International Progress Report

IPR-05-18

Äspö Hard Rock Laboratory

Prototype Repository

Hydraulic tests and deformation measurements during operation phase

Test campaign 5

Interference tests

Torbjörn Forsmark
Ingvar Rhén
SWECO VIAK AB

September 2005

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

Äspö Hard Rock Laboratory

Report no.	No.
IPR-05-18	F63K
Author	Date
Torbjörn Forsmark Ingvar Rhén	2005-09-13
Checked by	Date
Ingvar Rhén	2005-09-13
Niclas Bockgård	2005-12-20
Approved	Date
Anders Sjöland	2006-01-12

Äspö Hard Rock Laboratory

Prototype Repository

Hydraulic tests and deformation measurements during operation phase

Test campaign 5

Interference tests

Torbjörn Forsmark

Ingvar Rhén

SWECO VIAK AB

September 2005

Keywords: Äspö HRL, Prototype Repository, Hydrogeology, Hydraulic tests, Interference tests, Hydraulic parameters, Transmissivity, Storage coefficient

Abstract

The Prototype Repository Test is focused on testing and demonstrating the function of the SKB deep repository system. Activities aimed at contributing to development and testing of the practical, engineering measures required to rationally perform the steps of a deposition sequence are also included in the project but are also part of other projects.

This report describes the second interference test campaign during the operation period of the repository. It was done simultaneously with the fifth single hole test campaign.

The test campaign consisted of running 7 interference tests with one flowing section and 131 observation sections. Each test consisted approximately of a 6 hour flowing period and a 18 hour recovery period. One test had a flowing period of 20 hours and a following recovery period of more than 48 hours.

Sammanfattning

Huvudsyftet med prototypförvaret är att testa och demonstrera funktionen av en del av SKB's djupförvarssystem. Aktiviteter som syftar till utveckling och försök av praktiska och ingenjörsmässiga lösningar, som krävs för att på ett rationellt sätt kunna stegvis utföra deponeringen av kapslar med kärnbränsle, är inkluderade i projektet för prototypförvaret men även i andra projekt.

Denna rapport beskriver den andra interferenstestkampanjen som genomförts under pågående drift av prototypförvaret. Den genomfördes samtidigt som den femte enhålstestomgången gjordes.

Sammanlagt genomfördes 7 stycken interferenstester med en flödessektion och 131 observationssektioner. Varje test innehöll en 6 timmars flödesperiod och 18 timmars återhämtning. Ett försök genomfördes med en 20 timmars flödesperiod och en återhämtningperiod på 48 timmar.

Executive Summary

The Prototype Repository Test is focused on testing and demonstrating the function of the SKB deep repository system. Activities aimed at contributing to development and testing of the practical, engineering measures required to rationally perform the steps of a deposition sequence are also included in the project but are also part of other projects.

This report describes the second interference test campaign during the operation period of the repository. It was done simultaneously with the fifth single hole test campaign.

The test campaign consisted of running 7 interference tests with one flowing section and 131 observation sections. Each test consisted approximately of a 6 hour flowing period and a 18 hour recovery period. One test had a flowing period of 20 hours and a following recovery period of more than 48 hours.

The diffusivity, η, versus the distance, r, and the time lag, $t_{L,}$ versus the distance, r, are shown in Figure 1 below. The timelag t_L is defined as the time when the pressure response in an observation section section is greater than 0.1 metres. Data are from all 7 interference tests performed during the test campaign.

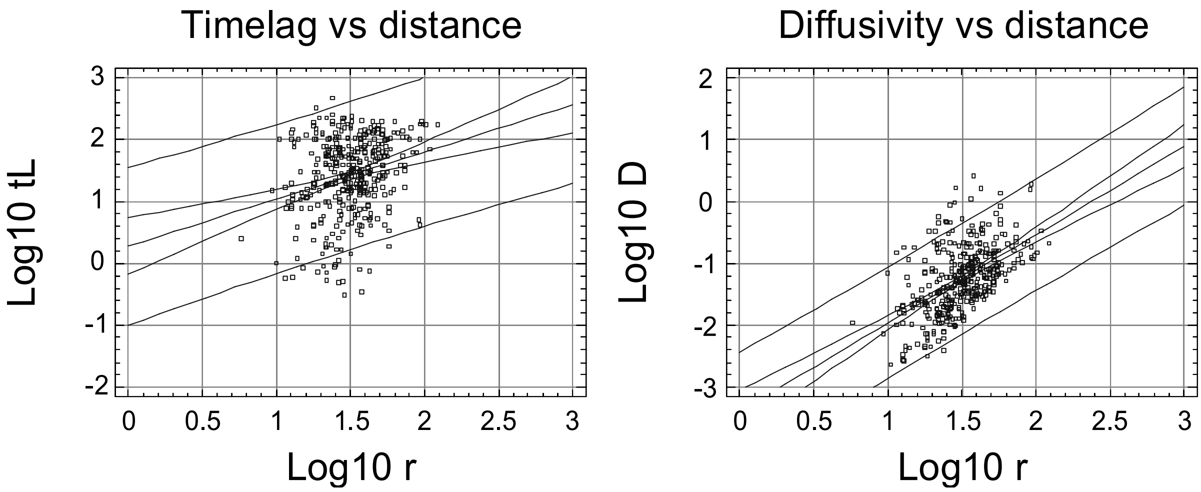


Figure 1 *Linear regression plots of time lag and diffusivity versus distance. Distance r in meters and t_L in minutes*

The equations of the regression lines in Figure 1 are

$$\text{Log}_{10}\, t_L = 0.763 * \text{Log}_{10}\, r + 0.279 \qquad \text{[min]}$$

$$\text{Log}_{10}\, \eta = 1.428 * \text{Log}_{10}\, r - 3.392 \qquad [m^2/s]$$

The apparent increase of diffusivity by distance in Figure 1 is probably not entirely relevant. As part of the flow is more spherical than radial the time lag should increase by distance. It is however probable that some feature with high transmissivity is involved at larger distances from the source that can partly justify a linear trend.

Possibly the most relevant estimates of diffusivity is for short distances, which may be up to around 10 metres. According to this the range for the diffusivity should be 0.001 – 0.1 m^2/s. However, from earlier experiences it is known that the diffusivity may become closer to 1 m^2/s for increasing transmissivities.

The storativity is not always received from a hydraulic test. In order to estimate an approximate value of the parameter a relationship between the evaluated transmissivity T_{EVAL} and the evaluated storativity S is established from the seven evaluated interference tests 5:21-5:27. The results are shown in Figure 2.

