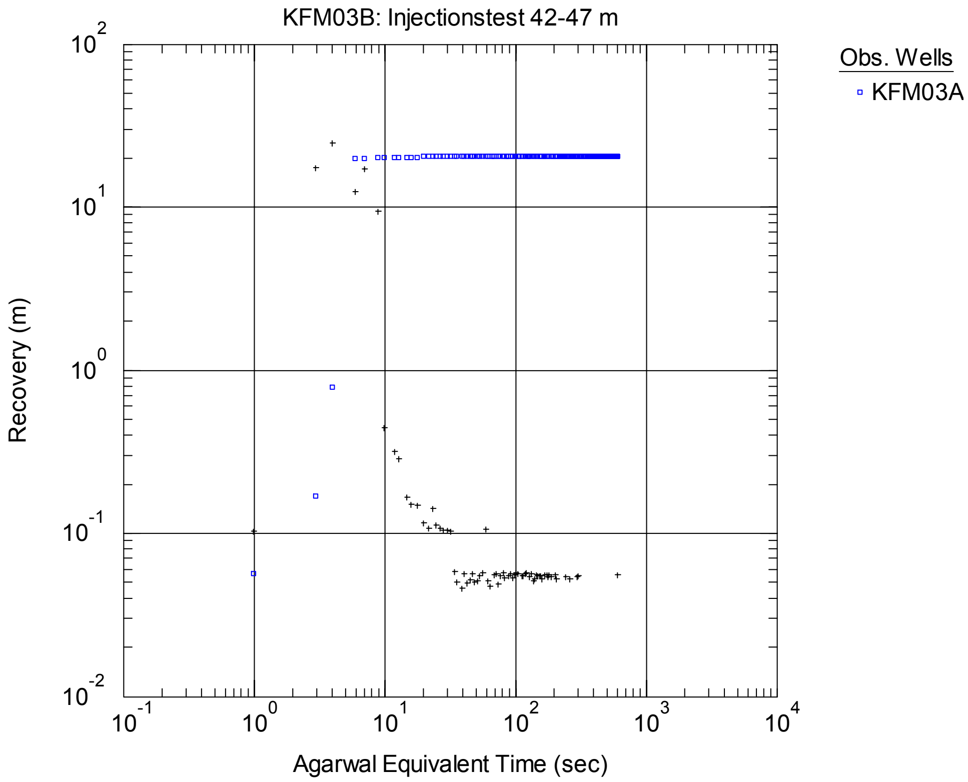


Figure A3-44. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 42–47 m in KFM03B.*

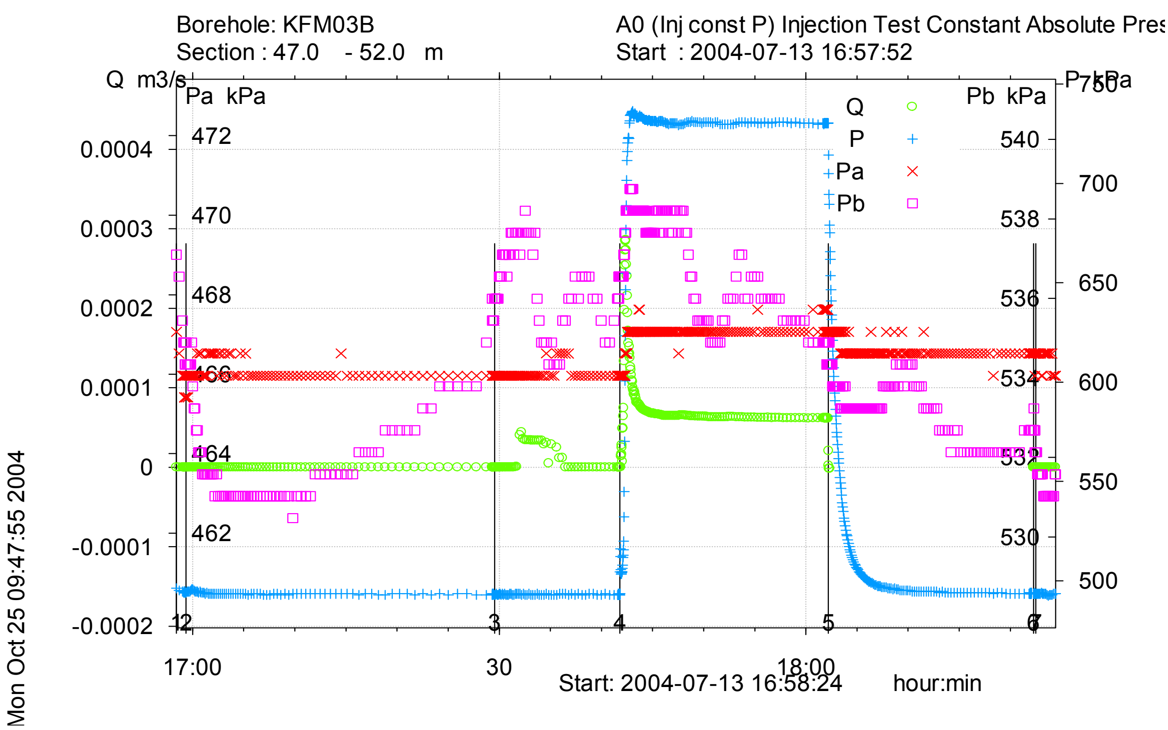


Figure A3-45. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 47–52 m in borehole KFM03B.*

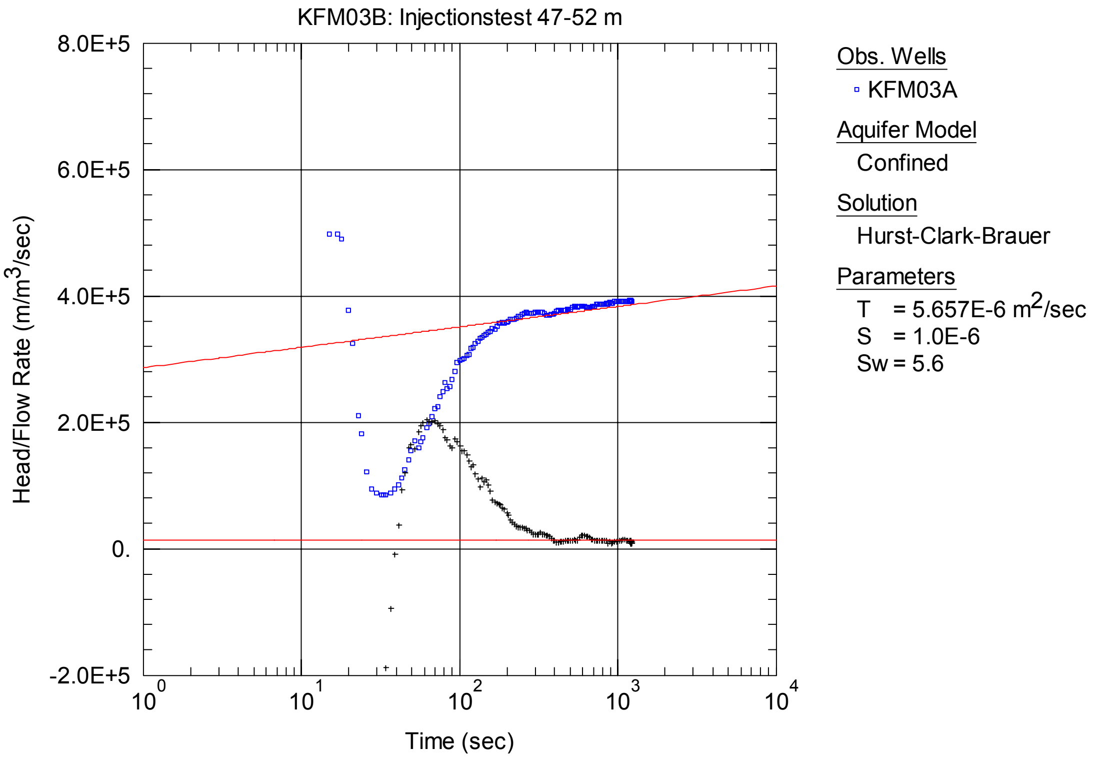


Figure A3-46. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 47–52 m in KFM03B.*

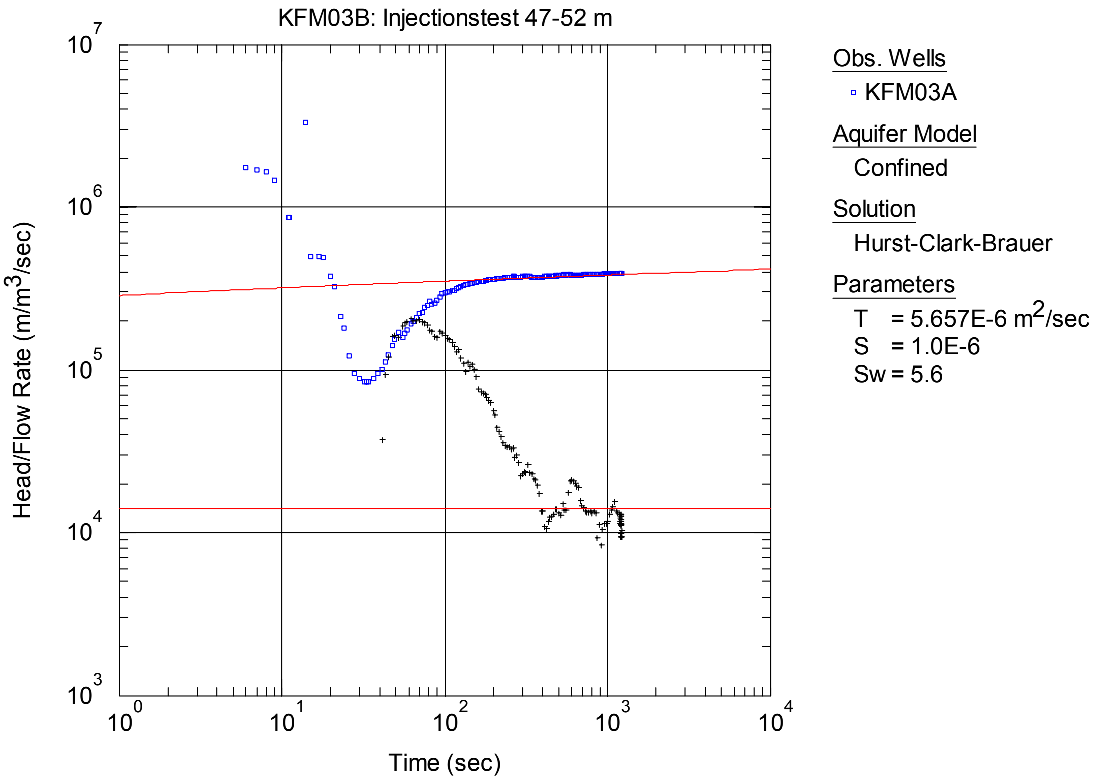


Figure A3-47. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 47–52 m in KFM03B.*

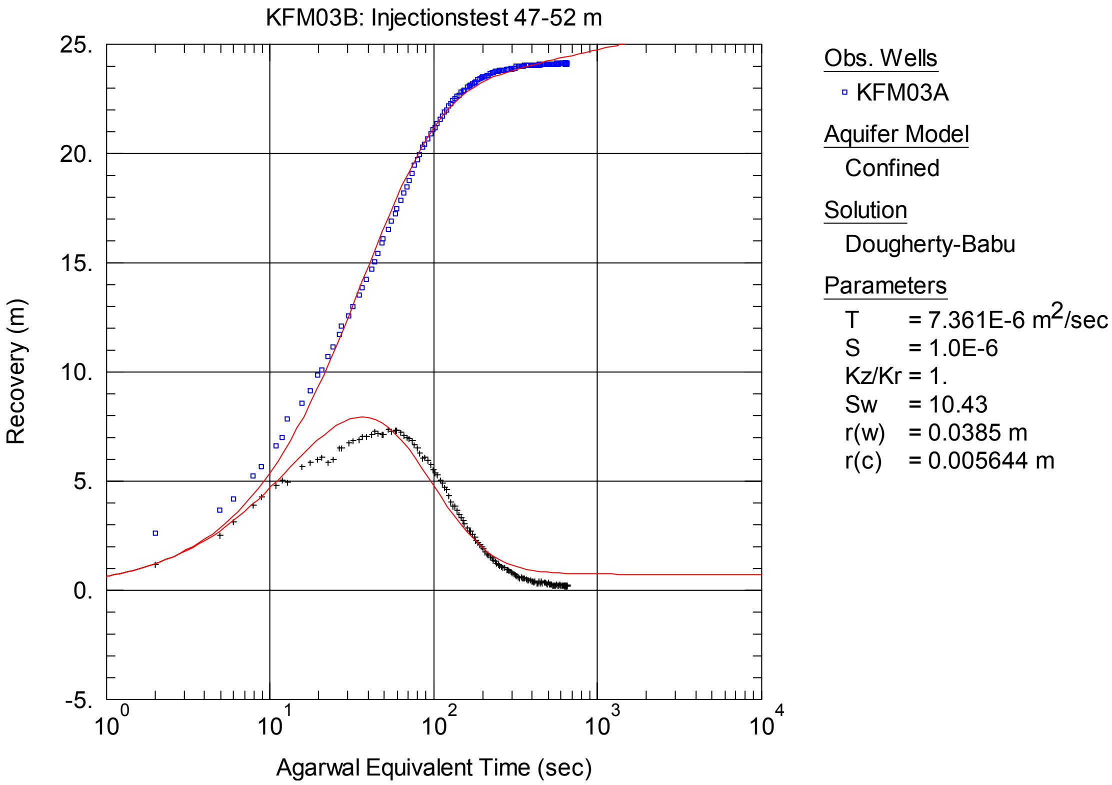


Figure A3-48. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 47–52 m in KFM03B.*

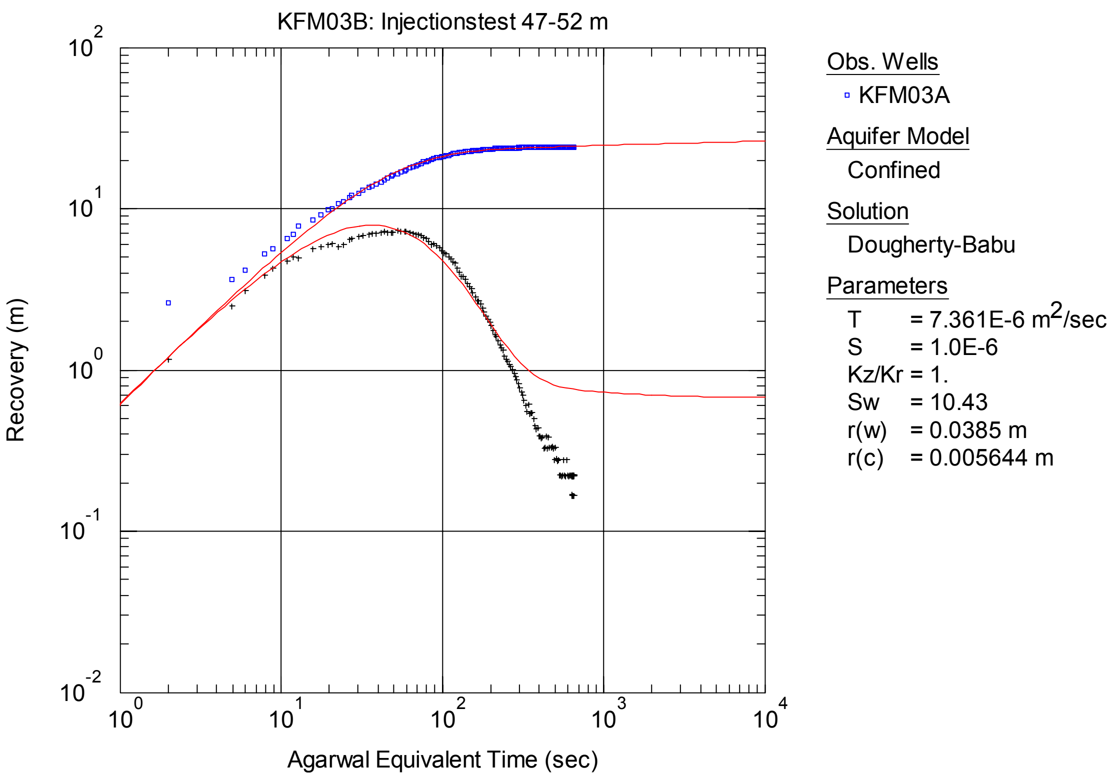


Figure A3-49. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 47–52 m in KFM03B.*

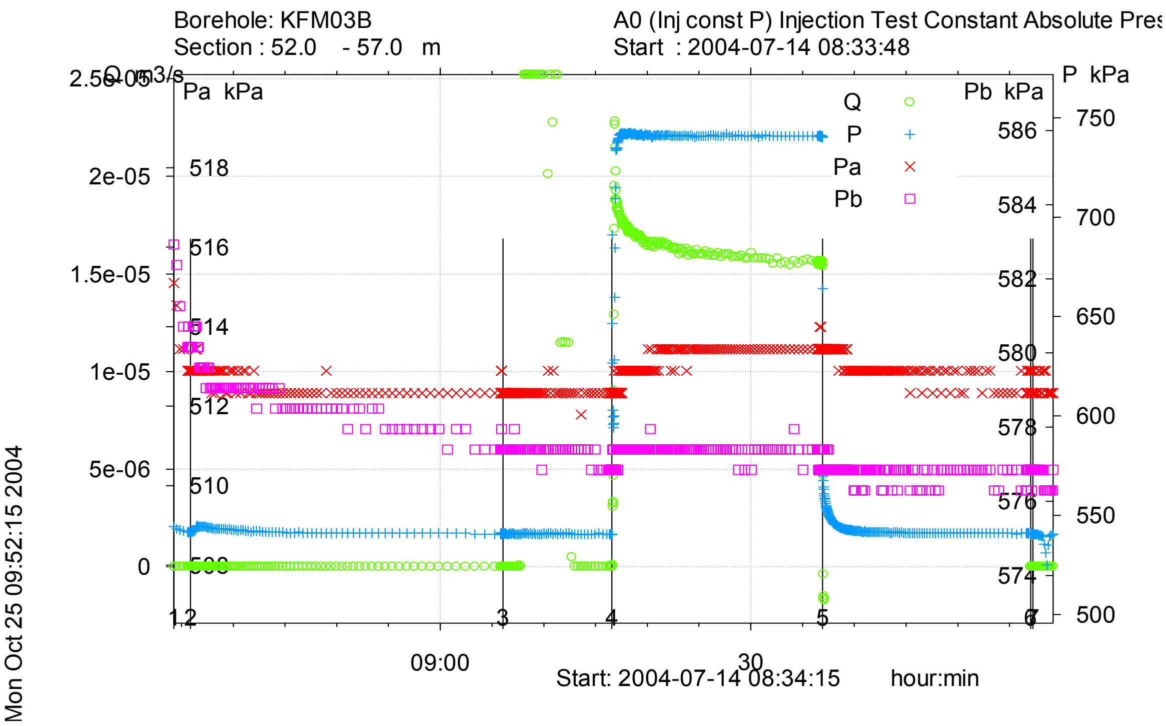


Figure A3-50. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 52–57 m in borehole KFM03B.*