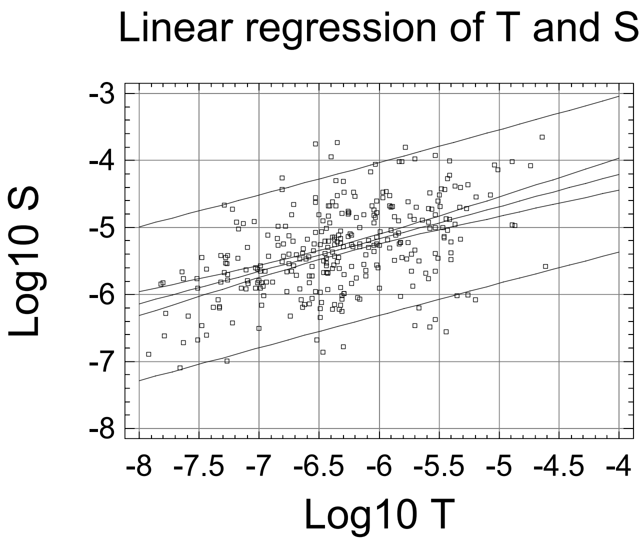


Figure 2 *Linear regression of T_{EVAL} and S. Transmissivity in m^2/s.*

The equation of the regression line in *Figure 2* is

$$\mathrm{Log}_{10}\, S = 0.483 * \mathrm{Log}_{10}\, T_{EVAL} - 2.272$$

Contents

1	**Background**	**17**
1.1	Äspö Hard Rock Laboratory	17
1.2	Prototype repository	18
	1.2.1 General objectives	18
2	**Objective**	**19**
3	**Scope**	**21**
4	**Equipment**	**23**
4.1	Description of equipment	23
4.2	Pressure sensors	24
4.3	Flowmeter equipment	25
4.4	Deformation measurements	26
	4.4.1 Measurement equipment	26
5	**Execution**	**31**
5.1	Preparations	31
5.2	Execution of tests/measurements	31
	5.2.1 Test principle	31
	5.2.2 Test procedure	32
5.3	Data handling	32
5.4	Analyses and interpretation	32
	5.4.1 Test borehole	32
	5.4.2 Interference tests	35
6	**Results**	**37**
6.1	General	37
6.2	Interference tests	38
	6.2.1 Test 5:21 – KA3539G:2	38
	6.2.2 Test 5:22 – KA3542G02:5	45
	6.2.3 Test 5:23 – KA3554G01:2	52
	6.2.4 Test 5:24 – KA3590G02:1	59
	6.2.5 Test 5:25 – KG0021A01:3	66
	6.2.6 Test 5:26 – KG0048A01:3	73
	6.2.7 Test 5:27 – KA3573A:4	80
6.3	Hydraulic diffusivity	87
6.4	Storativity	87
6.5	Deformation measurements	89
References		**91**

Tables

Table 3-1 Interference tests during the campaign in January 2005 21

Table 4-1 Data of the measurement sections (sensors, length, number of fractures etc). 28

Table 6-1 General test data for the pressure build-up test in section 15.85-17.60 m 38

Table 6-2 Interference test results for KA3539G, 15.85 - 17.60 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 43

Table 6-3 Interference test results for KA3539G, 15.85 - 17.60 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 44

Table 6-4 General test data for the pressure build-up test in section 2.00-8.00 m 45

Table 6-5 Interference test results for KA3542G02, 2.00 - 8.00 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, $\tilde{\eta}$) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 50

Table 6-6 Interference test results for KA3542G02, 2.00 - 8.00 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, $\tilde{\eta}$) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 51

Table 6-7 General test data for the pressure build-up test in section 22.60-24.15 m 52

Table 6-8 Interference test results for KA3554G01, 22.60 - 24.15 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 57

Table 6-9 Interference test results for KA3554G01, 22.60 - 24.15 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 58

Table 6-10 General test data for the pressure build-up test in section 25.50-30.01 m 59

Table 6-11 Interference test results for KA3590G02, 25.50 - 30.01 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 64

Table 6-12 Interference test results for KA3590G02, 25.50 - 30.01 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 65

Table 6-13 General test data for the pressure build-up test in section 35.00-36.00 m 66

Table 6-14 Interference test results for KG0021A01, 35.00 - 36.00 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 71

Table 6-15 Interference test results for KG0021A01, 35.00 - 36.00 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 72

Table 6-16 General test data for the pressure build-up test in section 32.80-33.80 m 73

Table 6-17 Interference test results for KG0048A01, 32.80 - 33.80 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 78

Table 6-18 Interference test results for KG0048A01, 32.80 - 33.80 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 79

Table 6-19 General test data for the pressure build-up test in section 10.50-12.50 m 80

Table 6-20 Interference test results for KA3573A, 10.50 - 12.50 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 85

Table 6-21 Interference test results for KA3573A, 10.50 - 12.50 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). 86

Figures

Figure 1-1	Location of Äspö Hard Rock Laboratory	17
Figure 4-1	All pressure transducers are connected to the HMS system. In the G-tunnel there is a computer in the HMS system where logging frequencies easily can be changed.	23
Figure 4-2	Pressure transducers connections	24
Figure 4-3	The equipment for flowrate measurement with Micro Motion Coriolis mass flowmeter system	25
Figure 4-4	A schematic figure, that shows the different parts of the test equipment and also the definitions of the terms outer and inner.	27
Figure 4-5	A detailed figure of the three anchors, sensors (strain gage), positioning cylinder etc.	29
Figure 6-1	Flow rates during draw down in KA3539G:2. Time in minutes.	39
Figure 6-2	Plot showing r^2/t_L during recovery of KA3539G:2 (Interference test 5:21) - plan view	41
Figure 6-3	Plot showing r^2/t_L during recovery of KA3539G:2 (Interference test 5:21) - vertical view	42
Figure 6-4	Flow rates during draw down in KA3542G02:5. Time in minutes.	46
Figure 6-5	Plot showing r^2/t_L during recovery of KA3542G02:5 (Interference test 5:22) - plan view	48
Figure 6-6	Plot showing r^2/t_L during recovery of KA3542G02:5 (Interference test 5:22) - vertical view	49
Figure 6-7	Flow rates during draw down in KA3554G01:2. Time in minutes.	53
Figure 6-8	Plot showing r^2/t_L during recovery of KA3554G01:2 (Interference test 5:23) - plan view	55
Figure 6-9	Plot showing r^2/t_L during recovery of KA3554G01:2 (Interference test 5:23) - vertical view	56
Figure 6-10	Flow rates during drawdown in KA3590G02:1. Time in minutes.	60
Figure 6-11	Plot showing r^2/t_L during recovery of KA3590G02:1 (Interference test 5:24) - plan view	62
Figure 6-12	Plot showing r^2/t_L during recovery of KA3590G02:1 (Interference test 5:24) - vertical view	63
Figure 6-13	Flow rates during draw down in KG0021A01:3. Time in minutes.	67
Figure 6-14	Plot showing r^2/t_L during recovery of KG0021A01:3 (Interference test 5:25) - plan view	69
Figure 6-15	Plot showing r^2/t_L during recovery of KG0021A01:3 (Interference test 5:25) – vertical view	70
Figure 6-16	Flow rates during draw down in KG0048A01:3.Time in minutes.	74

Figure 6-17 Plot showing r^2/t_L during recovery of KG0048A01:3 (Interference test 5:26) - plan view 76

Figure 6-18 Plot showing r^2/t_L during recovery of KG0048A01:3 (Interference test 5:26) - vertical view 77

Figure 6-19 Flow rates during draw down in KA3573A:4. Time in minutes. 81

Figure 6-20 Plot showing r^2/t_L during recovery of KA3573A:4 (Interference test 5:27) - plan view 83

Figure 6-21 Plot showing r^2/t_L during recovery of KA3573A:4 (Interference test 5:27) - vertical view 84

Figure 6-22 Linear regression plots of time lag and diffusivity versus distance 87

Figure 6-23 Linear regression of T_{EVAL} and S. 88

Figure 6-24 Linear regression of T_{EVAL} and S*. 89

Appendices

APPENDIX 1 Interference test 5:21 in KA3539G, section 15.85 m – 17.60 m.

APPENDIX 2 Interference test 5:22 in KA3542G02, section 2.00 m - 8.00 m.

APPENDIX 3 Interference test 5:23 in KA3554G01, section 22.60 m - 24.15 m.

APPENDIX 4 Interference test 5:24 in KA3590G02, section 25.50 m - 30.01 m.

APPENDIX 5 Interference test 5:25 in KG0021A01, section 35.00 m - 36.00 m.

APPENDIX 6 Interference test 5:26 in KG0048A01, section 32.80 m - 33.80 m.

APPENDIX 7 Interference test 5:27 in KA3573A, section 10.50 m - 12.50 m.

1 Background

1.1 Äspö Hard Rock Laboratory

In order to prepare for the siting and licensing of a spent fuel repository SKB has constructed an underground research laboratory.

In the autumn of 1990, SKB began the construction of Äspö Hard Rock Laboratory (Äspö HRL), see Figure 1-1, near Oskarshamn in the south-eastern part of Sweden. A 3.6 km long tunnel was excavated in crystalline rock down to a depth of approximately 460 m.

The laboratory was completed in 1995 and research concerning the disposal of nuclear waste in crystalline rock has since then been carried out.

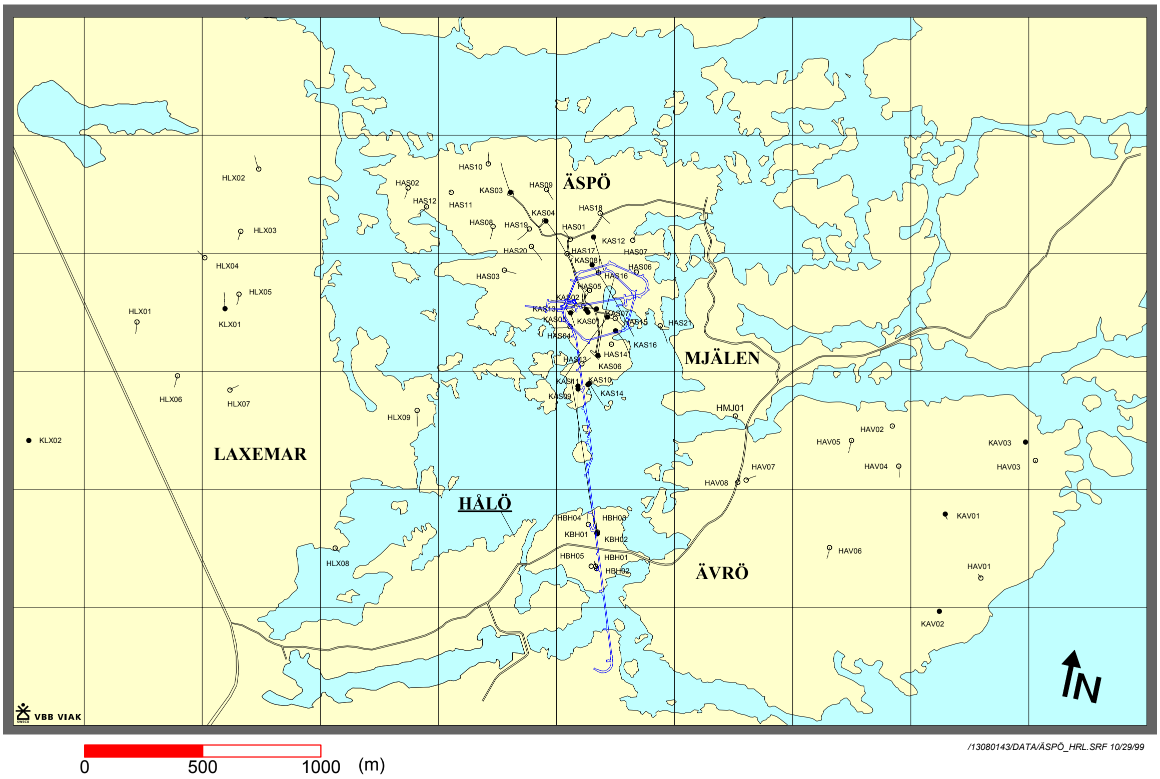


Figure 1-1 *Location of Äspö Hard Rock Laboratory*

1.2 Prototype repository

The Äspö Hard Rock Laboratory is an essential part of the research, development, and demonstration work performed by SKB in preparation for construction and operation of the deep repository for spent fuel. Within the scope of the SKB program for RD&D 1995, SKB has decided to carry out a project with the designation "Prototype Repository Test". The aim of the project is to test important components in the SKB deep repository system in full scale and in a realistic environment.

The Prototype Repository Test is focused on testing and demonstrating the function of the SKB deep repository system. Activities aimed at contributing to development and testing of the practical, engineering measures required to rationally perform the steps of a deposition sequence are also included. However, efforts in this direction are limited, since these matters are addressed in the Demonstration of Repository Technology project and to some extent in the Backfill and Plug Test.

1.2.1 General objectives

The Prototype Repository should simulate as many aspects as possible of a real repository, for example regarding geometry, materials, and rock environment. The Prototype Repository is a demonstration of the integrated function of the repository components. Results will be compared with models and assumptions to test their validity.

The major objectives for the Prototype Repository are:

- To test and demonstrate the integrated function of the repository components under realistic conditions in full scale and to compare results with models and assumptions.
- To develop, test and demonstrate appropriate engineering standards and quality assurance methods.
- To simulate appropriate parts of the repository design and the construction process.

The objective for the operation phase program is:

- To monitor processes and properties in the canister, buffer material, backfill and near-field rock mass

2 Objective

The objectives for the interference tests are:

- to estimate the hydraulic properties, transmissivity, storativity and hydraulic diffusivity
- that they shall provide hydrogeological data useful for setting up a hydrogeological model of the rock volume around the TBM tunnel.

3 Scope

Interference tests were done using 7 boreholes in the Prototype Repository tunnel or in the G-tunnel. The tested intervals and basic test data are listed in Table 3-1. The first figure in the test number indicates this being the fifth test campaign, while the second number indicates the numbering of the interference tests. Tests 5:1-5:13 were single hole tests done during the same period in January 2005, (*Forsmark, Rhén, 2005b)*. The same numbering of the tests as used during test campaign 1 to 4 is used *(Forsmark et al, 2004), (Forsmark, Rhén, 2004a, 2004b, 2004c, 2005a)*. Also indicated are those sections where Hydro Mechanical measurements (HM) are done.

Table 3-1 Interference tests during the campaign in January 2005

Bore hole	Section (m)	HM section	Test no.	Date of test	Start of test	Flow start	Flow stop	Test stop (Next day)
KA3539G:2	15.85-17.60	X	5:21	2005-01-20	13:30:00	15:30:00	21:30:00	15:30:00
KA3542G02:5	2.00-8.00	-	5:22	2005-01-24	13:00:00	15:00:00	21:00:00	15:00:00
KA3554G01:2	22.60-24.15	X	5:23	2005-01-22	13:00:00	15:00:00	21:00:00	15:00:00
KA3590G02:1	25.50-30.01	-	5:24	2005-01-21	13:00:00	15:00:00	21:00:00	15:00:00
KG0021A01:3	35.00-36.00	-	5:25	2005-01-19	14:00:00	16:00:00	22:00:00	16:00:00
KG0048A01:3	32.80-33.80	-	5:26	2005-01-23	14:00:00	16:00:00	22:00:00	16:00:00
KA3573A:4	10.50-12.50	-	5:27	2005-01-25	17:00:00	19:00:00	15:00:00*	19:00:00**

* = 2005-01-26, ** = 2005-01-28

In chapter 6 the results of the tests are presented.

4 Equipment

4.1 Description of equipment

A large number of boreholes were instrumented with one or several packers. In all packed-off sections, the water pressure will be measured. Each borehole section is connected to a tube of polyamide that via lead-through holes ends in the G-tunnel. All pressure transducers are placed in the G-tunnel to facilitate easy calibration and exchange of transducers that are out of order. The transducers are connected to the HMS system at Äspö Laboratory and it is a flexible system for changing the sampling frequency, see Figure 4-1. The maximum scan frequency is every 3rd second. During periods with no hydraulic tests, the sampling (storing a value in the data base) frequency will be every 2nd hour with an automatic increase of the sampling frequency if the pressure change since last registration is larger than 2kPa. During hydraulic tests, the sampling frequency may be up to 3rd second.

Figure 4-1 *All pressure transducers are connected to the HMS system. In the G-tunnel there is a computer in the HMS system where logging frequencies easily can be changed.*

4.2 Pressure sensors

The pressure in a borehole is transmitted via a plastic tube directly to a pressure transducer, see Figure 4-2.

The pressure transducers are either of the type DRUCK PTX 500 series or DRUCK PTX 600 series with a pressure range of 0 – 50 bar (absolute).