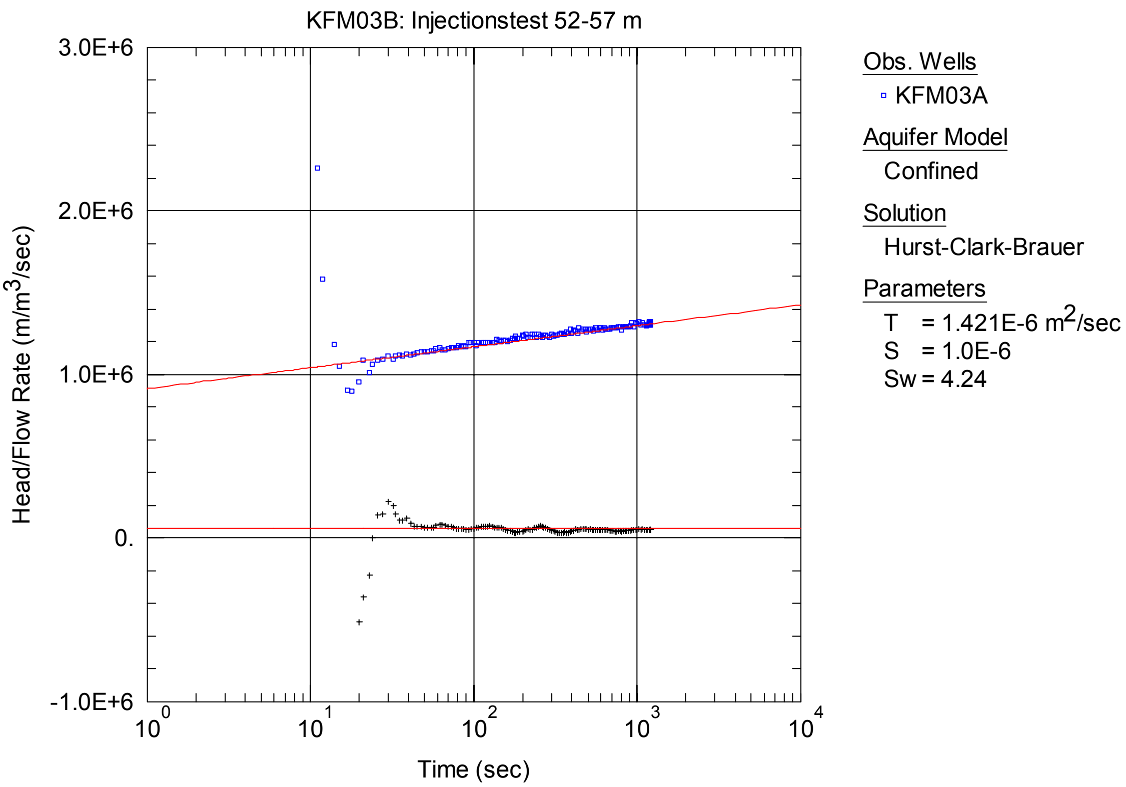


Figure A3-51. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 52–57 m in KFM03B.*

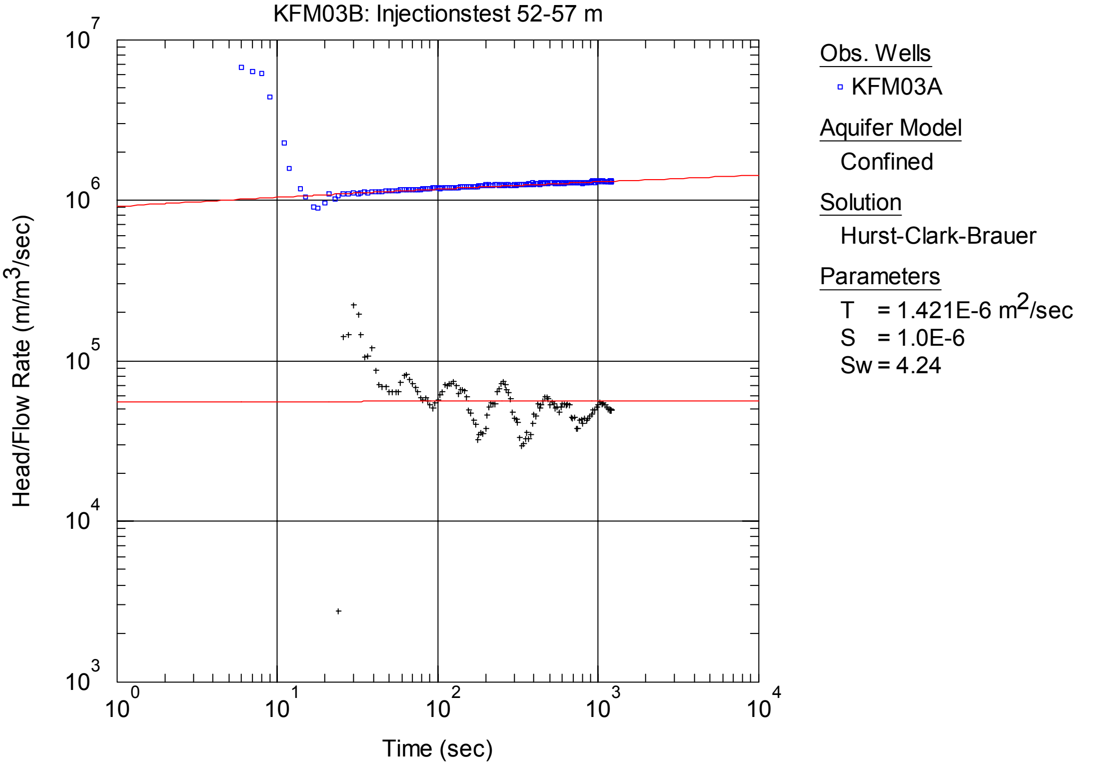


Figure A3-52. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 52–57 m in KFM03B.*

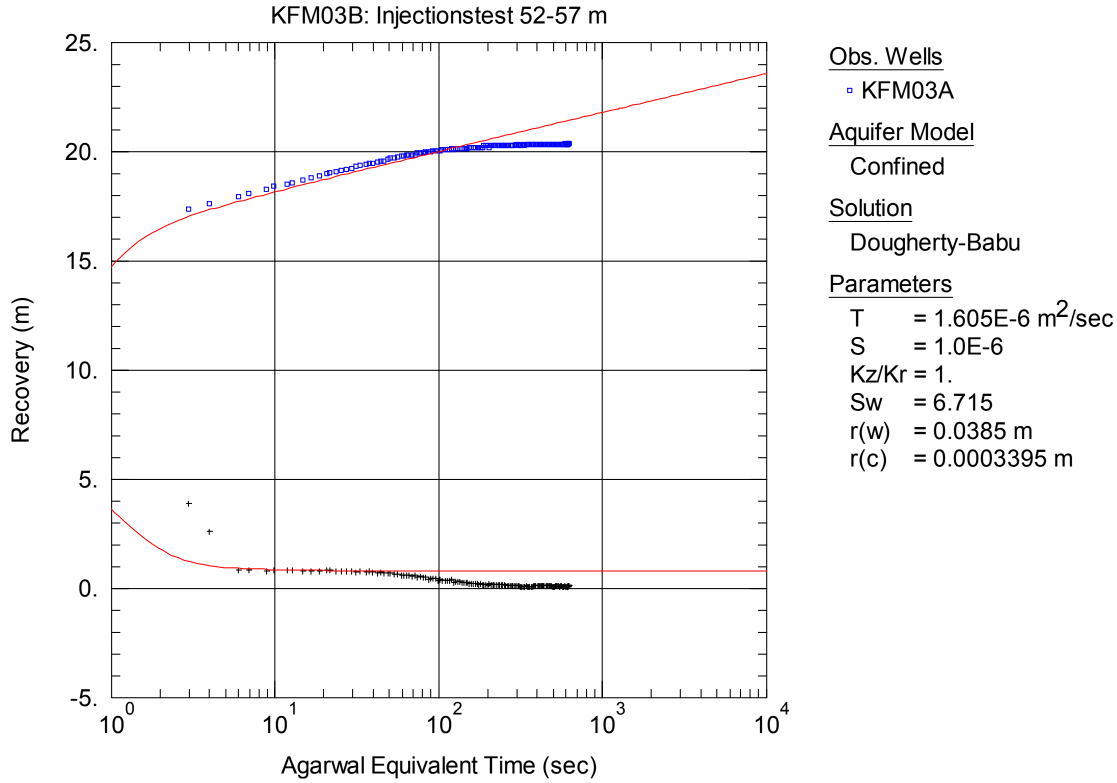


Figure A3-53. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 52–57 m in KFM03B.*

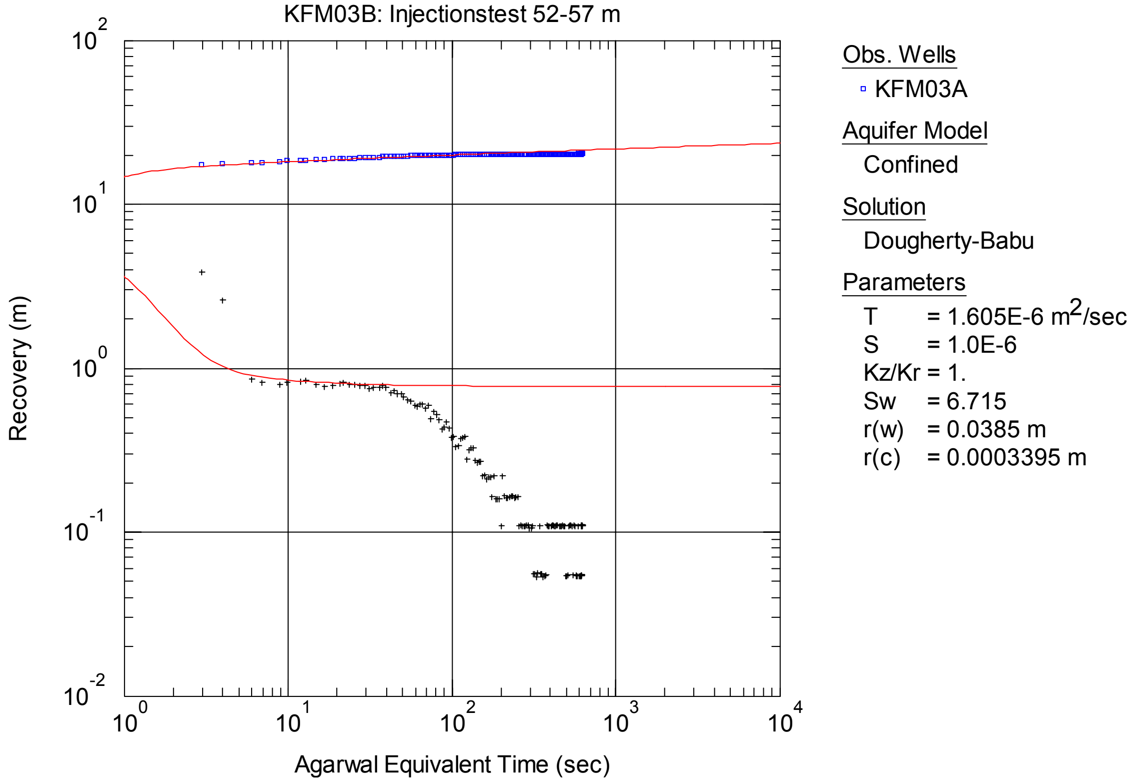


***Figure A3-54.** Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 52–57 m in KFM03B.*

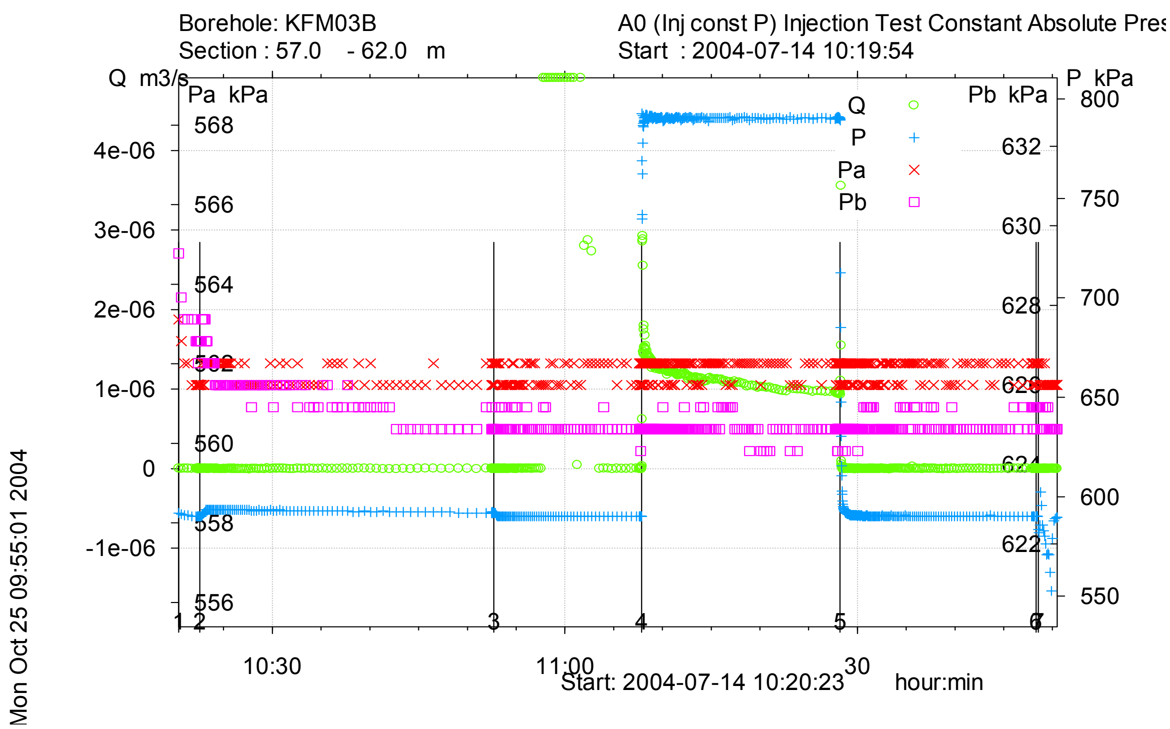


***Figure A3-55.** Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 57–62 m in borehole KFM03B.*

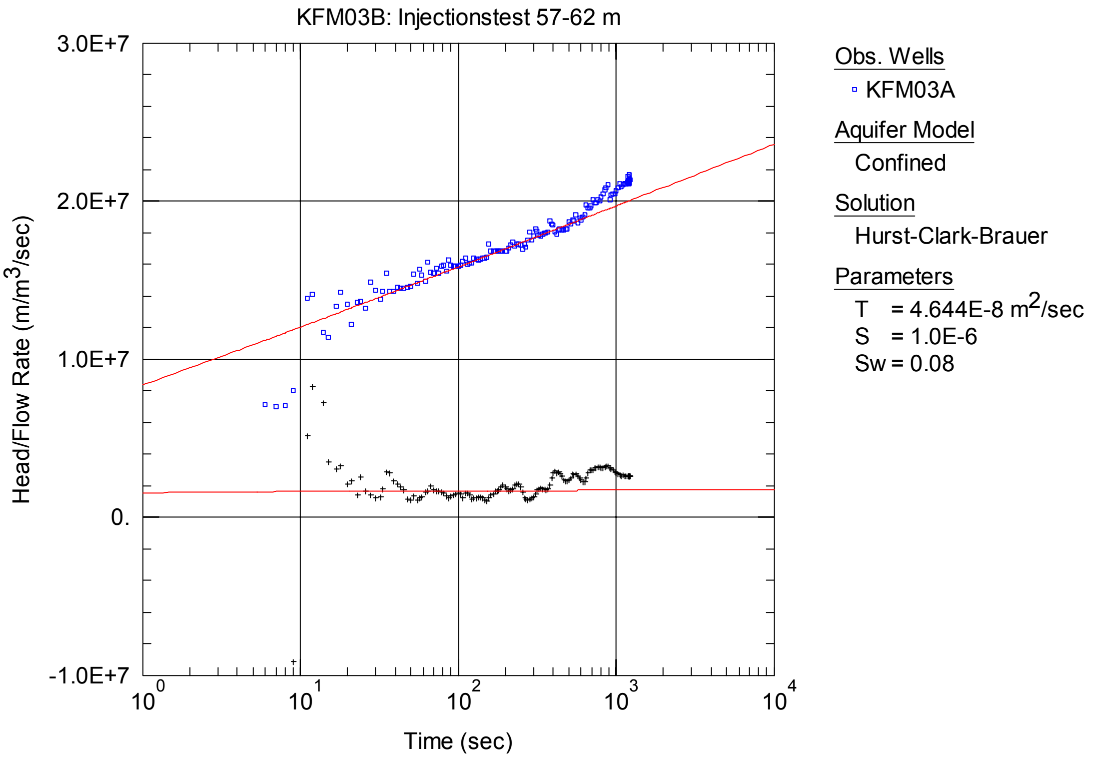


Figure A3-56. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 57–62 m in KFM03B. Showing fit to early PRF.*

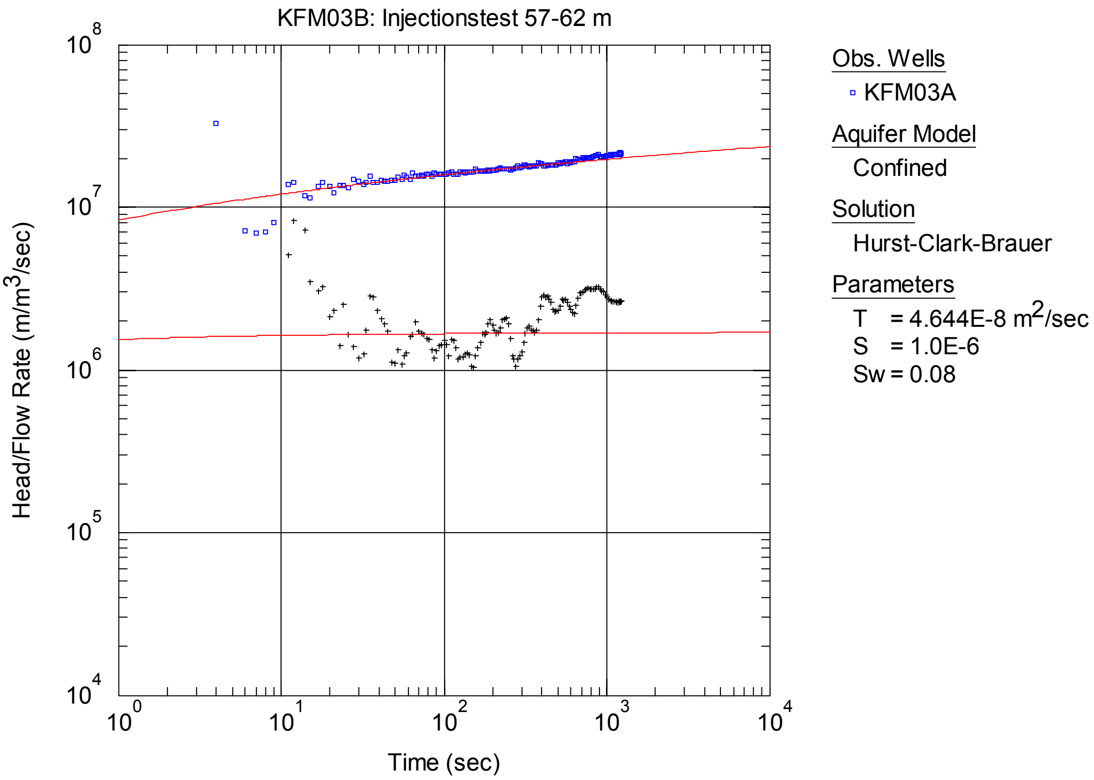


Figure A3-57. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 57–62 m in KFM03B. Showing fit to early PRF.*

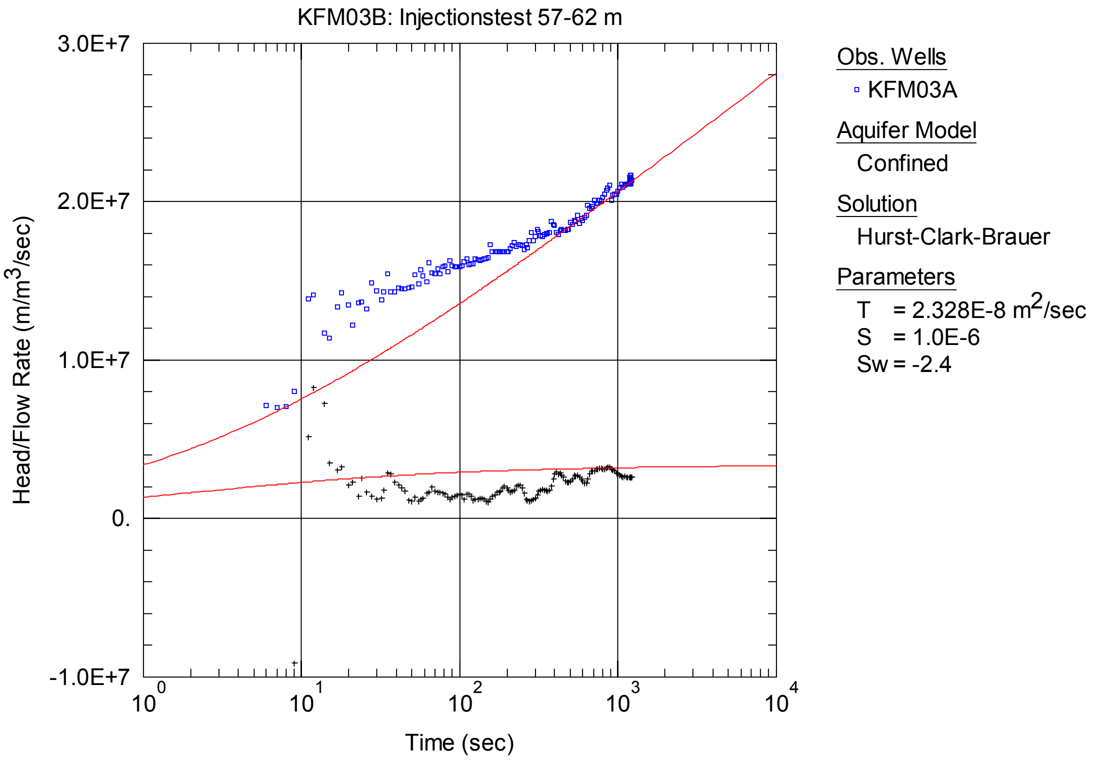


Figure A3-58. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 57–62 m in KFM03B. Showing fit to late PRF.*