According to the manufacturer the uncertainty for these transducers is +/-0.2 % (type500) and +/-0.08 % (type 600) of full scale (F.S) for the best straight line (B.S.L.). For the 600 series types the time drift is given to max. 0.05 % F.S., while no figure is given for the 500 series types. Normally, a pressure value is scanned once every third seconds. If the change since the latest stored value exceeds a "change value" of approximately 2 kPa the newly scanned value is stored. A value is always stored once every second hour, regardless of any changes.

Figure 4-2 *Pressure transducers connections*

4.3 Flowmeter equipment

A new kind of flowmeter, see Figure 4-3, was used in order to obtain continously flow measurements during the tests. The equipment system used was originally developed by Micro Motion, Inc. in USA, and is comprised of a sensor and a signal processing transmitter. It is called a Coriolis mass flowmeter and measures mass flow directly. The volume flow can be obtained when knowing the temperature, the pressure and finally the density of the fluid (water).

The fluid enters the sensor and travels through the sensor's flow tubes, which vibrate and twist. The twisting characteristic is called the Coriolis effect. According to Newton's Second Law of Motion, the amount of sensor tube twist is directly proportional to the mass flow rate of the fluid flowing through the tube.

The equipment unit consist of two flowmeters with different measurement ranges. The measurement range for the large flowmeter is 0 to appr. 36 kg/min and for the small flowmeter is 0 to approx. 1.8 kg/min.

***Figure 4-3** The equipment for flowrate measurement with Micro Motion Coriolis mass flowmeter system*

4.4 Deformation measurements

During storage of nuclear waste in the rock mass the temperature will increase due to the heat loss from the canisters with spent fuel. This will increase the rock stresses and the fractures will generally close, but may locally open due to the stress situation (*Alm et al, 2005).*

It is of great interest to investigate the magnitude of this effect on the fracture transmissivity since the fracture transmissivity is essential of two reasons. First, enough transmissivity is needed to provide the bentonite buffer with water if no artificial moistening of the buffer is arranged. Secondly, the transmissivity should be as low as possible in order to minimise the hydraulic contact with the canisters. The increased temperature will decrease the transmissivity, which in principal is positive in perspective of Safety Assessment. The last effect is however limited in time and may not be of any greater importance in Safety Assessment.

Displacement measurements are done continuously. Hydraulic tests will be made a number of times during the operation period for the ten measurement sections. An extra section is also equipped with hydromechanical measurements equipment and is used as a reference hole (KG0010B01). Most tests have been planned to be made during the first years of operation when the largest displacements are expected to occur. This report details the interference results from the fifth test campaign. They were done in order to provide hydrogeological data useful for setting up a hydrogeological model of the rock volume around the TBM tunnel.

In order to investigate the hydro mechanical response of the fractures as a result of the increased thermal load, two different approaches are considered.

The first approach is to measure the change of the fracture width as function of temperature and time. The displacement is both measured for the intact rock as for a section with one or more fractures.

The second approach implies that the mechanical response is evaluated indirect by using the results from hydraulic tests. Single hole hydro tests was performed in the same sections as the mechanical measurements are made (*Forsmark, Rhén, 2005b*).

All results from the hydromechanical measurements will be documented in separate documents.

4.4.1 Measurement equipment

In order to measure the fracture deformation (and to separate the fracture deformation from the deformation of the intact rock) due to the increased temperature a measurement equipment has been developed.

The equipment consists of two hydraulic packers, which hydraulically isolate the test section. Between the packers three anchors are placed. These anchors are fixed to the borehole wall and in the sections between the anchors sensors (strain gage) are mounted. These sections are called mechanical measurement sections. The sensors will register any relative movement between the anchors; see Figure 4-4 and 4-5. The temperature is also measured in each sensor by a thermistor.

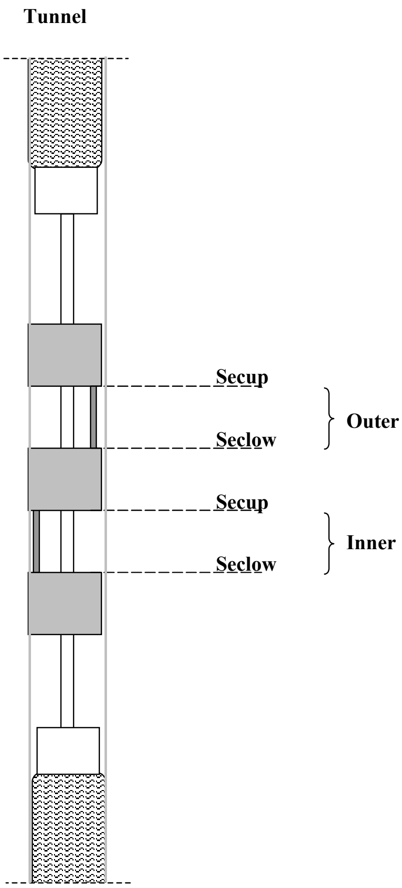


Figure 4-4 *A schematic figure, that shows the different parts of the test equipment and also the definitions of the terms outer and inner.*

The deformation is measured in two sections in each borehole. One mechanical measurement section is placed over a fracture (or fractures) and the other mechanical measurement section is placed over intact rock. That makes it possible to separate the fracture deformation from the deformation of the intact rock.

Of all boreholes in the prototype tunnel, ten are equipped as described above. Five of the measurement sections are placed over a single fracture and the rest are placed over two-six fractures, see Table 4-1.

Since hydraulic packers isolate the test sections and the test sections have contact with the tunnel (atmospheric pressure) via tubes and valves it is possible to perform hydraulic tests in the sections.

Table 4-1 Data of the measurement sections (sensors, length, number of fractures etc).

Label	Cable mark	Sensor S/N	Position	Secup	Seclow	Section length (m)	Number of fractures
KA3539G-2-1	HRA 1121	3511	Inner	16.77	16.97	0.20	2
KA3539G-2-2	HRA 1122	3510	Outer	16.47	16.67	0.20	0
KA3542G01-3-1	HRA 1231	3513	Inner	19.47	19.67	0.20	0
KA3542G01-3-2	HRA 1232	3512	Outer	19.17	19.37	0.20	1
KA3542G02-2-1	HRA 1321	3515	Inner	26.50	26.70	0.20	1
KA3542G02-2-2	HRA 1322	3514	Outer	26.20	26.40	0.20	0
KA3544G01-2-1	HRA 1621	3509	Inner	9.82	10.02	0.20	1
KA3544G01-2-2	HRA 1622	3508	Outer	9.52	9.72	0.20	0
KA3546G01-2-1	HRA 1721	3517	Inner	7.67	7.87	0.20	1
KA3546G01-2-2	HRA 1722	3516	Outer	7.37	7.57	0.20	0
KA3548A01-3-1	HRA 1831	3526	Inner	9.70	10.15	0.45	2
KA3548A01-3-2	HRA 1832	3518	Outer	9.40	9.60	0.20	0
KA3550G01-2-1	HRA 2121	3527	Inner	6.10	6.70	0.60	6
KA3550G01-2-2	HRA 2122	3519	Outer	5.80	6.00	0.20	0
KA3552G01-2-1	HRA 2521	3521	Inner	5.25	5.45	0.20	0
KA3552G01-2-2	HRA 2522	3520	Outer	4.95	5.15	0.20	2
KA3554G01-2-1	HRA 2821	3525	Inner	23.54	23.80	0.26	2
KA3554G01-2-2	HRA 2822	3522	Outer	23.24	23.44	0.20	0
KA3554G02-4-1	HRA 2941	3524	Inner	11.40	11.60	0.20	0
KA3554G02-4-2	HRA 2942	3523	Outer	11.10	11.30	0.20	1
KG0010B01-1-1	-	3238	Inner	3.66	3.86	0.20	-
KG0010B01-1-2	-	3507	Outer	3.36	3.56	0.20	-