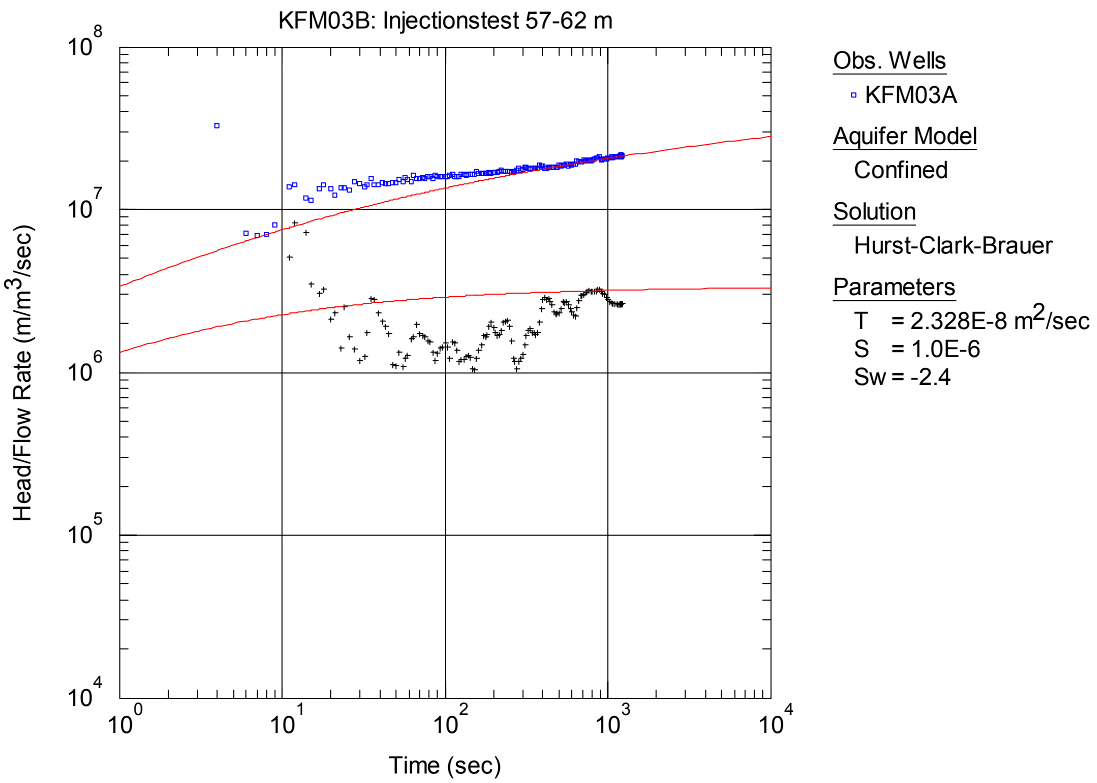


Figure A3-59. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 57–62 m in KFM03B. Showing fit to late PRF.*

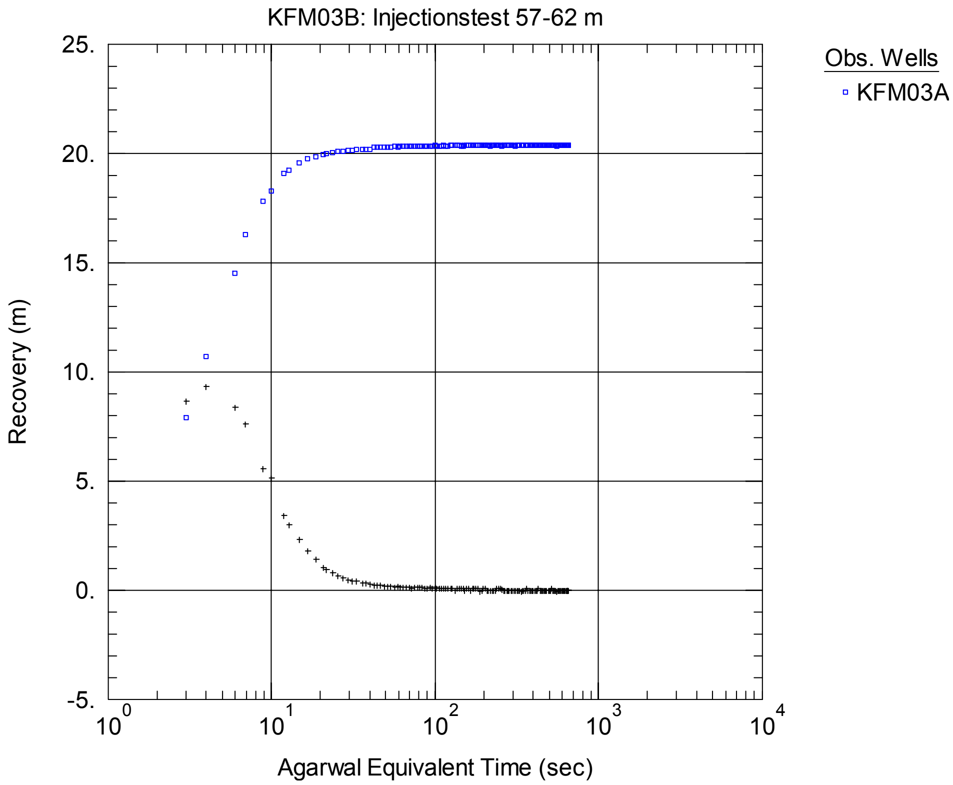


Figure A3-60. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 57–62 m in KFM03B.*

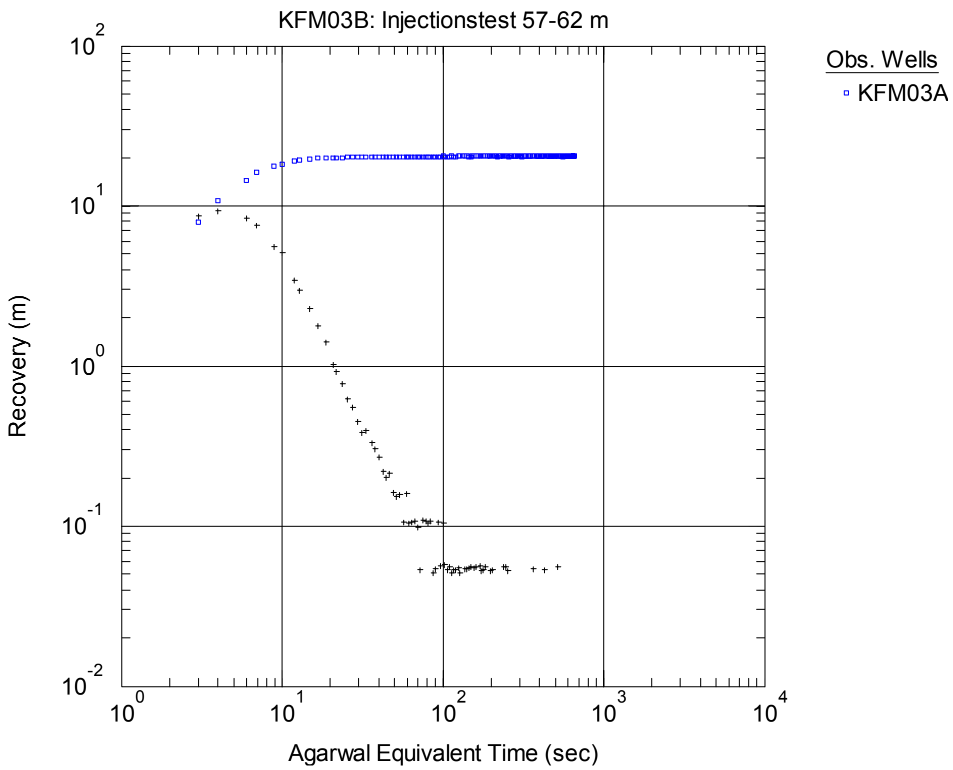


Figure A3-61. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 57–62 m in KFM03B.*

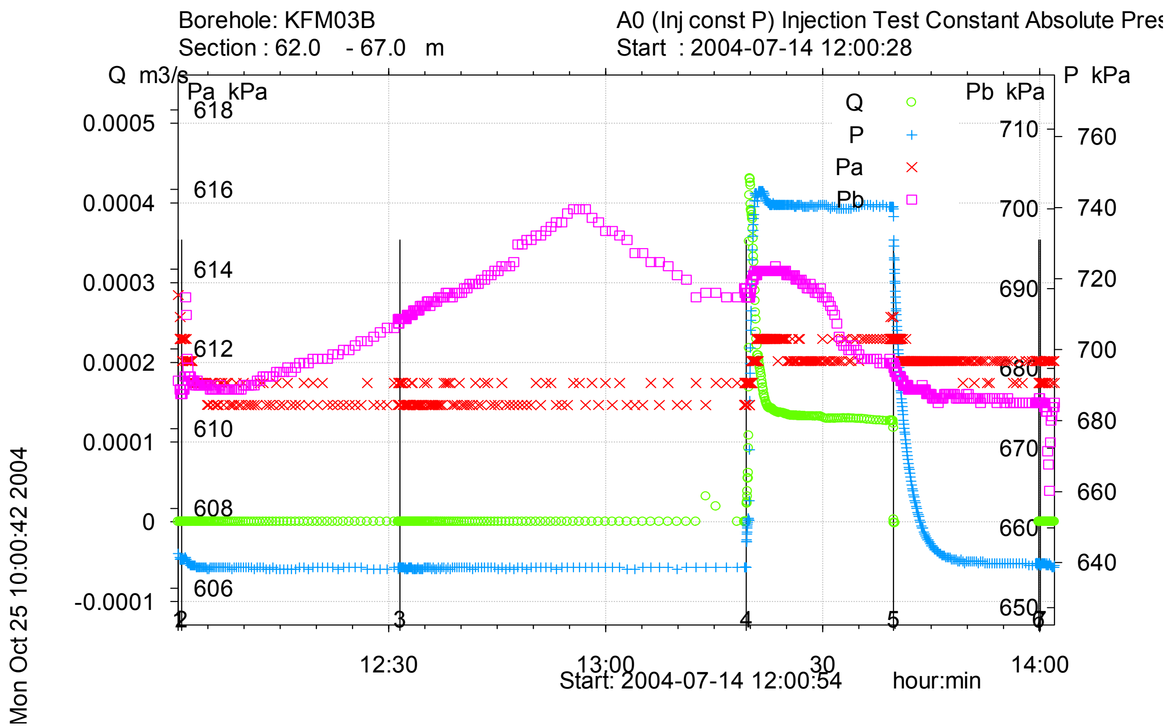


Figure A3-62. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 62–67 m in borehole KFM03B.*

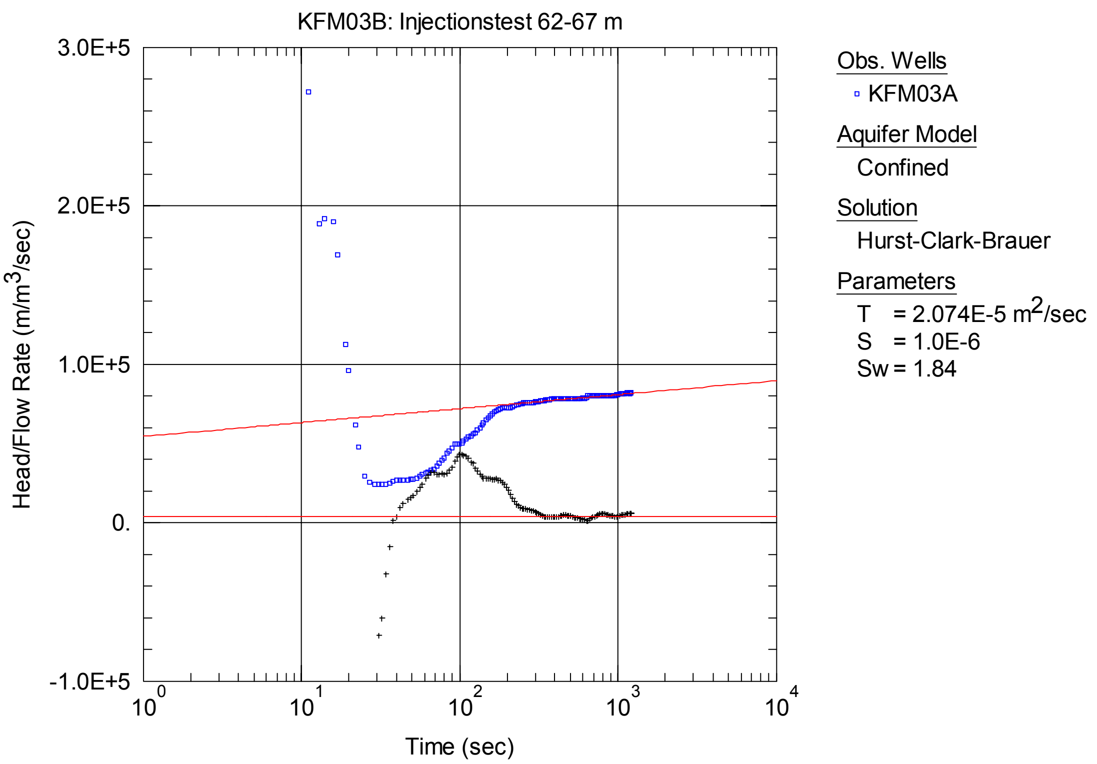


Figure A3-63. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 62–67 m in KFM03B.*

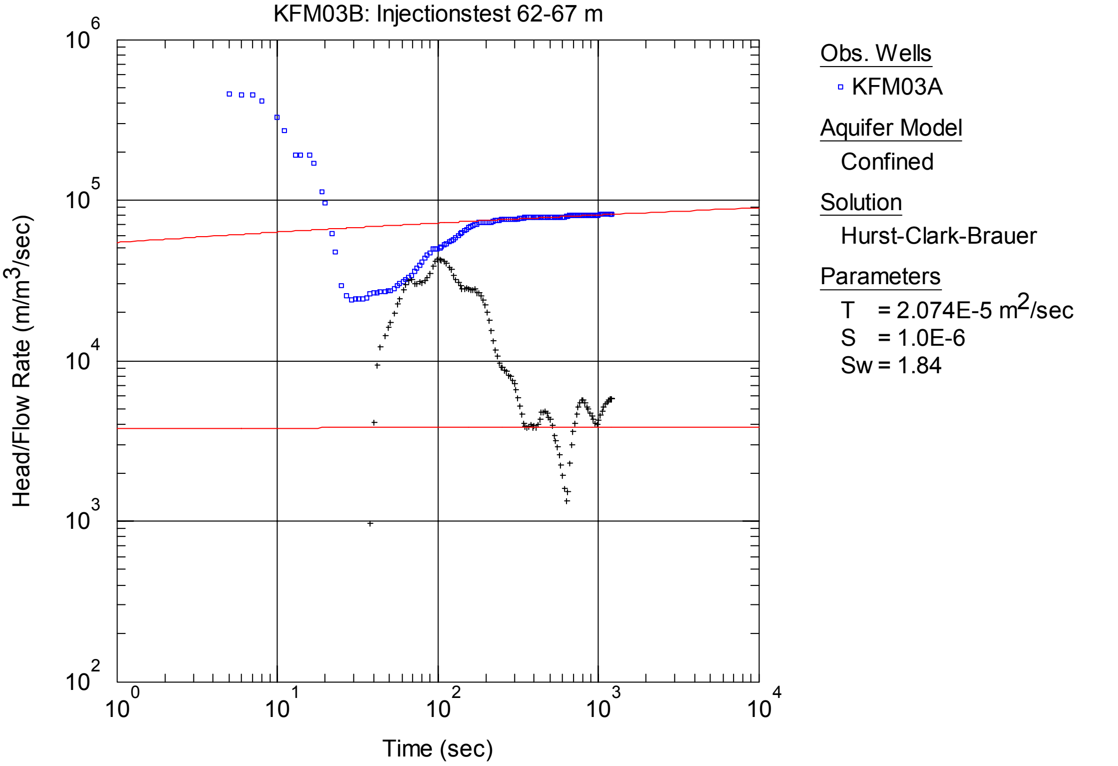


Figure A3-64. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 62–67 m in KFM03B.*

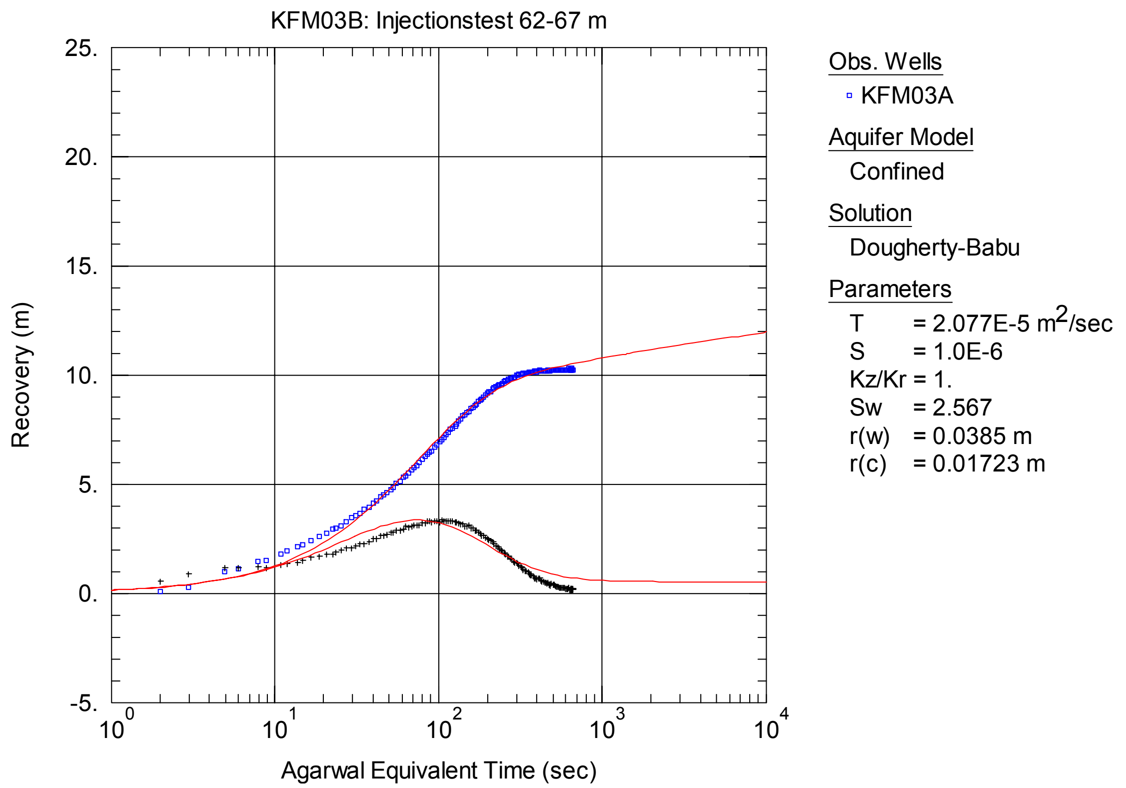


Figure A3-65. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 62–67 m in KFM03B.*