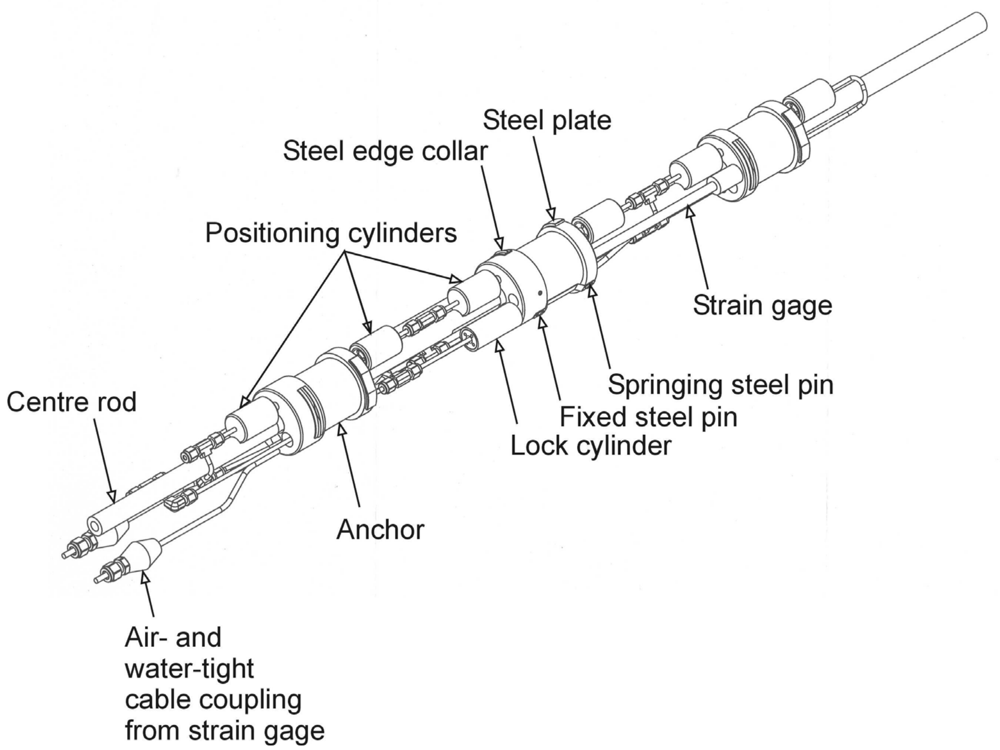


Figure 4-5 *A detailed figure of the three anchors, sensors (strain gage), positioning cylinders etc.*

5 Execution

5.1 Preparations

Planning is an important step in the preparation stage. No other activities, which may cause pressure responses, must occur in the neighbourhood of the test area. Such activities include drilling, blasting and flowing of boreholes.

Preparations also include checking of equipment to be used in the tests. The equipment includes:

- measuring glasses of various sizes
- watches synchronized with the HMS system (only normal time)
- protocols for flow measurements
- water sampling bottles
- hand calculator
- flow rate measurement equipment with Micro Motion flowmeter system

5.2 Execution of tests/measurements

5.2.1 Test principle

The main purposes of interference tests are to:

- Estimate the hydraulic properties of water bearing hydraulic features or systems of hydraulic features
- Provide draw down and recovery data which can be used to calibrate numerical groundwater model

It is important to perform interference tests to obtain the effective transmissivity of a hydraulic feature. To evaluate the storativity of the feature, observations in other borehole sections than the test section are necessary and they must also intersect the hydraulic feature.

Interference tests can be rather time consuming in planning, execution, processing of data and evaluation of data. It is very important to plan interference tests and other activities, which may cause pressure responses (for example drilling) so that they do not interfere with each other. If other tests or activities cause pressure responses, they may ruin the interference test.

5.2.2 Test procedure

The following measurement cycle was used:

- Initialising of the HMS system 30 minutes before flow start with logging interval of 5 minutes
- A couple of minutes before flow start and until 5 minutes after flow start the highest logging interval of 2 seconds were used. Thereafter the logging interval was 30 seconds which was used until 30 minutes after flow start and a logging interval of 5 minutes was then used once again
- The flow was measured manually 2-3 times the first 5 minutes after flow start, 2-3 times the following 60 minutes and 3 times shortly before flow stop
- From shortly before flow stop until 5 minutes after flow stop the highest logging interval of 2 seconds were used. Thereafter the logging interval was 30 seconds which was used until 30 minutes after flow start and a logging interval of 5 minutes was then used
- The valve shutting was done as swiftly as possible

5.3 Data handling

The test operator was keeping a diary during the test period. Data from the hydro tests includes:

- Daily logs in accordance with Äspö Hard Rock Laboratory routines
- Protocols from flow measurements

The project coordinator collected all data and delivered it to the data handling responsible person at Äspö for further SICADA handling.

5.4 Analyses and interpretation

5.4.1 Test borehole

The following description applies to the analysis in this report. The analysis done is for the recovery phase only.

While plotting the data, three different kinds of graphs were produced. The first plot is made in a linear scale. The time, date and hours is indicated on the horizontal axis. The pressure (p), expressed in bar or metres of water head is indicated on the vertical axis. The second plot is made in a semi-logarithmic diagram, where the pressure change, Δp, is plotted versus the equivalent time, dt_e, in minutes. The equivalent time, dt_e, (*Spane, Wurstner, 1993*) is defined as

$$dt_e = (t_p \cdot dt) / (t_p + dt) \qquad \text{where}$$

t_p = the flowing time of the borehole before shutting the valve

dt = the time after shutting the valve

The pressure change Δp is calculated as

Δp	=	$p(dt) - p(t_p)$
$p(dt)$	=	measured pressure at time dt after shutting the valve
$p(t_p)$	=	measured pressure just before shutting the valve

The third plot is made in a logarithmic diagram, where the change of pressure, Δp, is plotted versus the equivalent time, dt_e, in minutes. The derivative of the pressure is also plotted in this diagram.

The pressure normally is signed using the p and a change of pressure using a Δp. In the diagrams the pressure can be expressed in bar, kPa or in metres of water head. In the formulas below however the praxis is to use the s for the change of water head and Δs for the difference of pressure over one decade in a logarithmic diagram. The s or Δs values shall be expressed in metres before used in the formulas.

Hydrologic test analysis based on the derivative of pressure (i.e., rate of pressure change) with respect to the natural logarithm of time has been shown to significantly improve the diagnostic and quantitative analysis of slug and constant-rate discharge tests (i.e., pumping tests) (*Spane, Wurstner, 1993*). The improvement in hydrologic test analysis is attributed to the sensitivity of the derivative response to small variations in the rate of pressure change that occurs during testing, which would otherwise be less obvious with standard pressure change versus time analysis techniques. The sensitivity of pressure derivatives to pressure change responses facilitates their use in identifying the presence of wellbore storage, boundaries, and establishment of flow conditions, as e.g. radial flow, within the test data record. Specifically, pressure derivative analysis can be used to:

- diagnostically determine formation response (homogeneous vs. heterogeneous) and boundary conditions (impermeable or constant head) that are evident during the test,

- determine when radial flow conditions are established and, therefore, when straight-line solution analysis of draw down data is valid, and

- assist in log-log type-curve matching to determine hydraulic properties for test data exhibiting wellbore storage and/or leakage effects.

The software DERIV, (*Spane, Wurstner, 1993*), is used to produce the derivative. DERIV is a software for converting slug and constant-rate discharge test data and type curves to derivative format. The software has features that permit the smoothing of noisy test data, accounts for pressure derivative end-effects, and can be used to convert slug test data to equivalent constant-rate test responses.

Two different geohydrological parameters of the borehole can easily be evaluated. These parameters are:

- the specific capacity, Q/s (m^2/s)
- the transmissivity, T (m^2/s)

The specific capacity is as mentioned above, Q/s, where Q is the calculated average water flow before shutting the valve and s is the maximum change of pressure, in metres, during the test.