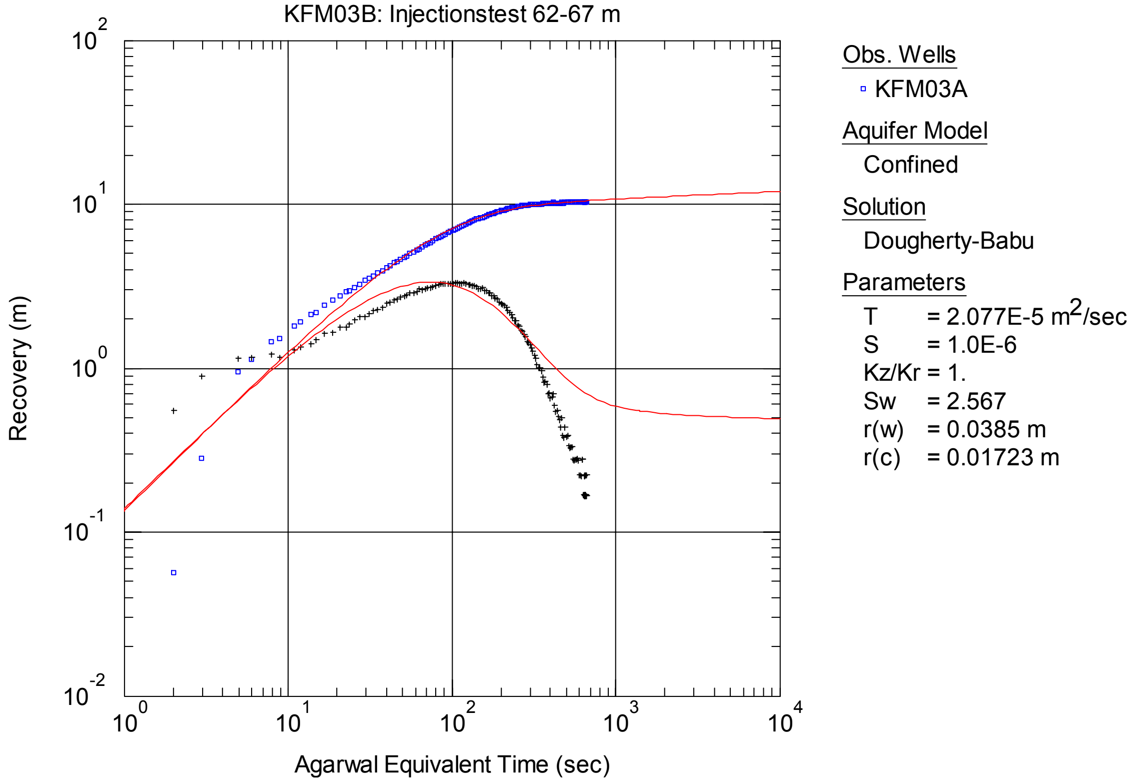


Figure A3-66. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 62–67 m in KFM03B.*

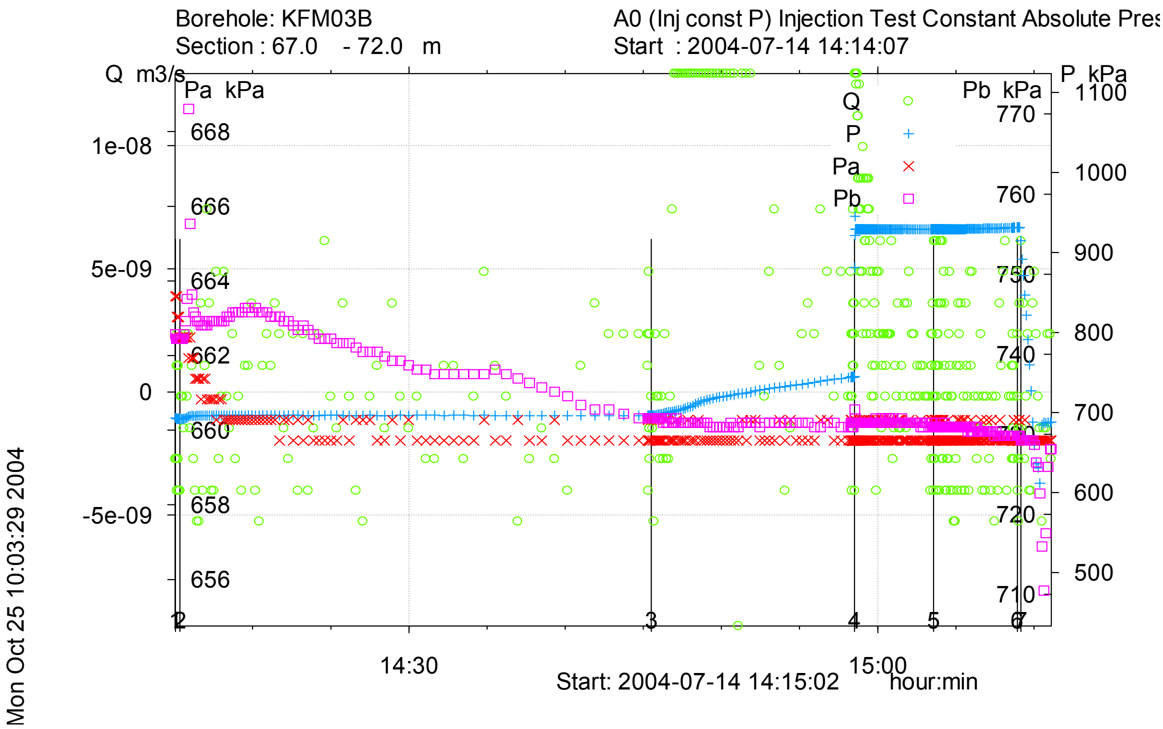


Figure A3-67. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 67–72 m in borehole KFM03B.*

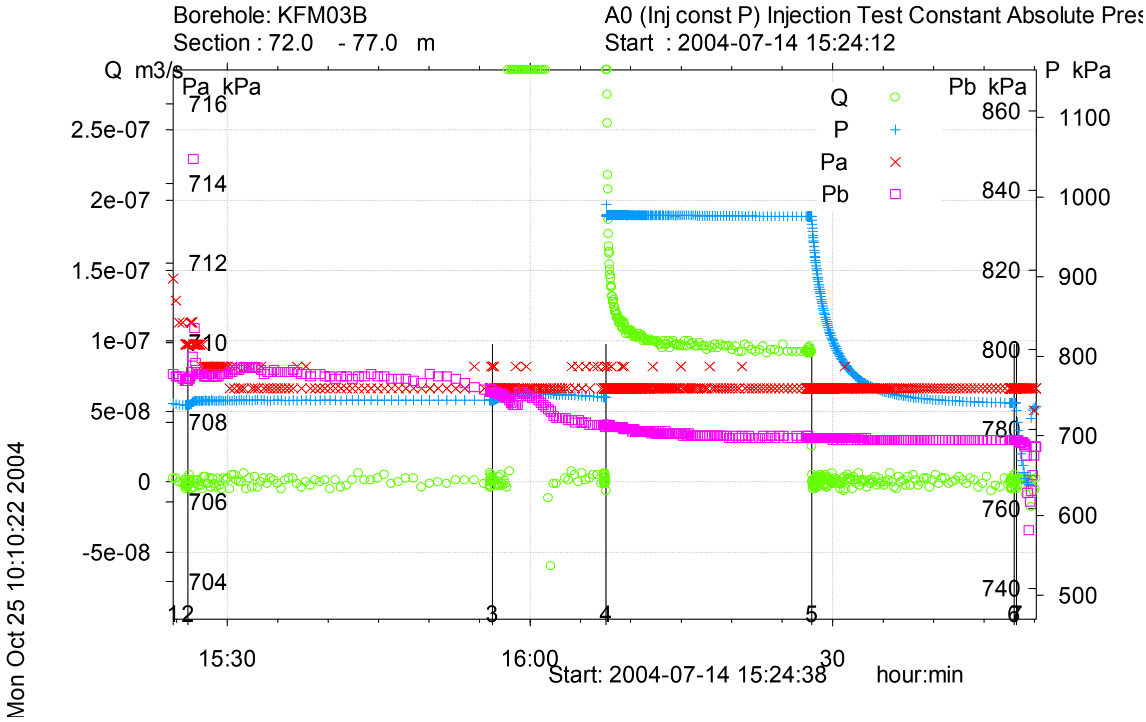


Figure A3-68. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 72–77 m in borehole KFM03B.*

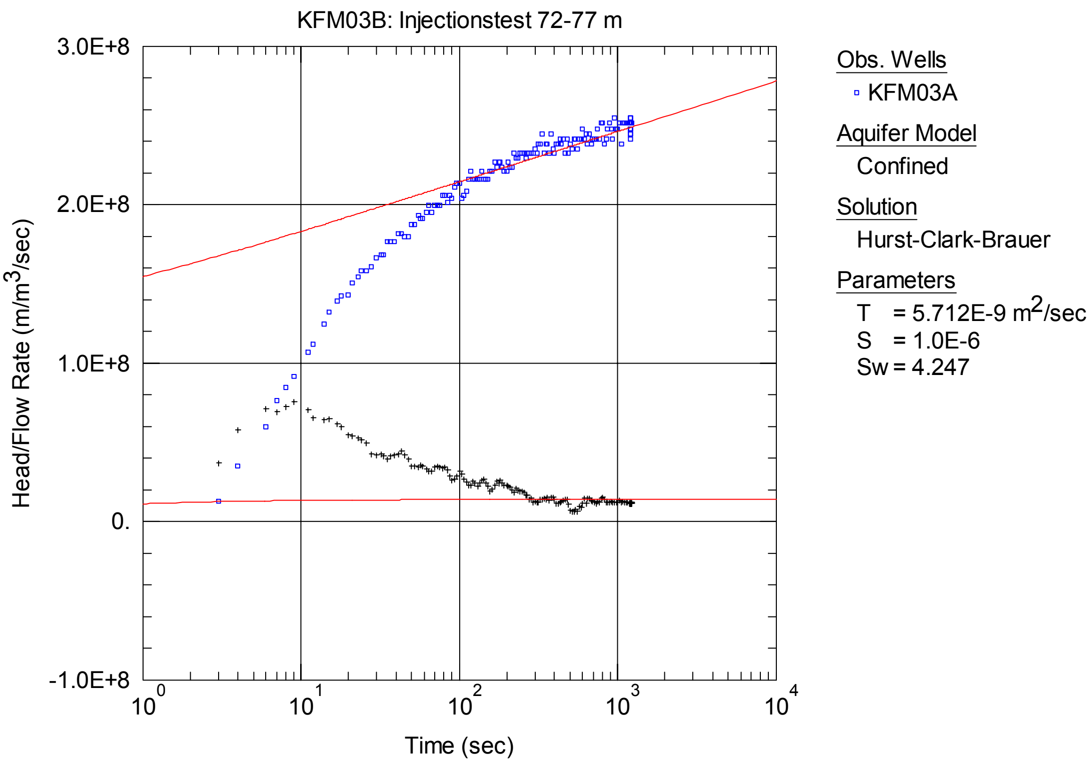


Figure A3-69. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 72–77 m in KFM03B.*

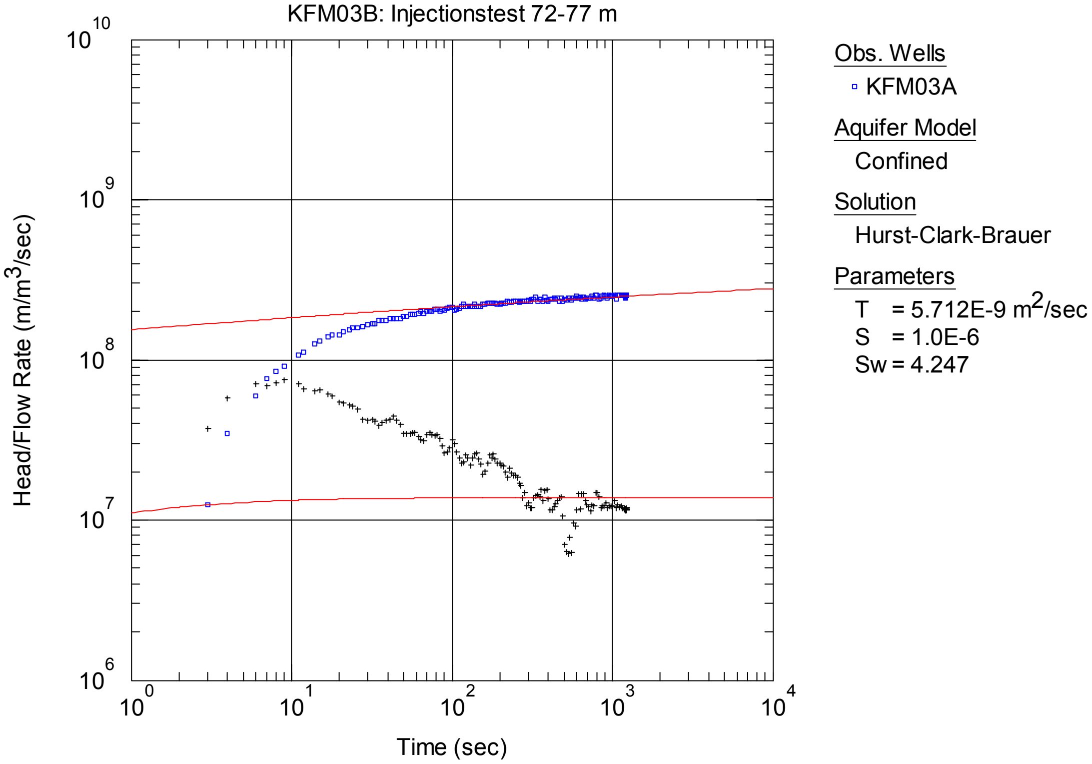


Figure A3-70. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 72–77 m in KFM03B.*

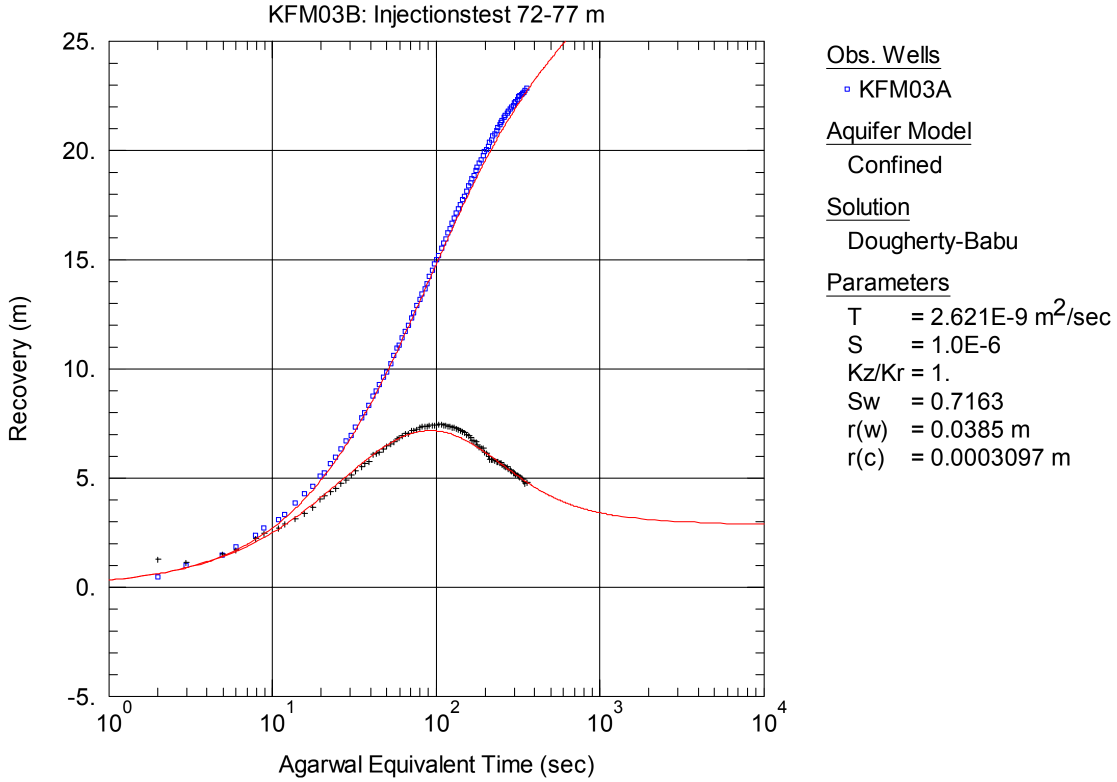


Figure A3-71. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 72–77 m in KFM03B.*

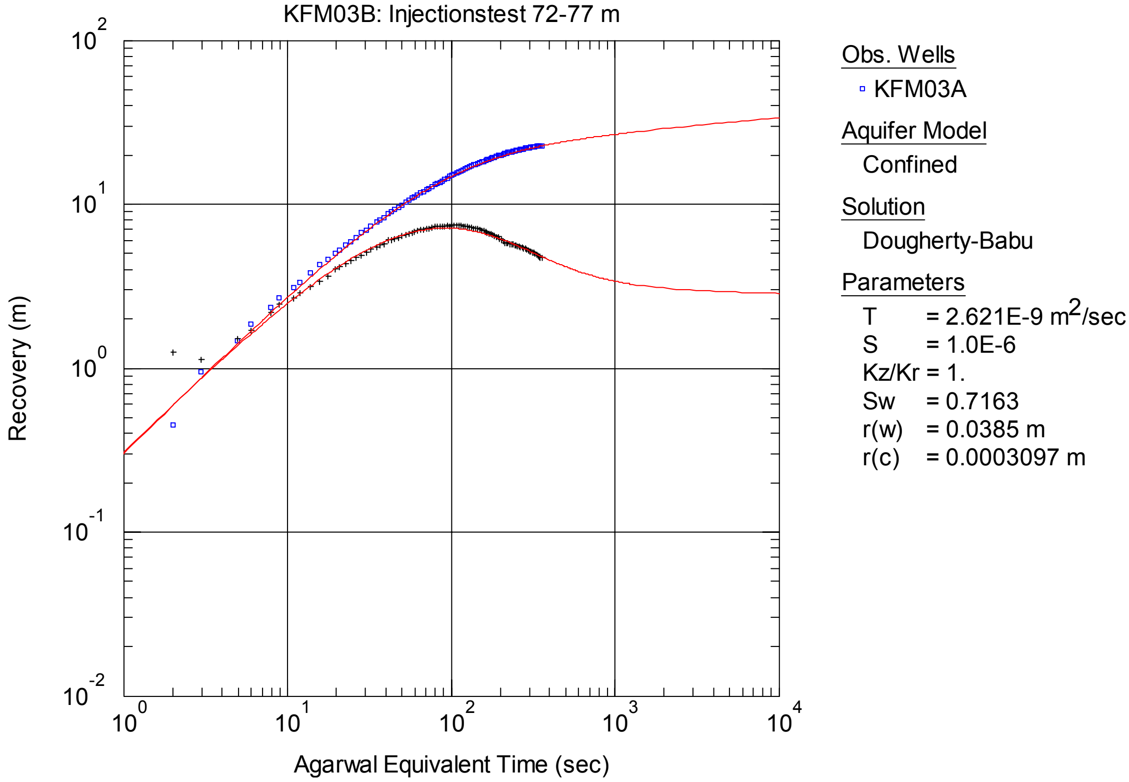


Figure A3-72. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 72–77 m in KFM03B.*