To evaluate the transmissivity, T, the following methodology should be used:

The flow regime can be estimated from the logarithmic plot. In most cases the flow can be said to be radial to the borehole approximately 1.0-1.5 decades after the time the curve has left the 1:1 curve. The 1:1 curve indicates the well bore storage, WBS. The transmissivity is then calculated with Jacob's semi logarithmic approximation of Theis well function

$T = 0.183 \cdot Q / \Delta s$

Q = the average flow rate before shutting the valve (m^3/s)

Δs = the pressure change in metres during a decade along the straight line (radial flow period) in the semi logarithmic diagram.

Sometimes both the logarithmic and the semi logarithmic diagrams indicate a more complicated flow regime than described above (WBS, transition, radial flow) and in these cases it is necessary to decide what part of the curve and what evaluation method that is appropriate for estimating the hydraulic properties.

The Moye formula can be used for interpretation of stationary tests in order to get an estimate of the transmissivity

$T_{Moye} = Q \cdot (1 + \ln(L/(2 \cdot r_w))) / (2 \cdot \pi \cdot \Delta h)$ where

$\Delta h = (p_0 - p_p) / (\rho_w \cdot g)$ [m]

L = test section length [m]

r_w = borehole radius [m]

p_0 = absolute pressure in test section before start of flow period [Pa]

p_p = absolute pressure in test section before stop of flow period [Pa]

ρ_w = water density [kg/m^3]

g = acceleration of gravity [m/s^2]

5.4.2 Interference tests

Pressure registration was made in neighbouring boreholes during the flowing and recovery phase of every interference test. In Tables 6-1 to 6-21 the results of the tests are presented. In Appendices 1 to 7 some evaluated observation sections ($r^2/t_L > 1$, see below) are presented. The mid-chainage of each bore hole section is the mid-point between the packers. The distance, r, between different bore hole sections has been calculated as the spherical distance using co-ordinates for the mid-chainage for each section. The evaluation of transmissivity $T_{EVAL,}$ and storativity S, has been made using the Theis log-log type curve method assuming radial flow. The calculation of the hydraulic diffusivity is based on radial flow (*Streltsova, 1988*) :

$$\eta = T / S = r^2 / [\, 4 \cdot t_L \cdot (1 + t_L / dt) \cdot \ln(1 + dt / t_L)]$$

The time lag t_L is defined as the time when the pressure response in an observation section is greater than 0.1 metres. The pumping time is included as dt. As can be seen in equation above the diffusivity is proportional to r^2 / t_L. S^* in the test result tables in *Chapter 6* is calculated as $S^* = T / \eta$. The values of diffusivity and storativity should be seen as approximate values as the flow dimension is not always radial. When the flow is interpreted as radial flow T_{EVAL} is shown in the table for the observation sections.

The pressure response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m). This classification is made from drawdown pressure head plots. Two columns in the tables show $P_0 - P_f$ and $P_p - P_f$, *Tables 6-1 to 6-21*, using HMS data. These data are not always stable. Therefor for some sections where no response is noticed the value may be negative or there may exist a general pressure trend, increasing or decreasing.

The relation r^2/t_L is used as an indicator to better understand whether a pressure response really indicate a good hydraulic connection or not. A small response at a large distance may actually indicate a better connection than a larger response at a shorter distance. This classification is done using the recovery response, since the recovery response is more distinct in regard to the timelag, t_L .

In the test evaluation the following grouping is used:

- **Some** hydraulic connection: $r^2/t_L < 1$ [m^2/s]
- A **rather good** hydraulic connection: $1 < r^2/t_L < 2$ [m^2/s]
- A **good** hydraulic connection: $2 < r^2/t_L < 4$ [m^2/s]
- A **very good** hydraulic connection: $4 < r^2/t_L$ [m^2/s]

Due to unknown causes the highest logging frequency of 2 seconds was not initiated for two of the interference tests, namely tests 5:21 and 5:25. Therefor fewer observation responses were registered than otherwise expected.

6 Results

6.1 General

During two interference test campaigns in 1999, (*Forsmark T, Rhén, I, 1999, 2000)*, two major hydraulic features or system of features, one on the south side and one on the north side of the prototype repository were observed. They were evaluated regarding geometry and hydraulic parameters, such as transmissivity and storativity. The system of features strikes WNW.

The results from the now performed interference tests confirm this idea of almost vertical sets of parallel hydraulic features or system of features running in a WNW direction.

Several of the evaluated transmissivities of observation sections can certainly be discussed but may give an indication of the magnitude of the transmissivity. It is likely that only a few observation sections may be in more direct contact with the flowing section, thus giving a firmer basis for the evaluation.

The evaluated (average) diffusivity is also likely to be greater as the distance through the fracture network is in most cases probable greater than the now used spherical distance.

Due to the above mentioned uncertainties the evaluated storativity is uncertain, but should probably indicate reasonable values of the storativity

6.2 Interference tests

6.2.1 Test 5:21 – KA3539G:2

General test data for the pressure build-up test in the interval 15.85-17.60 m of borehole KA3539G are presented in Table 6-1.

Table 6-1 General test data for the pressure build-up test in section 15.85-17.60 m of borehole KA3539G

General test data			
Borehole section	KA3539G:2		
Test No	5:21		
Field crew	J. Magnusson, A. Blom (SWECO VIAK)		
Test equipment system	HMS		
General comment	Interference test		
	Nomen-clature	Unit	Value
Test section- secup	Secup	m	15.85
Test section- seclow	Seclow	m	17.60
Test section length	L_w	m	1.75
Test section diameter	$2 \cdot r_w$	mm	76
Test start (start of pressure registration)		yymmdd hh:mm	20050120 13:30:00
Packer expanded		yymmdd hh:mm:ss	-
Start of flow period		yymmdd hh:mm:ss	20050120 15:30:00
Stop of flow period		yymmdd hh:mm:ss	20050120 21:30:00
Test stop (stop of pressure registration)		yymmdd hh:mm	20050121 15:30:00
Total flow time	t_p	min	360
Total recovery time	t_F	min	1080

Pressure data

Pressure data	**Nomen-clature**	**Unit**	**Value**	**Comment**
Absolute pressure in borehole before start of flow period	p_0	kPa	1972	
Absolute pressure in test section before stop of flow	p_p	kPa	526	
Max absolute pressure in test section during recovery period	p_f	kPa	1985	
Maximal pressure change during flow period	dp_p	kPa	1446	

Flow data

Flow data	**Nomen-clature**	**Unit**	**Value**
Flow rate from test section just before stop of flowing	Q_p	m^3/s	$2.20 \cdot 10^{-5}$
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	$2.43 \cdot 10^{-5}$
Total volume discharged during flow period	V_p	m^3	0.525

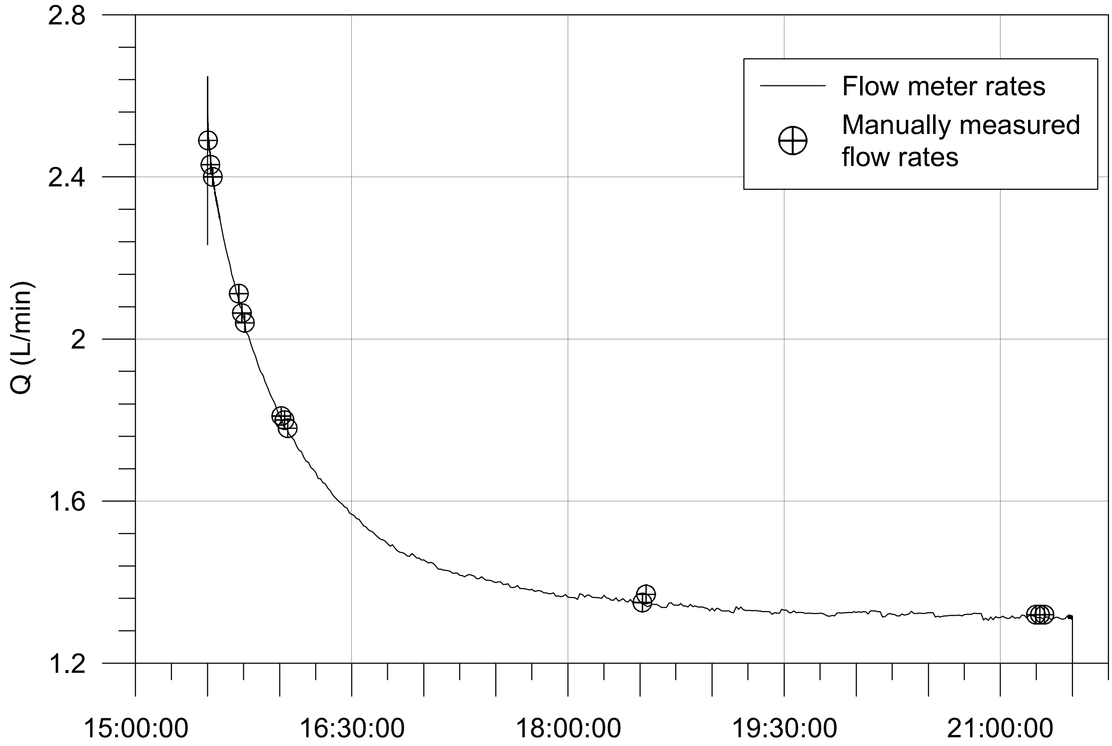


Figure 6-1 *Flow rates during draw down in KA3539G:2. Time in minutes.*

Comments to the test

The test was successful in regard to pressure response.

Interpreted flow regimes – flowing section

0 – 0.05	minutes	Well Bore Storage (WBS)
0.05 – 0.25	minutes	Transition period
0.25 – 0.4	minutes	Radial flow period
0.4 – 0.8	minutes	Transition period
0.8 – 2	minutes	Possible linear channel flow
2 –	minutes	Transition period

Calculated parameters

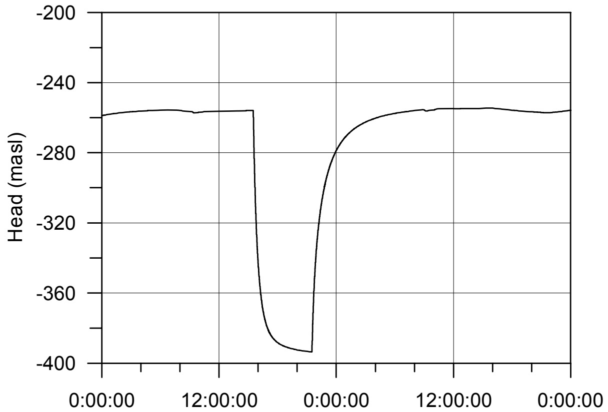
Quantitative analysis was made for recovery phases in lin-log- and log-log diagrams according to the methods described in Section 5.4.1.

Selected representative parameters

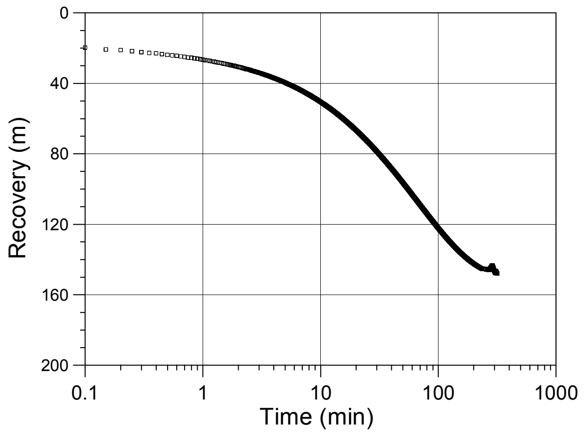
The selected representative parameters from the test in the interval 15.85-17.60 m in KA3539G are presented in the Test Summary Sheet below. The selected parameters are derived from the recovery period.

Test Summary Sheet			
Project:	PROTOTYPE	Test type:	PBT
Area:	ÄSPÖ	Test no:	5:21 (Single hole test 5:13b)
Borehole ID:	KA3539G	Test start:	2005-01-20 13:30
Test section (m):	15.85-17.60	Responsible for test performance:	SWECO VIAK AB J. Magnusson/A. Blom
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	SWECO VIAK AB T. Forsmark

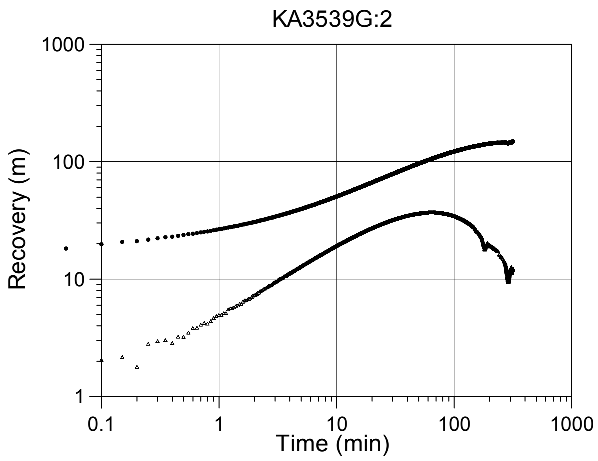
Linear plot Head



Lin-Log plot



Log-Log plot incl. derivative- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)	1972		
p_i (kPa)			
p_p(kPa)	526	p_F (kPa)	1985
Q_p (m^3/s)	$2.20 \cdot 10^{-5}$		
tp (min)	360	t_F (min)	1080
S*		S*	$1 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(gr C)			
Derivative fact.		Derivative fact.	0.2
Results		**Results**	
Q/s (m^2/s)	$1.5 \cdot 10^{-7}$	Flow regime:	Radial
T_{Moye}(m^2/s)	$1.0 \cdot 10^{-7}$	dt_{e1} (min)	0.25
Flow regime:		dt_{e2} (min)	0.4
dt_1 (min)		T (m^2/s)	$6.6 \cdot 10^{-7}$
dt_2 (min)		S (-)	
T (m^2/s)		K_s (m/s)	
S (-)		S_s (1/m)	
K_s (m/s)		C (m^3/Pa)	
S_s (1/m)		C_D (-)	
C (m^3/Pa)		ξ (-)	-0.8
C_D (-)			
ξ (-)			

Interpreted formation and well parameters.

Flow regime:	Radial	C (m^3/Pa)	
dt_1 (min)	0.25	C_D (-)	
dt_2 (min)	0.4	ξ (-)	-0.8
T_T (m^2/s)	$6.6 \cdot 10^{-7}$		
S (-)			
K_s (m/s)			
S_s (1/m)			

Comments: A channel flow regime is established during this test.

The test was carried out in KA3539G, section 15.85 - 17.60 metres. The flow period was for 360 minutes with a final flow of 1.32 l/min, while the pressure build-up time was 1080 minutes. In Figure 6-2 and Figure 6-3 the r^2/t_L recordings are shown and in Table 6-2 and Table 6-3 the interference test results are presented. Diagrams of evaluated bore hole sections are presented in Appendix 1.