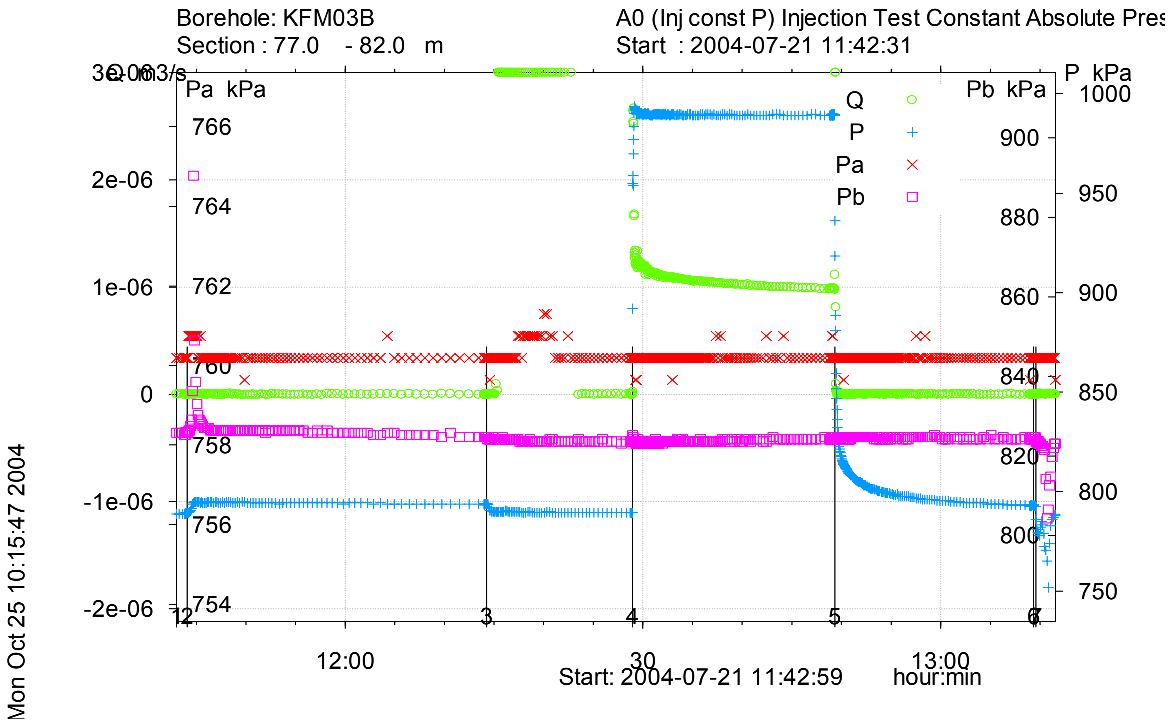


Figure A3-73. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 77–82 m in borehole KFM03B.*

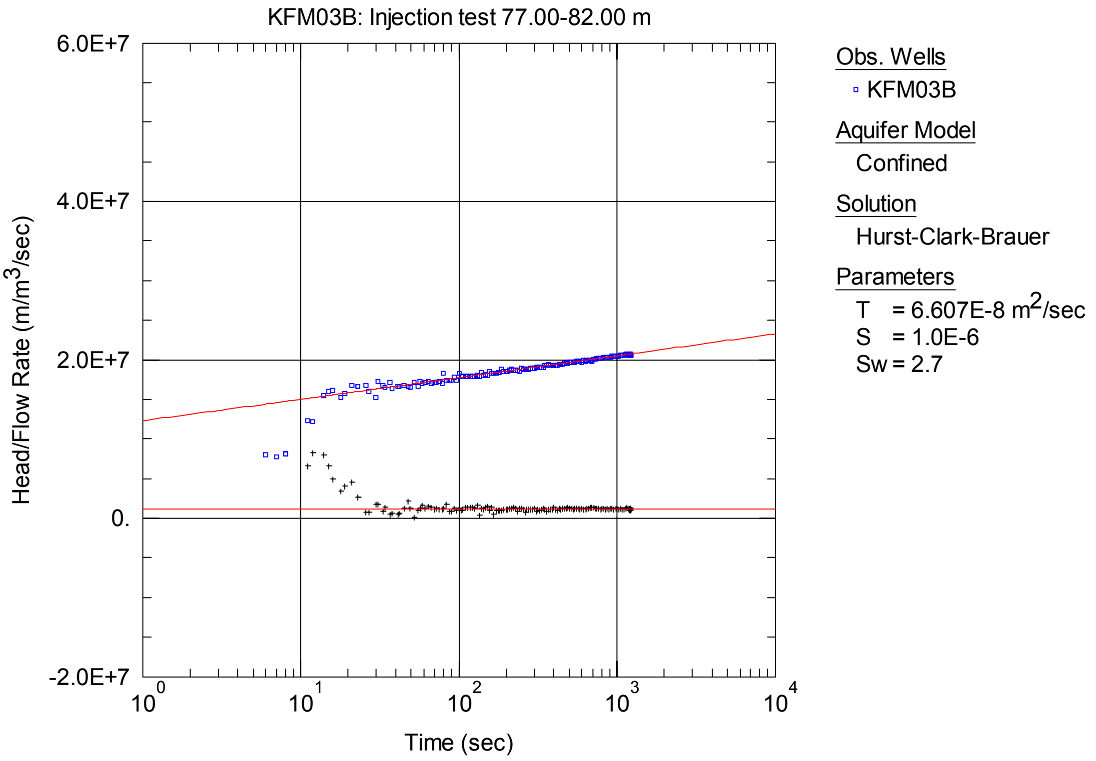


Figure A3-74. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 77–82 m in KFM03B.*

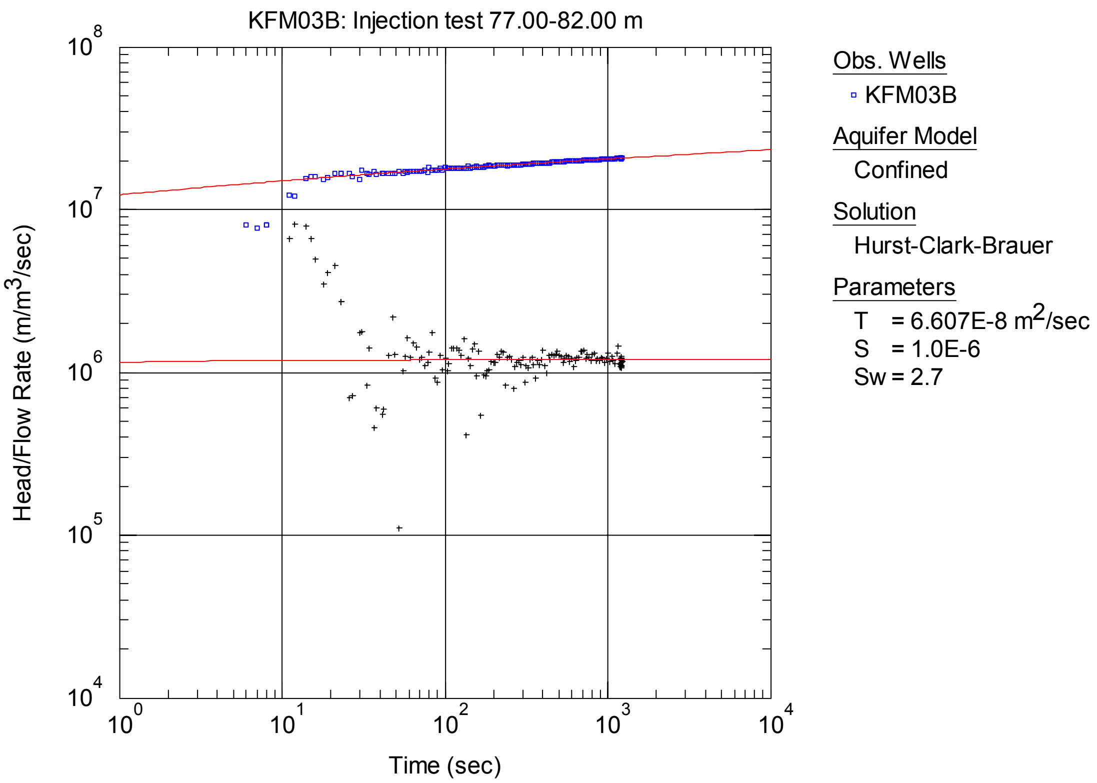


Figure A3-75. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 77–82 m in KFM03B.*

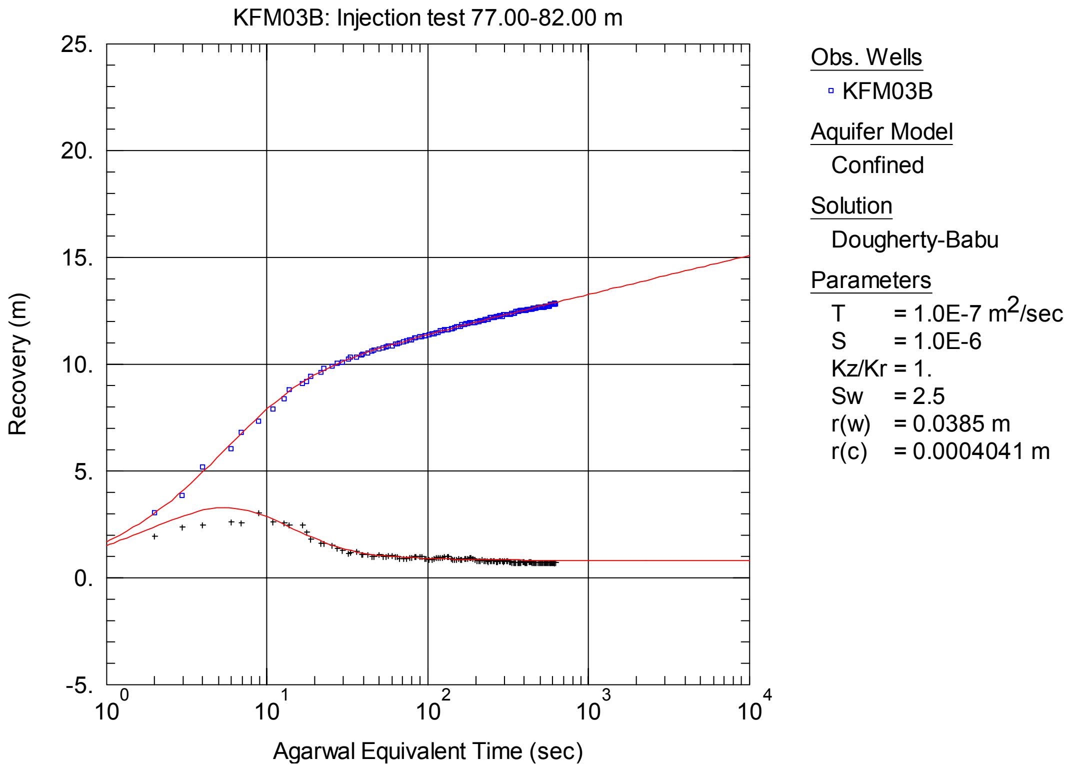


Figure A3-76. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 77–82 m in KFM03B.*

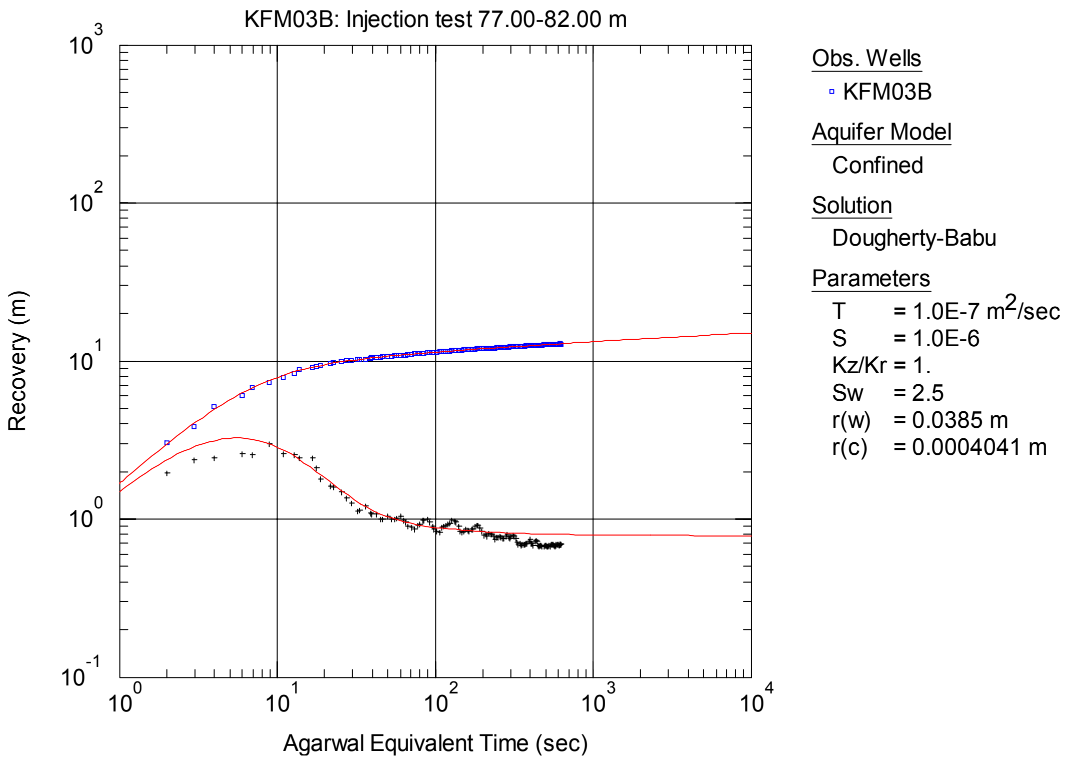


Figure A3-77. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 77–82 m in KFM03B.*

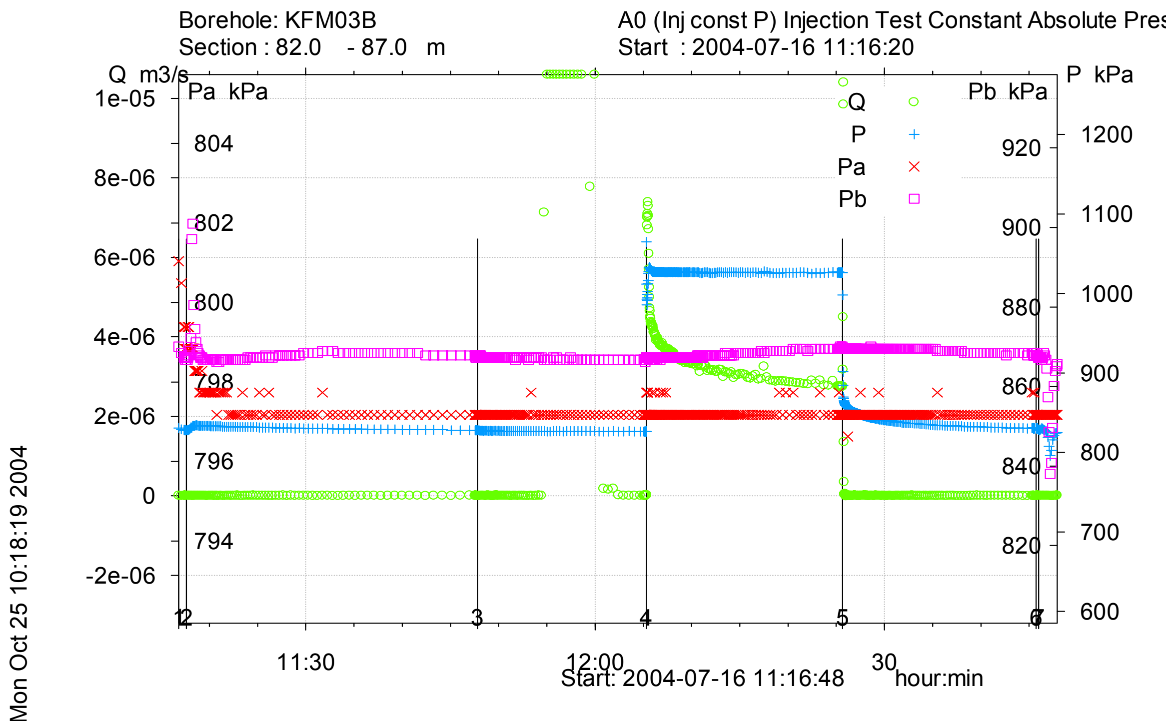


Figure A3-78. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 82–87 m in borehole KFM03B.*

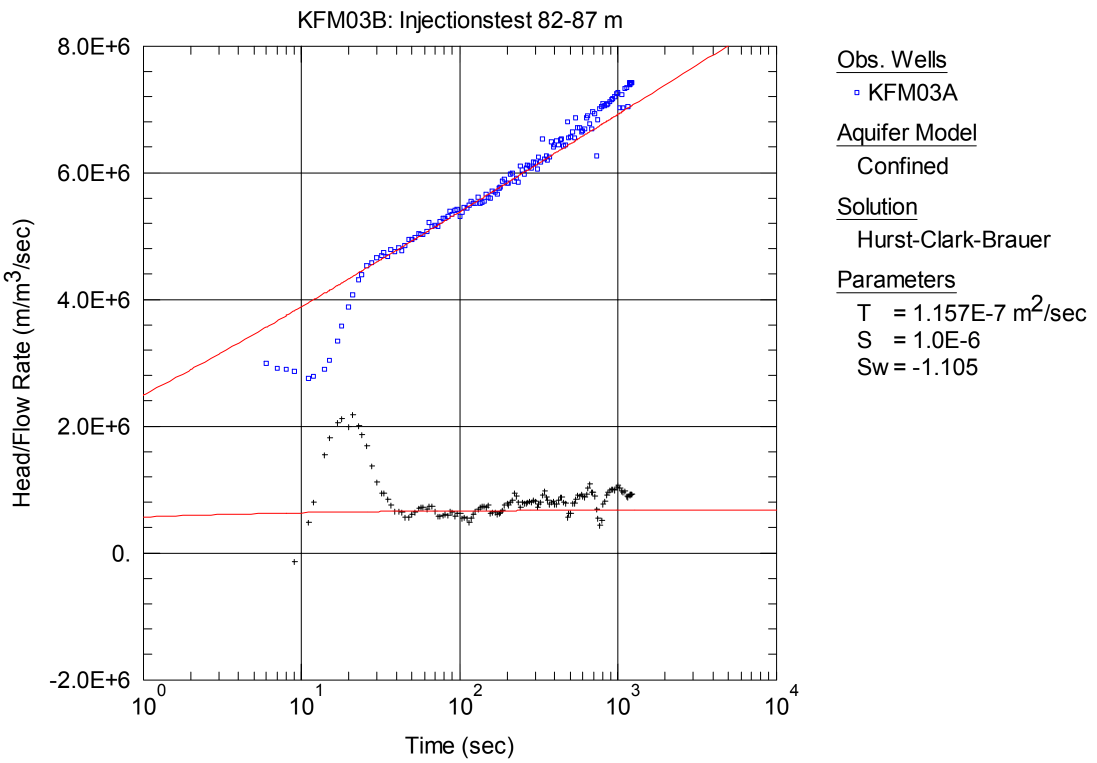


Figure A3-79. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 82–87 m in KFM03B. Showing fit to early PRF.*

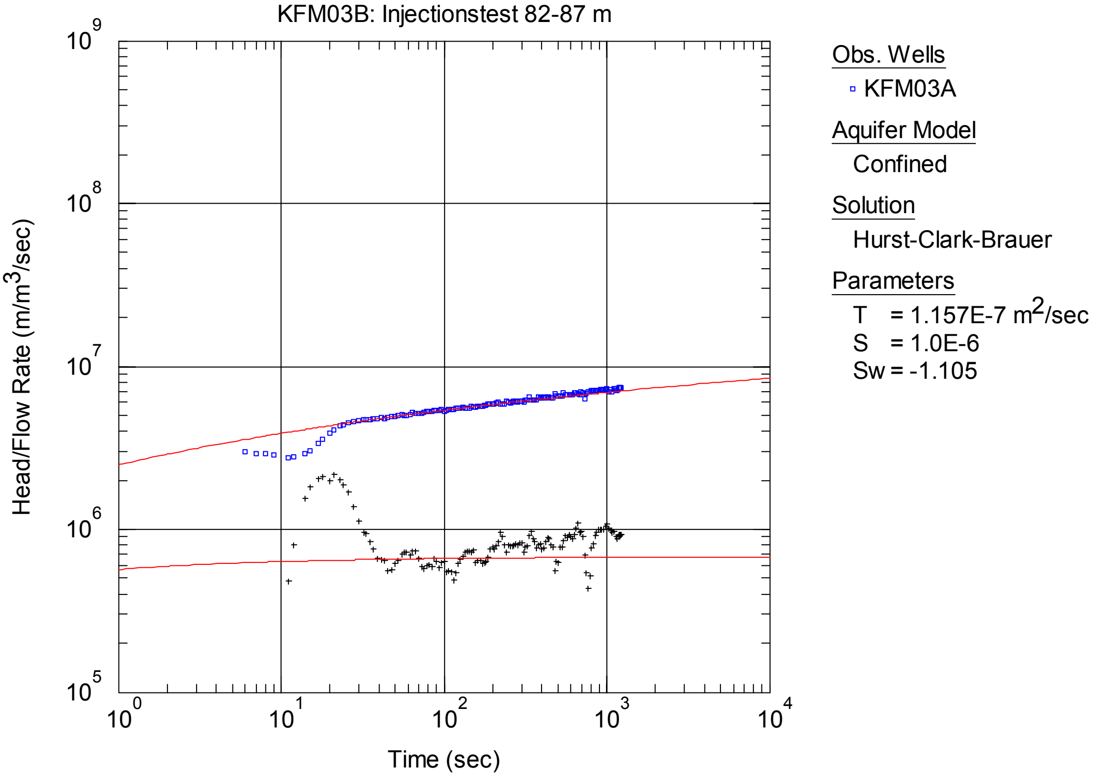


Figure A3-80. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 82–87 m in KFM03B. Showing fit to early PRF.*

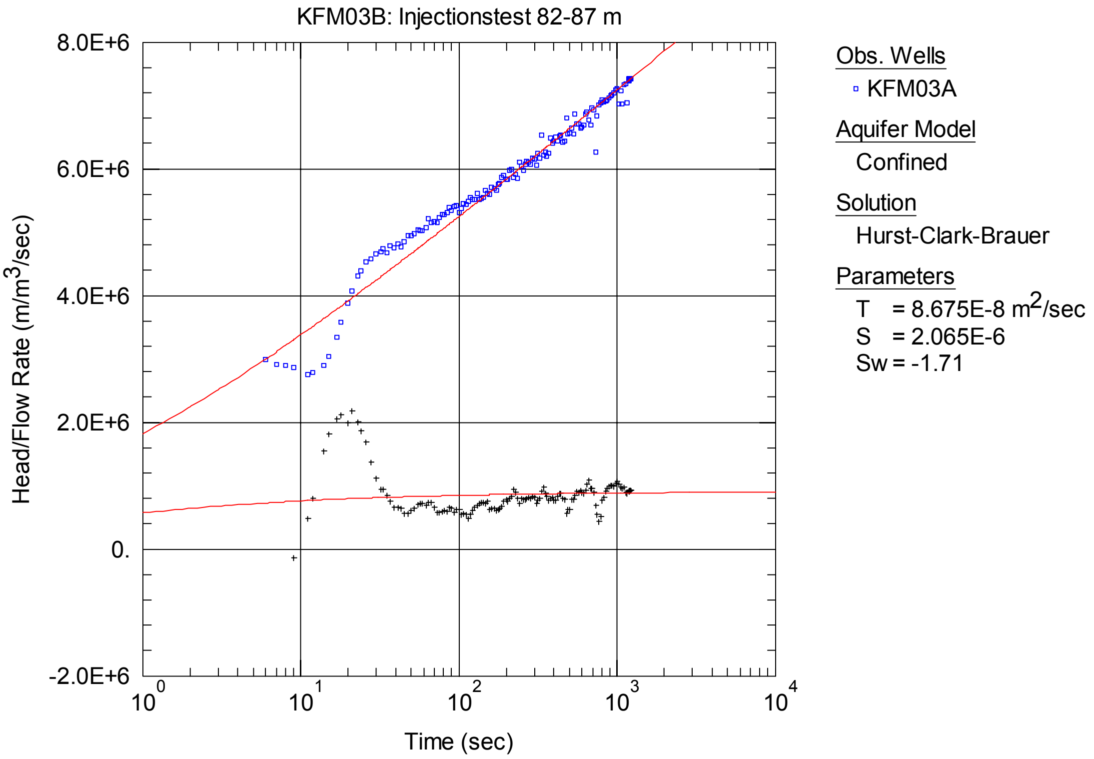


Figure A3-81. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 82–87 m in KFM03B. Showing fit to late PRF.*

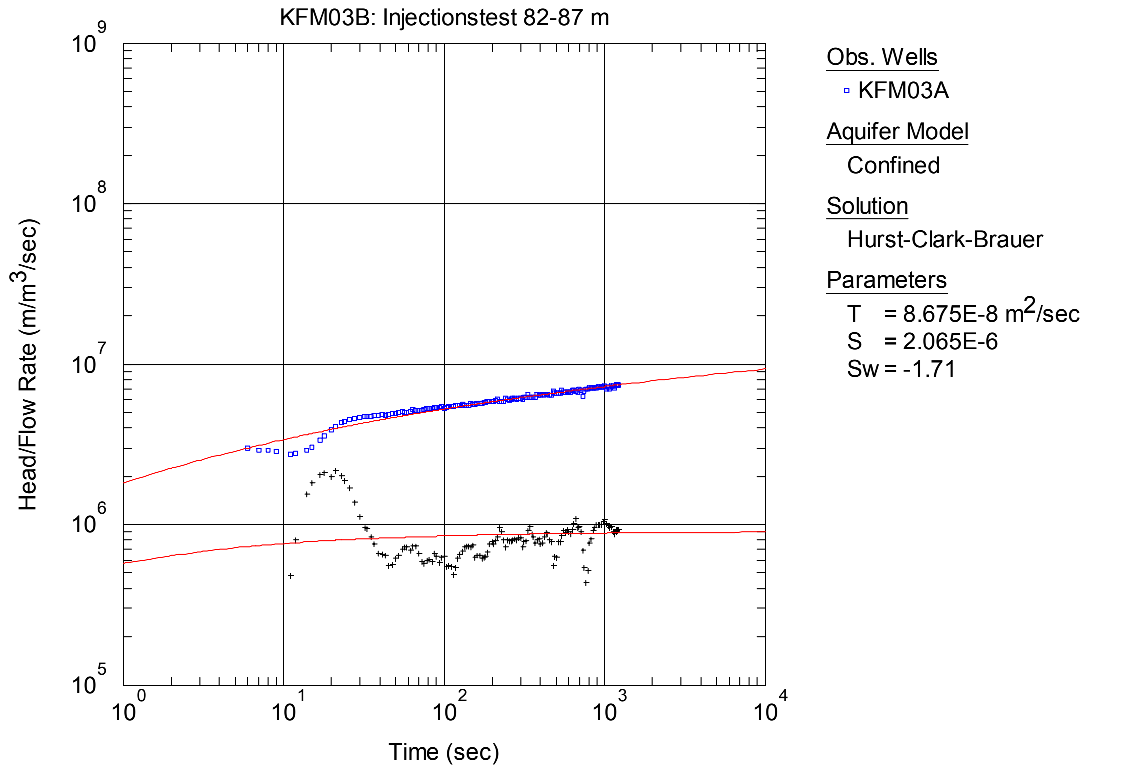


Figure A3-82. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 82–87 m in KFM03B. Showing fit to late PRF.*

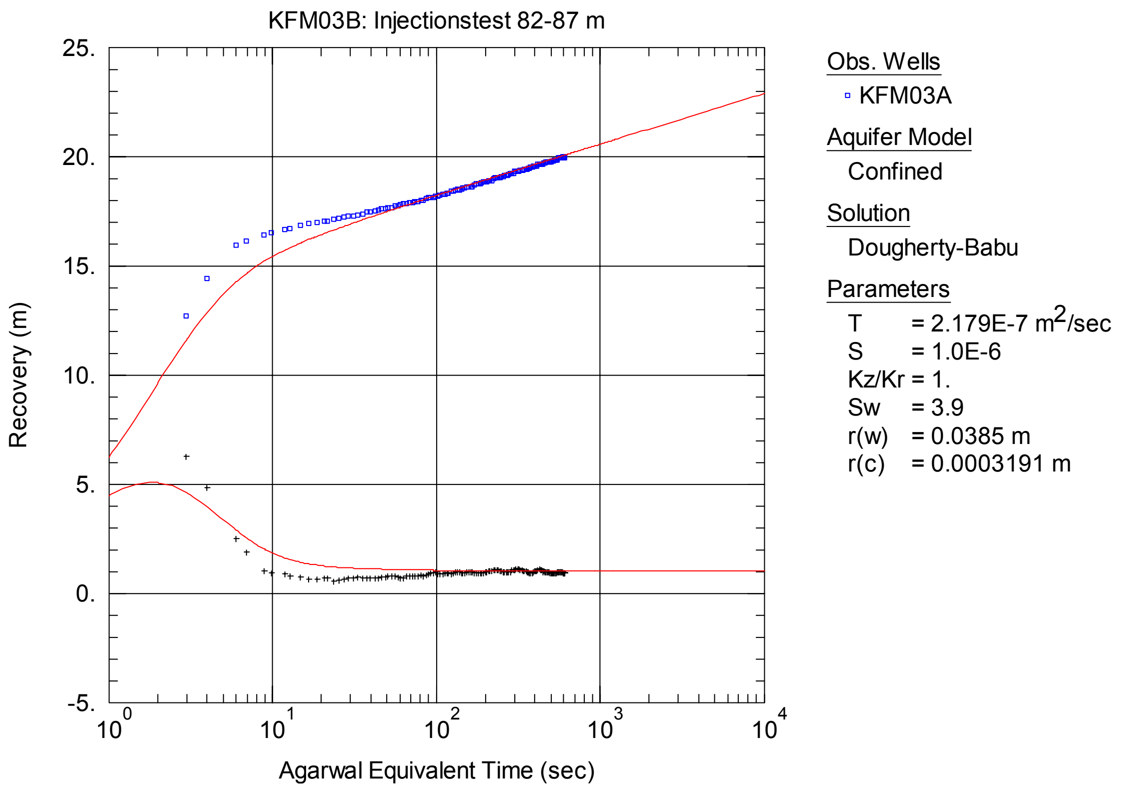


Figure A3-83. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 82–87 m in KFM03B.*

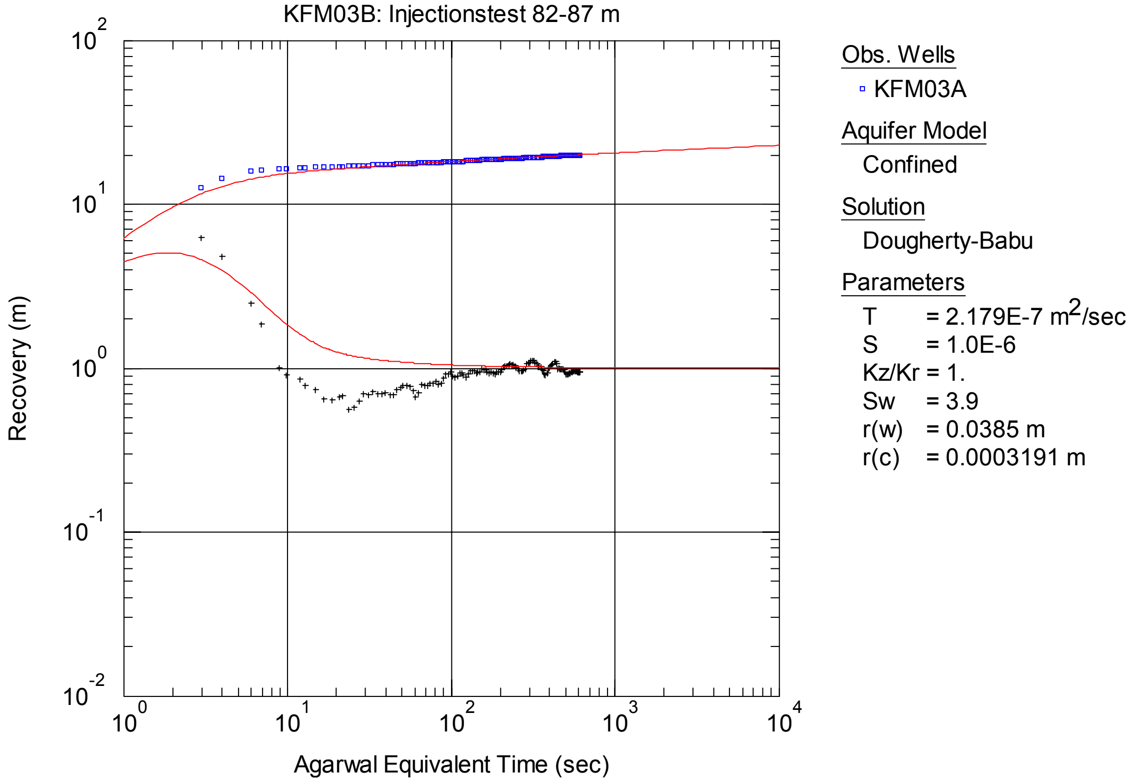


Figure A3-84. Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 82–87 m in KFM03B.

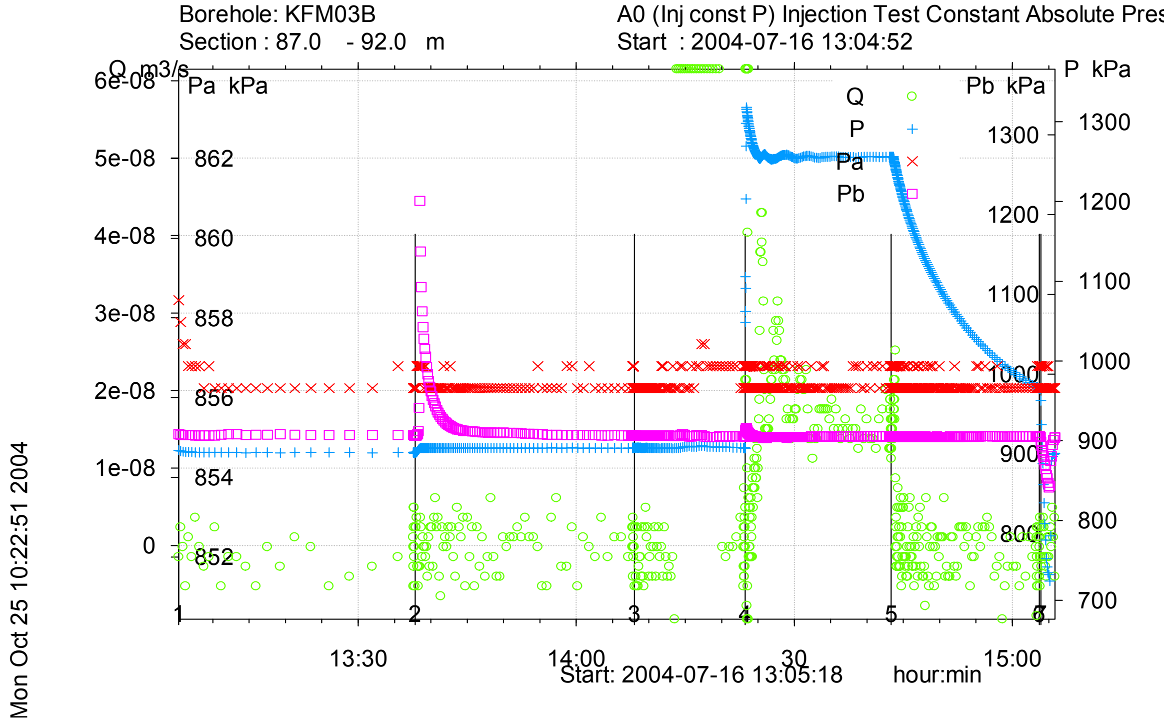


Figure A3-85. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 87–92 m in borehole KFM03B.

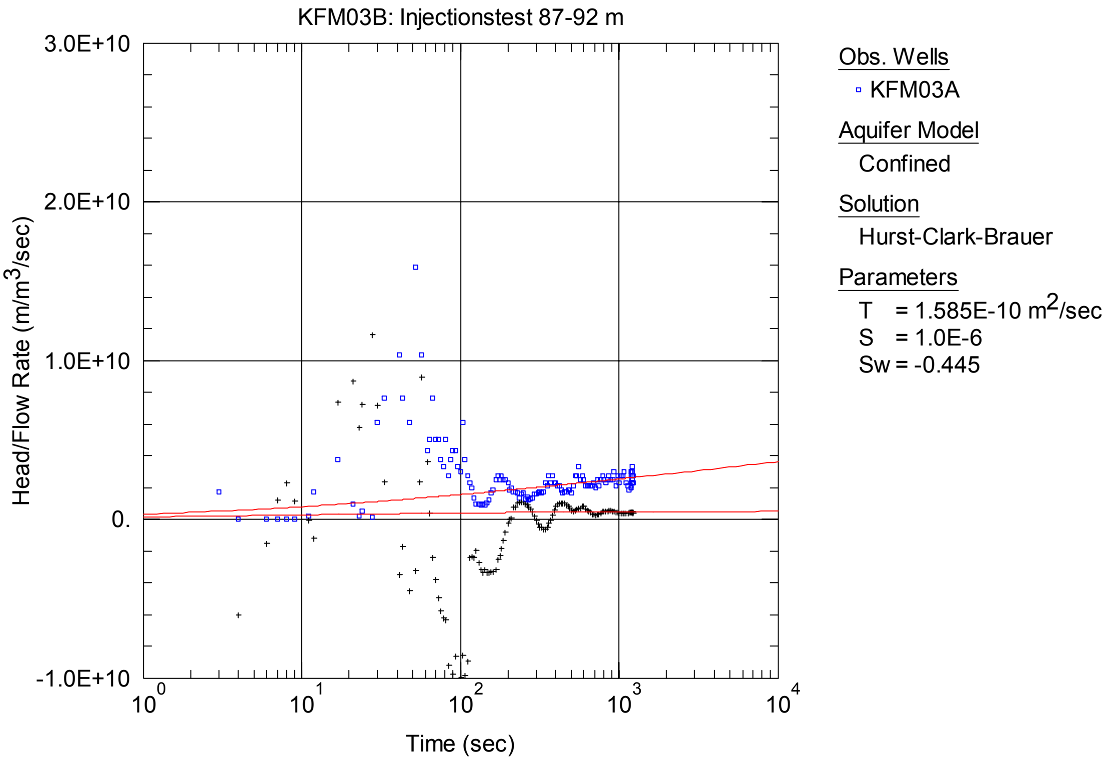


***Figure A3-86.** Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 87–92 m in KFM03B.*

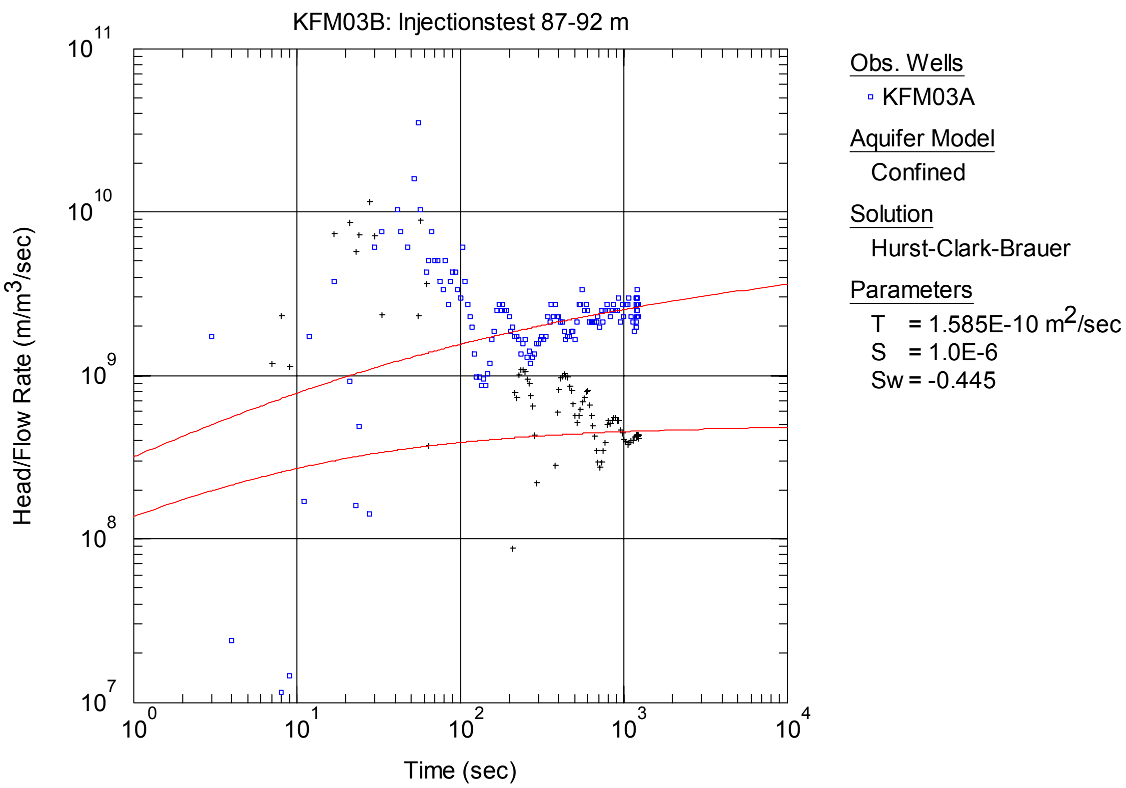


***Figure A3-87.** Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 87–92 m in KFM03B.*

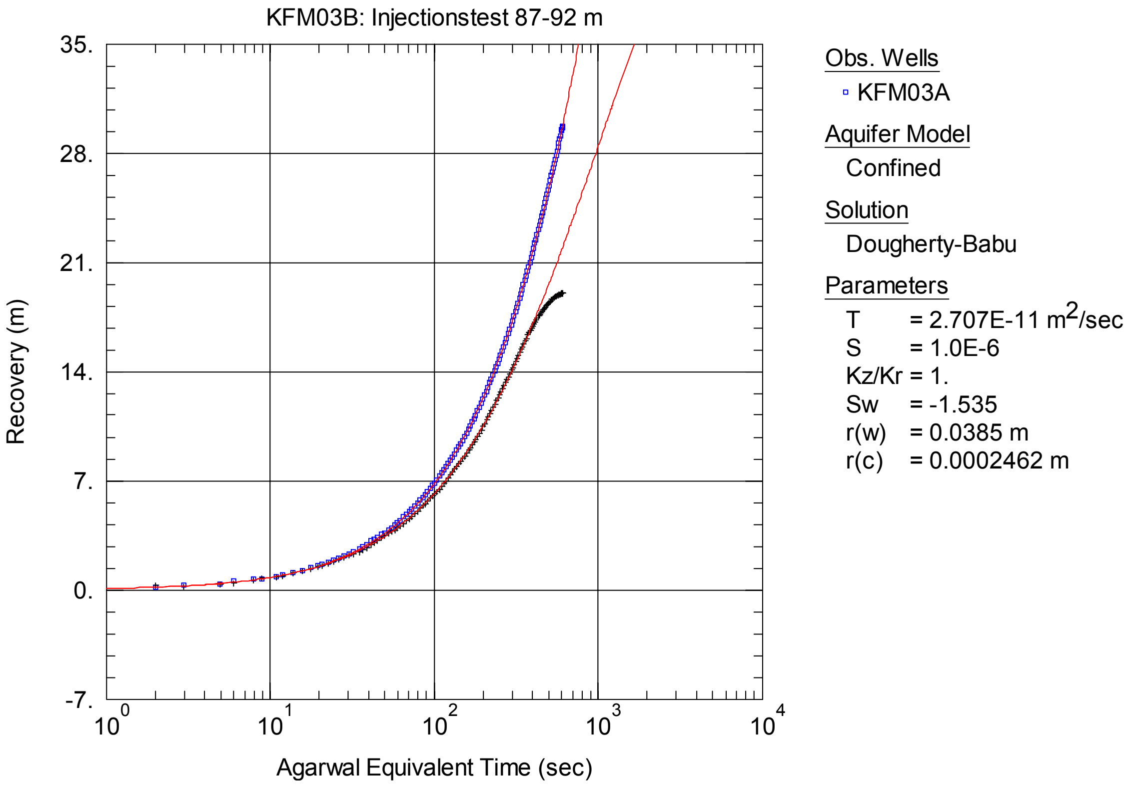


Figure A3-88. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 87–92 m in KFM03B.*

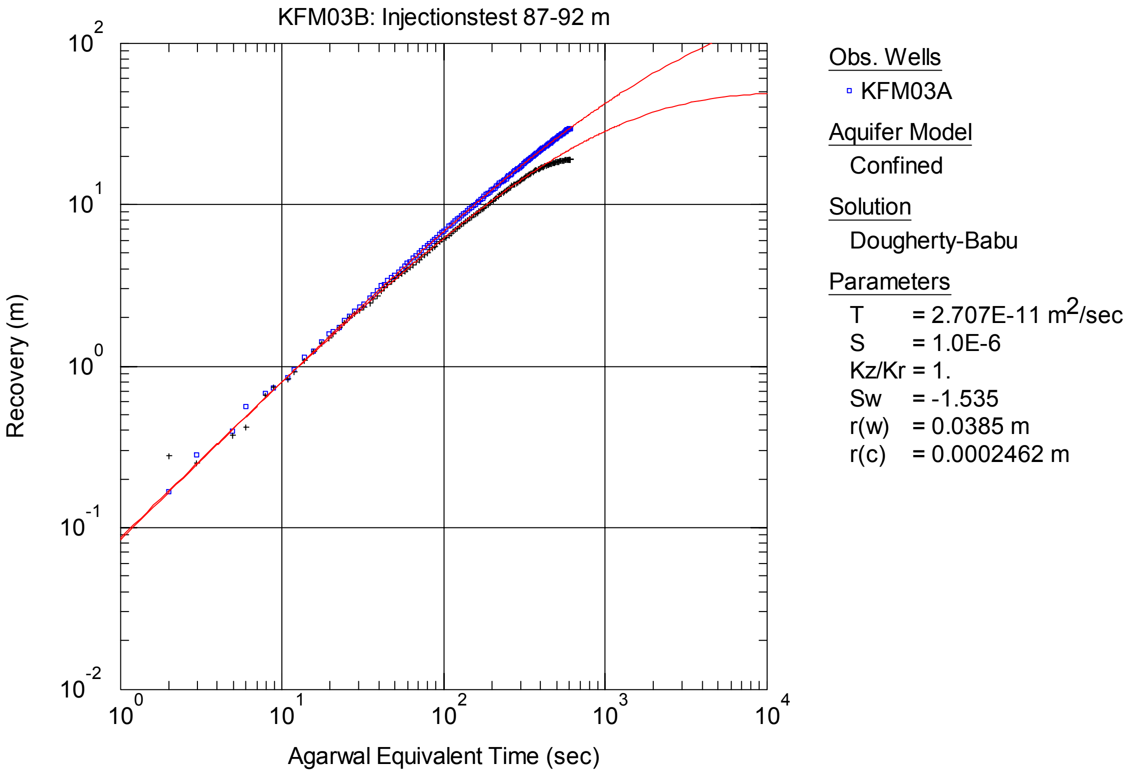


Figure A3-89. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 87–92 m in KFM03B.*

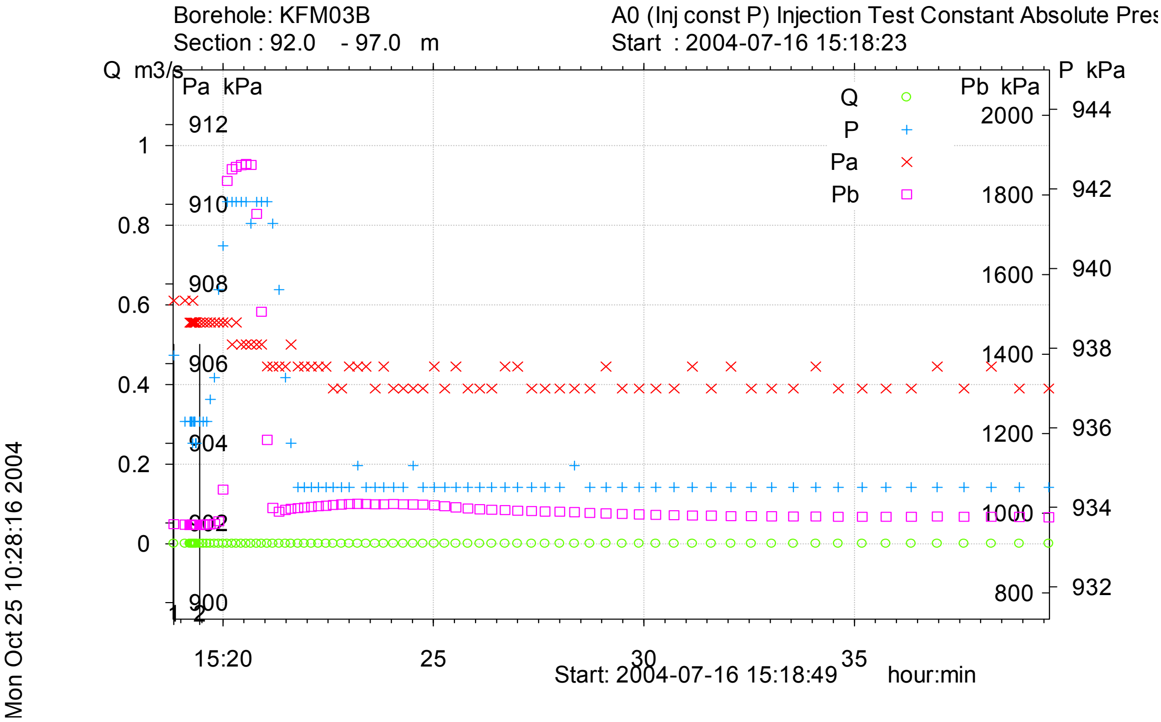
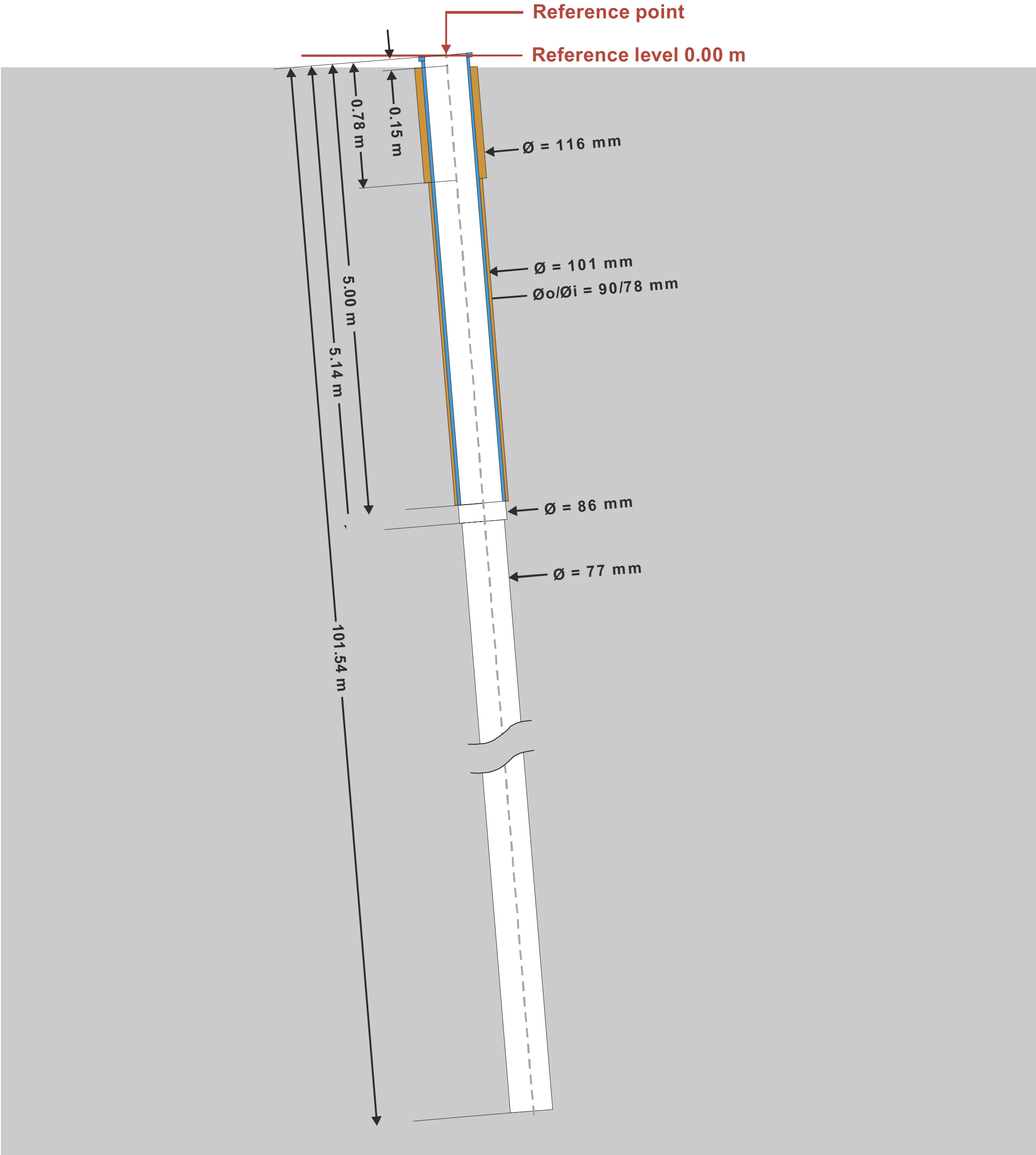


Figure A3-90. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 92–97 m in borehole KFM03B.*

Borehole technical data

Technical data

Borehole KFM03B



Drilling reference point
Northing: 6697844.20 (m), RT90 2,5 gon V 0:-15
Easting: 1634618.98 (m), RT90 2,5 gon V 0:-15
Elevation: 8.47 (m), RHB 70

Borehole
Bearing: 264.49°
Inclination: –85.30°
Length: 101.54 m

Percussion drilling period
Drilling start date:
Drilling stop date:

Core drilling period
Drilling start date: 2003-06-29
Drilling stop date: 2003-07-02

Appendix 5

Sicada tables

Nomenclature plu_s_hole_test_d

Column	Datatype	Unit	Column Description	Alt symbol
site	CHAR		Investigation site name	
activity_type	CHAR		Activity type code	
start_date	DATE		Date (yymmdd hh:mm:ss)	
stop_date	DATE		Date (yymmdd hh:mm:ss)	
project	CHAR		project code	
idcode	CHAR		Object or borehole identification code	
secup	FLOAT	m	Upper section limit (m)	
seclow	FLOAT	m	Lower section limit (m)	
section_no	INTEGER	number	Section number	
test_type	CHAR		Test type code (1–7), see table description	
formation_type	CHAR		1: Rock, 2: Soil (superficial deposits)	
start_flow_period	DATE	yyyymmdd	Date & time of pumping/injection start (YYYY-MM-DD hh:mm:ss)	
stop_flow_period	DATE	yyyymmdd	Date & time of pumping/injection stop (YYYY-MM-DD hh:mm:ss)	
flow_rate_end_qp	FLOAT	m^3/s	Flow rate at the end of the flowing period	
value_type_qp	CHAR		0:true value,–1<lower meas.limit1:>upper meas.limit	
mean_flow_rate_qm	FLOAT	m^3/s	Arithmetic mean flow rate during flow period	
q_measl__l	FLOAT	m^3/s	Estimated lower measurement limit of flow rate	Q-measl-L
q_measl__u	FLOAT	m^3/s	Estimated upper measurement limit of flow rate	Q-measl-U
tot_volume_vp	FLOAT	m^3	Total volume of pumped(positive) or injected(negative) water	
dur_flow_phase_tp	FLOAT	s	Duration of the flowing period of the test	
dur_rec_phase_tf	FLOAT	s	Duration of the recovery period of the test	
initial_head_hi	FLOAT	m	Hydraulic head in test section at start of the flow period	
head_at_flow_end_hp	FLOAT	m	Hydraulic head in test section at stop of the flow period.	
final_head_hf	FLOAT	m	Hydraulic head in test section at stop of recovery period.	
initial_press_pi	FLOAT	kPa	Groundwater pressure in test section at start of flow period	
press_at_flow_end_pp	FLOAT	kPa	Groundwater pressure in test section at stop of flow period.	
final_press_pf	FLOAT	kPa	Ground water pressure at the end of the recovery period.	
fluid_temp_tew	FLOAT	oC	Measured section fluid temperature, see table description	
fluid_elcond_ecw	FLOAT	mS/m	Measured section fluid el. conductivity,see table descr.	
fluid_salinity_tdsw	FLOAT	mg/l	Total salinity of section fluid based on EC,see table descr.	
fluid_salinity_tdswm	FLOAT	mg/l	Tot. section fluid salinity based on water sampling,see...	
reference	CHAR		SKB report No for reports describing data and evaluation	
comments	VARCHAR		Short comment to data	
error_flag	CHAR		If error_flag = "*" then an error occured and an error	
in_use	CHAR		If in_use = "*" then the activity has been selected as	
sign	CHAR		Signature for QA data accknowledge (QA – OK)	
lp	FLOAT	m	Hydraulic point of application	

Nomenclature plu_s_hole_test_ed1

Column	Datatype	Unit	Column Description	Alt symbol
site	CHAR		Investigation site name	
activity_type	CHAR		Activity type code	
start_date	DATE		Date (yymmdd hh:mm:ss)	
stop_date	DATE		Date (yymmdd hh:mm:ss)	
project	CHAR		project code	
idcode	CHAR		Object or borehole identification code	
secup	FLOAT	m	Upper section limit (m)	
seclow	FLOAT	m	Lower section limit (m)	
section_no	INTEGER	number	Section number	
test_type	CHAR		Test type code (1–7), see table description!	
formation_type	CHAR		Formation type code. 1: Rock, 2: Soil (superficial deposits)	
lp	FLOAT	m	Hydraulic point of application for test section, see descr.	
seclen_class	FLOAT	m	Planned ordinary test interval during test campaign.	
spec_capacity_q_s	FLOAT	m^2/s	Specific capacity (Q/s) of test section, see table descript.	Q/s
value_type_q_s	CHAR		0:true value,–1:Q/s<lower meas.limit,1:Q/s>upper meas.limit	
transmissivity_tq	FLOAT	m^2/s	Tranmissivity based on Q/s, see table description	
value_type_tq	CHAR		0:true value,–1:TQ<lower meas.limit,1:TQ>upper meas.limit.	
bc_tq	CHAR		Best choice code. 1 means TQ is best choice of T, else 0	
transmissivity_moye	FLOAT	m^2/s	Transmissivity,TM, based on Moye (1967)	T_M
bc_tm	CHAR		Best choice code. 1 means Tmoye is best choice of T, else 0	
value_type_tm	CHAR		0:true value,–1:TM<lower meas.limit,1:TM>upper meas.limit.	
hydr_cond_moye	FLOAT	m/s	K_M: Hydraulic conductivity based on Moye (1967)	K_M
formation_width_b	FLOAT	m	b:Aquifer thickness repr. for T(generally b=Lw) ,see descr.	b
width_of_channel_b	FLOAT	m	B:Inferred width of formation for evaluated TB	
tb	FLOAT	m^3/s	TB:Flow capacity in 1D formation of T & width B, see descr.	
l_measl_tb	FLOAT	m^3/s	Estimated lower meas. limit for evaluated TB,see description	
u_measl_tb	FLOAT	m^3/s	Estimated upper meas. limit of evaluated TB,see description	
sb	FLOAT	m	SB:S=storativity,B=width of formation,1D model,see descript.	
assumed_sb	FLOAT	m	SB* : Assumed SB,S=storativity,B=width of formation,see...	
leakage_factor_lf	FLOAT	m	Lf:1D model for evaluation of Leakage factor	
transmissivity_tt	FLOAT	m^2/s	TT:Transmissivity of formation, 2D radial flow model,see...	T_T
value_type_tt	CHAR		0:true value,–1:TT<lower meas.limit,1:TT>upper meas.limit,	
bc_tt	CHAR		Best choice code. 1 means TT is best choice of T, else 0	
l_measl_q_s	FLOAT	m^2/s	Estimated lower meas. limit for evaluated TT,see table descr	Q/s-measl-L
u_measl_q_s	FLOAT	m^2/s	Estimated upper meas. limit for evaluated TT,see description	Q/s-measl-U
storativity_s	FLOAT		S:Storativity of formation based on 2D rad flow,see descr.	
assumed_s	FLOAT		Assumed Storativity,2D model evaluation,see table descr.	
leakage_coeff	FLOAT	1/s	K'/b':2D rad flow model evaluation of leakage coeff,see desc	
hydr_cond_ksf	FLOAT	m/s	Ksf:3D model evaluation of hydraulic conductivity,see desc.	
value_type_ksf	CHAR		0:true value,–1:Ksf<lower meas.limit,1:Ksf>upper meas.limit,	
l_measl_ksf	FLOAT	m/s	Estimated lower meas.limit for evaluated Ksf,see table desc.	
u_measl_ksf	FLOAT	m/s	Estimated upper meas.limit for evaluated Ksf,see table descr	
spec_storage_ssf	FLOAT	1/m	Ssf:Specific storage,3D model evaluation,see table descr.	
assumed_ssf	FLOAT	1/m	Ssf*:Assumed Spec.storage,3D model evaluation,see table des.	
c	FLOAT	m^3/pa	C: Wellbore storage coefficient; flow or recovery period	C
cd	FLOAT		CD: Dimensionless wellbore storage coefficient	
skin	FLOAT		Skin factor;best estimate of flow/recovery period,see descr.	ξ

Column	Datatype	Unit	Column Description	Alt symbol
dt1	FLOAT	s	Estimated start time of evaluation, see table description	dt_1
dt2	FLOAT	s	Estimated stop time of evaluation. see table description	dt_2
t1	FLOAT	s	Start time for evaluated parameter from start flow period	
t2	FLOAT	s	Stop time for evaluated parameter from start of flow period	
dte1	FLOAT	s	Start time for evaluated parameter from start of recovery	
dte2	FLOAT	s	Stop time for evaluated parameter from start of recovery	
p_horner	FLOAT	kPa	p*:Horner extrapolated pressure, see table description	
transmissivity_t_nlr	FLOAT	m^2/s	T_NLR Transmissivity based on None Linear Regression...	
storativity_s_nlr	FLOAT		S_NLR=storativity based on None Linear Regression,see..	
value_type_t_nlr	CHAR		0:true value,–1:T_NLR<lower meas.limit,1:>upper meas.limit	
bc_t_nlr	CHAR		Best choice code. 1 means T_NLR is best choice of T, else 0	
c_nlr	FLOAT	m^3/pa	Wellbore storage coefficient, based on NLR, see descr.	
cd_nlr	FLOAT		Dimensionless wellbore storage constant, see table descrip.	
skin_nlr	FLOAT		Skin factor based on Non Linear Regression,see desc.	
transmissivity_t_grf	FLOAT	m^2/s	T_GRF:Transmissivity based on Genelized Radial Flow,see...	
value_type_t_grf	CHAR		0:true value,–1:T_GRF<lower meas.limit,1:>upper meas.limit	
bc_t_grf	CHAR		Best choice code. 1 means T_GRF is best choice of T, else 0	
storativity_s_grf	FLOAT		S_GRF:Storativity based on Generalized Radial Flow, see des.	
flow_dim_grf	FLOAT		Inferred flow dimesion based on Generalized Rad. Flow model	
comment	VARCHAR	no_unit	Short comment to the evaluated parameters	
error_flag	CHAR		If error_flag = "*" then an error occured and an error	
in_use	CHAR		If in_use = "*" then the activity has been selected as	
sign	CHAR		Signature for QA data accknowledge (QA – OK)	

Nomenclature plu_s_hole_test_obs

Column	Datatype	Unit	Column Description
site	CHAR		Investigation site name
activity_type	CHAR		Activity type code
idcode	CHAR		Object or borehole identification code
start_date	DATE		Date (yymmdd hh:mm:ss)
secup	FLOAT	m	Upper section limit (m)
seclow	FLOAT	m	Lower section limit (m)
obs_secup	FLOAT	m	Upper limit of observation section
obs_seclow	FLOAT	m	Lower limit of observation section
pi_above	FLOAT	kPa	Groundwater pressure above test section,start of flow period
pp_above	FLOAT	kPa	Groundwater pressure above test section,at stop flow period
pf_above	FLOAT	kPa	Groundwater pressure above test section at stop recovery per
pi_below	FLOAT	kPa	Groundwater pressure below test section at start flow period
pp_below	FLOAT	kPa	Groundwater pressure below test section at stop flow period
pf_below	FLOAT	kPa	Groundwater pressure below test section at stop recovery per
comments	VARCHAR		Comment text row (unformatted text)

KFM03B plu_s_hole_test_d. Left (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	start_date	stop_date	secup	seclow	test_type	formation_type	start_flow_period	stop_flow_period	flow_rate_end_qp	value_type_qp	mean_flow_rate_qm
KFM03B	20040802 10:48	20040802 13:39	7.00	12.00	3	1	20040802 12:56:59	20040802 13:16:59	2.97E–05	0	4.38E-05
KFM03B	20040712 11:41	20040712 14:09	12.00	17.00	3	1	20040712 13:26:38	20040712 13:46:59	3.49E–07	0	4.23E-07
KFM03B	20040721 14:25	20040721 16:00	17.00	22.00	3	1	20040721 15:18:15	20040721 15:38:37	8.60E–08	0	1.95E-07
KFM03B	20040712 16:30	20040712 18:01	22.00	27.00	3	1	20040712 17:18:28	20040712 17:38:49	1.39E–06	0	1.58E-06
KFM03B	20040713 09:04	20040713 10:35	27.00	32.00	3	1	20040713 09:52:46	20040713 10:13:05	8.27E–07	0	9.27E-07
KFM03B	20040713 11:41	20040713 12:34	32.00	37.00	3	1	20040713 11:51:49	20040713 12:12:06	3.07E–04	0	3.13E-04
KFM03B	20040713 13:18	20040713 14:55	37.00	42.00	3	1	20040713 14:12:59	20040713 14:33:17	2.89E–04	0	3.01E-04
KFM03B	20040713 15:14	20040713 16:40	42.00	47.00	3	1	20040713 15:58:15	20040713 16:18:33	5.94E–06	0	6.55E-06
KFM03B	20040713 16:57	20040713 18:24	47.00	52.00	3	1	20040713 17:41:49	20040713 18:02:11	6.18E–05	0	6.88E-05
KFM03B	20040714 08:33	20040714 09:59	52.00	57.00	3	1	20040714 09:16:35	20040714 09:36:53	1.56E–05	0	1.61E-05
KFM03B	20040714 10:19	20040714 11:50	57.00	62.00	3	1	20040714 11:07:52	20040714 11:28:13	9.51E–07	0	1.09E-06
KFM03B	20040714 12:00	20040714 14:02	62.00	67.00	3	1	20040714 13:19:26	20040714 13:39:44	1.26E–04	0	1.44E-04
KFM03B	20040714 14:14	20040714 15:11	67.00	72.00	3	1	20040714 14:58:31	20040714 15:03:36		-1	
KFM03B	20040714 15:24	20040714 16:50	72.00	77.00	3	1	20040714 16:07:33	20040714 16:27:55	9.23E–08	0	1.06E-07
KFM03B	20040721 11:42	20040721 13:11	77.00	82.00	3	1	20040721 12:28:57	20040721 12:49:18	9.84E–07	0	1.05E-06
KFM03B	20040716 11:16	20040716 12:47	82.00	87.00	3	1	20040716 12:05:18	20040716 12:25:39	2.74E–06	0	3.16E-06
KFM03B	20040716 13:04	20040716 15:05	87.00	92.00	3	1	20040716 14:23:15	20040716 14:43:37	1.44E–08	0	3.56E-08

KFM03B plu_s_hole_test_d. Right (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	secup	seclow	q_measl__l	q_measl__u	tot_volume_vp	dur_flow_phase_tp	dur_rec_phase_tf	initial_press_pi	press_at_flow_end_pp	final_press_pf	fluid_temp_tew	reference	comments
KFM03B	7.00	12.00	1.7E–08	1.0E–03	–5.25E–02	1,200	1,202	109.42	340.67	156.33	6.88		
KFM03B	12.00	17.00	1.7E–08	1.0E–03	–5.16E–04	1,221	1,205	160.75	361.63	183.37	6.61		
KFM03B	17.00	22.00	1.7E–08	1.0E–03	–2.39E–04	1,222	1,203	208.21	449.94	213.17	6.67		
KFM03B	22.00	27.00	1.7E–08	1.0E–03	–1.93E–03	1,221	1,205	254.84	454.90	257.32	6.63		
KFM03B	27.00	32.00	1.7E–08	1.0E–03	–1.13E–03	1,219	1,206	291.27	492.57	291.54	6.56		
KFM03B	32.00	37.00	1.7E–08	1.0E–03	–3.81E–01	1,217	1,208	345.08	549.97	345.63	6.66		Pressure increase in section below test section.

KFM03B	37.00	42.00	1.7E–08	1.0E–03	–3.66E–01	1,218	1,208	396.27	608.89	398.61	6.76		Pressure increase in section above test section.
KFM03B	42.00	47.00	1.7E–08	1.0E–03	–7.98E–03	1,218	1,205	444.42	645.30	444.42	6.59		
KFM03B	47.00	52.00	1.7E–08	1.0E–03	–8.41E–02	1,222	1,203	493.12	730.30	494.08	6.72		
KFM03B	52.00	57.00	1.7E–08	1.0E–03	–1.96E–02	1,218	1,205	540.44	740.65	541.00	6.51		
KFM03B	57.00	62.00	1.7E–08	1.0E–03	–1.34E–03	1,221	1,205	590.12	790.31	590.12	6.52		
KFM03B	62.00	67.00	1.7E–08	1.0E–03	–1.76E–01	1,218	1,205	638.69	740.23	639.79	6.77		
KFM03B	67.00	72.00	6.0E–09	1.0E–03		305	321	744.65	928.99	930.63	6.62		
KFM03B	72.00	77.00	1.7E–08	1.0E–03	–1.30E–04	1,222	1,203	747.96	975.62	741.34	6.66		
KFM03B	77.00	82.00	1.7E–08	1.0E–03	–1.28E–03	1,221	1,203	789.34	989.10	793.22	6.70		
KFM03B	82.00	87.00	1.7E–08	1.0E–03	–3.86E–03	1,221	1,205	826.46	1,026.12	830.19	6.72		
KFM03B	87.00	92.00	7.5E–09	1.0E–03	–4.35E–05	1,222	1,221	890.90	1,256.25	966.51	6.80		

KFM03B plu_s_hole_test_ed1. Left (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	start_date	stop_date	secup	seclow	test_type	formation_type	spec_capacity_q_s	value_type_q_s	transmissivity_moye	bc_tm	value_type_tm	hydr_cond_moye	formation_width_b
KFM03B	20040802 10:48	20040802 13:39	7.00	12.00	3	1	1.26E–06	0	1.04E–06	0	0	2.08E–07	5.00
KFM03B	20040712 11:41	20040712 14:09	12.00	17.00	3	1	1.71E–08	0	1.40E–08	0	0	2.81E–09	5.00
KFM03B	20040721 14:25	20040721 16:00	17.00	22.00	3	1	3.49E–09	0	2.87E–09	0	0	5.75E–10	5.00
KFM03B	20040712 16:30	20040712 18:01	22.00	27.00	3	1	6.83E–08	0	5.62E–08	0	0	1.12E–08	5.00
KFM03B	20040713 09:04	20040713 10:35	27.00	32.00	3	1	4.03E–08	0	3.32E–08	0	0	6.64E–09	5.00
KFM03B	20040713 11:41	20040713 12:34	32.00	37.00	3	1	1.47E–05	0	1.21E–05	0	0	2.42E–06	5.00
KFM03B	20040713 13:18	20040713 14:55	37.00	42.00	3	1	1.33E–05	0	1.10E–05	0	0	2.20E–06	5.00
KFM03B	20040713 15:14	20040713 16:40	42.00	47.00	3	1	2.90E–07	0	2.39E–07	0	0	4.78E–08	5.00
KFM03B	20040713 16:57	20040713 18:24	47.00	52.00	3	1	2.56E–06	0	2.11E–06	1	0	4.21E–07	5.00
KFM03B	20040714 08:33	20040714 09:59	52.00	57.00	3	1	7.65E–07	0	6.30E–07	0	0	1.26E–07	5.00
KFM03B	20040714 10:19	20040714 11:50	57.00	62.00	3	1	4.66E–08	0	3.84E–08	0	0	7.68E–09	5.00
KFM03B	20040714 12:00	20040714 14:02	62.00	67.00	3	1	1.22E–05	0	1.01E–05	0	0	2.01E–06	5.00
KFM03B	20040714 14:14	20040714 15:11	67.00	72.00	3	1		–1		0	–1		5.00
KFM03B	20040714 15:24	20040714 16:50	72.00	77.00	3	1	3.98E–09	0	3.28E–09	0	0	6.55E–10	5.00

idcode	start_date	stop_date	secup	seclow	test_type	formation_type	spec_capacity_q_s	value_type_q_s	transmissivity_moye	bc_tm	value_type_tm	hydr_cond_moye	formation_width_b
KFM03B	20040721 11:42	20040721 13:11	77.00	82.00	3	1	4.83E–08	0	3.98E–08	0	0	7.96E–09	5.00
KFM03B	20040716 11:16	20040716 12:47	82.00	87.00	3	1	1.35E–07	0	1.11E–07	0	0	2.22E–08	5.00
KFM03B	20040716 13:04	20040716 15:05	87.00	92.00	3	1	3.86E–10	0	3.18E–10	0	0	6.36E–11	5.00

KFM03B plu_s_hole_test_ed1. Right (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	secup	seclow	transmissivity_tt	value_type_tt	bc_tt	l_measl_q_s	u_measl_q_s	assumed_s	c	skin	t1	t2	dte1	dte2	comment
KFM03B	7.00	12.00	5.57E–07	0	1	7.1E–10	5.0E–04	1.00E–06		–4.41			10	700	
KFM03B	12.00	17.00	1.20E–08	0	1	8.1E–10	5.0E–04	1.00E–06	4.45E–11	–1.00	80	500			
KFM03B	17.00	22.00	1.53E–08	0	1	6.8E–10	5.0E–04	1.00E–06	2.92E–11	0.00	10	40			
KFM03B	22.00	27.00	4.64E–08	0	1	8.2E–10	5.0E–04	1.00E–06	8.34E–11	–1.60	130	1,200			
KFM03B	27.00	32.00	4.21E–08	0	1	8.1E–10	5.0E–04	1.00E–06	5.61E–11	0.66	150	1,200			
KFM03B	32.00	37.00	7.12E–06	0	1	8.0E–10	5.0E–04	1.00E–06		–4.07	20	70			
KFM03B	37.00	42.00	7.99E–06	0	1	7.7E–10	5.0E–04	1.00E–06		–3.92	20	200			
KFM03B	42.00	47.00	2.25E–07	0	1	8.1E–10	5.0E–04	1.00E–06		–1.68	50	1,200			
KFM03B	47.00	52.00	5.66E–06	0	0	6.9E–10	5.0E–04	1.00E–06		5.60	400	1,200			
KFM03B	52.00	57.00	1.42E–06	0	1	8.2E–10	5.0E–04	1.00E–06		4.24	100	1,200			
KFM03B	57.00	62.00	4.64E–08	0	1	8.2E–10	5.0E–04	1.00E–06		0.08	20	500			
KFM03B	62.00	67.00	2.07E–05	0	1	1.6E–09	5.0E–04	1.00E–06		1.84	300	1,200			
KFM03B	67.00	72.00		–1	0	3.0E–10	5.0E–04	1.00E–06							
KFM03B	72.00	77.00	2.62E–09	0	1	7.2E–10	5.0E–04	1.00E–06	3.14E–11	0.72			3	300	
KFM03B	77.00	82.00	6.61E–08	0	1	8.2E–10	5.0E–04	1.00E–06		2.70	50	1,221			
KFM03B	82.00	87.00	1.16E–07	0	1	8.2E–10	5.0E–04	1.00E–06		–1.11	30	400			
KFM03B	87.00	92.00	1.58E–10	0	1	2.0E–10	5.0E–04	1.00E–06	1.83E–11	–0.44	100	1,200			

KFM03B plu_s_hole_test_obs (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	start_date	stop_date	secup	seclow	obs_secup	obs_seclow	pi_above	pp_above	pf_above	pi_below	pp_below	pf_below	comments
KFM03B	20040802 10:48	20040802 13:39	7.00	12.00	5.15	6.00	99.98	102.46	108.25				
KFM03B	20040802 10:48	20040802 13:39	7.00	12.00	13.00	101.54				132.26	132.40	132.40	
KFM03B	20040712 11:41	20040712 14:09	12.00	17.00	5.15	11.00	134.75	135.86	136.42				
KFM03B	20040712 11:41	20040712 14:09	12.00	17.00	18.00	101.54				180.99	180.99	180.99	
KFM03B	20040721 14:25	20040721 16:00	17.00	22.00	5.15	16.00	175.74	176.29	177.26				
KFM03B	20040721 14:25	20040721 16:00	17.00	22.00	23.00	101.54				241.03	239.92	238.40	
KFM03B	20040712 16:30	20040712 18:01	22.00	27.00	5.15	21.00	223.63	224.32	224.73				
KFM03B	20040712 16:30	20040712 18:01	22.00	27.00	28.00	101.54				293.07	294.86	289.75	
KFM03B	20040713 09:04	20040713 10:35	27.00	32.00	5.15	26.00	266.83	267.24	268.34				
KFM03B	20040713 09:04	20040713 10:35	27.00	32.00	33.00	101.54				326.74	326.74	326.74	
KFM03B	20040713 11:41	20040713 12:34	32.00	37.00	5.15	31.00	321.33	323.00	324.10				
KFM03B	20040713 11:41	20040713 12:34	32.00	37.00	38.00	101.54				379.61	403.49	381.42	
KFM03B	20040713 13:18	20040713 14:55	37.00	42.00	5.15	36.00	367.57	417.39	371.02				
KFM03B	20040713 13:18	20040713 14:55	37.00	42.00	43.00	101.54				428.89	431.64	429.44	
KFM03B	20040713 15:14	20040713 16:40	42.00	47.00	5.15	41.00	417.38	417.38	416.84				
KFM03B	20040713 15:14	20040713 16:40	42.00	47.00	48.00	101.54				483.26	483.54	486.85	
KFM03B	20040713 16:57	20040713 18:24	47.00	52.00	5.15	46.00	465.96	467.34	466.52				
KFM03B	20040713 16:57	20040713 18:24	47.00	52.00	53.00	101.54				536.55	534.62	532.68	
KFM03B	20040714 08:33	20040714 09:59	52.00	57.00	5.15	51.00	512.33	513.44	512.89				
KFM03B	20040714 08:33	20040714 09:59	52.00	57.00	58.00	101.54				576.85	577.12	576.85	
KFM03B	20040714 10:19	20040714 11:50	57.00	62.00	5.15	56.00	561.73	562.01	562.01				
KFM03B	20040714 10:19	20040714 11:50	57.00	62.00	63.00	101.54				624.89	624.89	625.44	
KFM03B	20040714 12:00	20040714 14:02	62.00	67.00	5.15	61.00	611.00	612.52	611.69				
KFM03B	20040714 12:00	20040714 14:02	62.00	67.00	68.00	101.54				689.48	680.65	675.68	
KFM03B	20040714 14:14	20040714 15:11	67.00	72.00	5.15	66.00	659.72	659.72	659.72				
KFM03B	20040714 14:14	20040714 15:11	67.00	72.00	73.00	101.54				731.45	730.89	729.79	

idcode	start_date	stop_date	secup	seclow	obs_secup	obs_seclow	pi_above	pp_above	pf_above	pi_below	pp_below	pf_below	comments
KFM03B	20040714 15:24	20040714 16:50	72.00	77.00	5.15	71.00	708.85	708.85	708.85				
KFM03B	20040714 15:24	20040714 16:50	72.00	77.00	78.00	101.54				780.72	777.83	777.27	
KFM03B	20040721 11:42	20040721 13:11	77.00	82.00	5.15	76.00	760.19	760.19	760.19				
KFM03B	20040721 11:42	20040721 13:11	77.00	82.00	83.00	101.54				823.65	824.48	824.75	
KFM03B	20040716 11:16	20040716 12:47	82.00	87.00	5.15	81.00	797.16	797.16	797.16				
KFM03B	20040716 11:16	20040716 12:47	82.00	87.00	88.00	101.54				866.71	869.61	867.81	
KFM03B	20040716 13:04	20040716 15:05	87.00	92.00	5.15	86.00	856.66	856.24	856.24				
KFM03B	20040716 13:04	20040716 15:05	87.00	92.00	93.00	101.54				922.48	922.48	921.92	