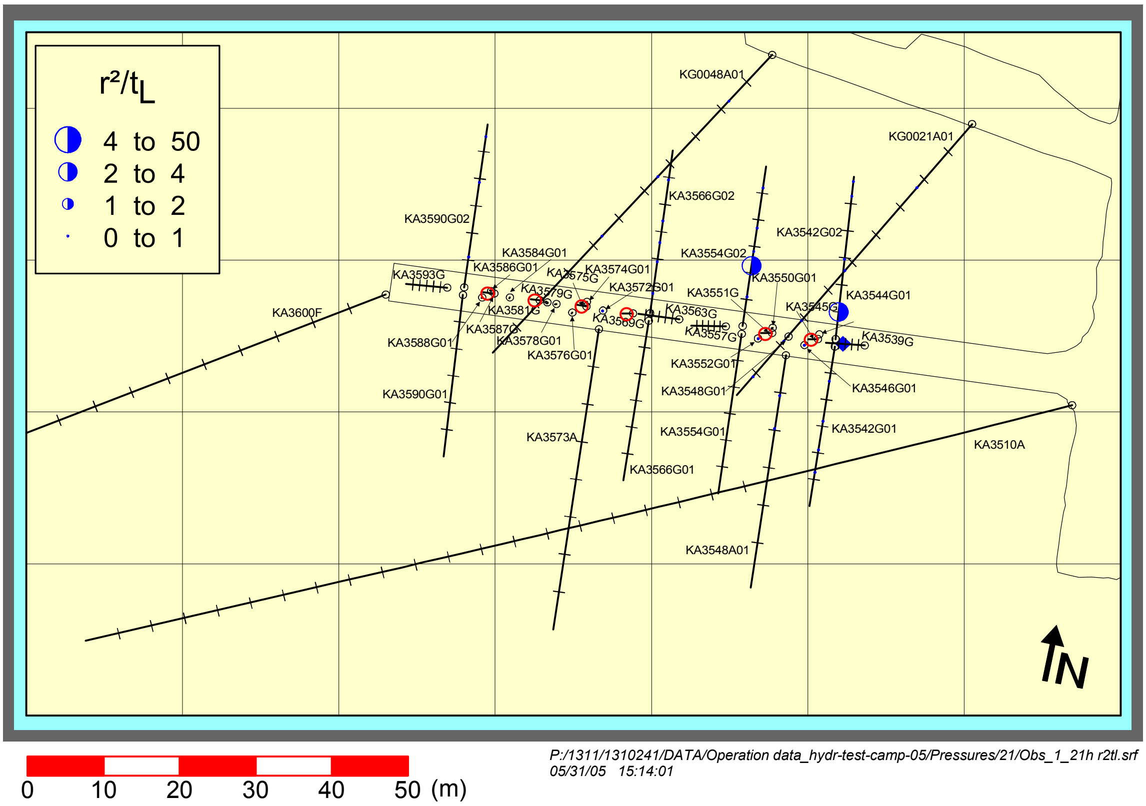


Figure 6-2 *Plot showing r^2/t_L during recovery of KA3539G:2 (Interference test 5:21) - plan view*

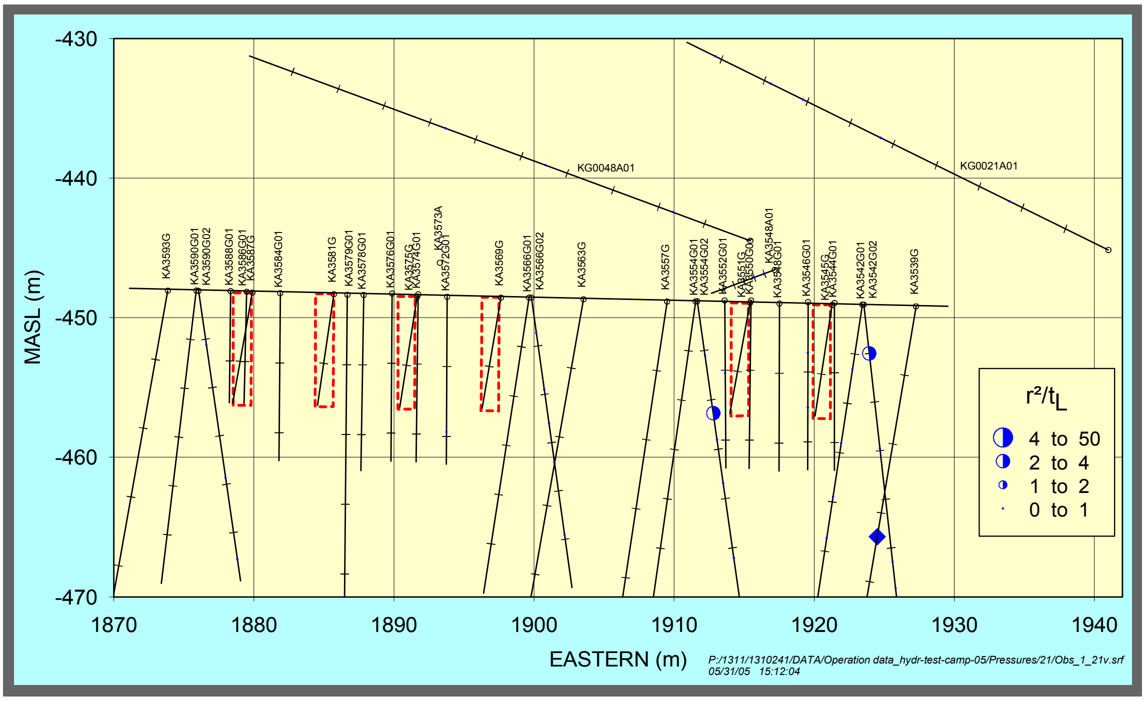


Figure 6-3 *Plot showing r^2/t_L during recovery of KA3539G:2 (Interference test 5:21) - vertical view*

A **good** ($2 < r^2/t_L < 4$) hydraulic connection is established between the flow section and KA3554G02:4 and KA3542G02:5.

The transmissivity of the observation sections with $r^2/t_L > 1$, i.e. the sections mentioned above is within the range $1.0 \cdot 10^{-7} - 3.2 \cdot 10^{-7}$ m^2/s. The transmissivity of the flowing section is evaluated to be $6.6 \cdot 10^{-5}$ m^2/s with the evaluation period 0.25 – 0.4 minutes.

In the figures above the activation of the north side system of hydraulic features can be observed. There also is shown connections with the system on the south side of the repository. It can be imagined that there exists several parallel systems connected with intersecting minor systems.

Due to unknown causes the highest logging frequency of 2 seconds was not initiated for this test. Therefor fewer observation responses were registered than otherwise expected.

Table 6-2 Interference test results for KA3539G, 15.85 - 17.60 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2 / t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3510A:1	125.00	150.00	137.50	107.10	-	-	-	-	-	-	0	0.2	1.4
KA3510A:2	110.00	124.00	117.00	86.87	-	-	-	-	-	-	0	0.6	2.5
KA3510A:3	75.00	109.00	92.00	62.44	-	-	-	-	-	-	0	-2.5	40.6
KA3510A:4	51.00	74.00	62.50	34.61	-	-	-	-	-	-	0	-13.7	17.0
KA3510A:5	4.50	50.00	27.25	15.75	-	-	-	-	-	-	2	12.9	31.7
KA3539G:1	18.60	30.00	24.30	7.56	-	-	-	-	-	-	2	1349.7	1362.5
KA3539G:2	**15.85**	**17.60**	**16.73**	**0.00**	-	-	-	**6.6E-07**	-	-	2	1445.9	1458.9
KA3539G:3	10.00	14.85	12.43	4.30	-	-	-	-	-	-	2	1012.0	1025.5
KA3539G:4	4.00	9.00	6.50	10.23	-	-	-	-	-	-	2	1154.9	1166.4
KA3542G01:1	27.00	30.00	28.50	21.02	-	-	-	-	-	-	1	4.9	23.1
KA3542G01:2	21.30	26.00	23.65	17.30	60	0.083	9.15E-03	-	-	-	2	47.4	76.6
KA3542G01:3	18.60	20.30	19.45	14.62	31	0.115	1.04E-02	1.9E-07	2.2E-05	1.8E-05	2	61.4	87.4
KA3542G01:4	10.50	17.60	14.05	12.47	130	0.020	2.76E-03	4.2E-08	6.4E-07	1.5E-05	2	55.0	84.3
KA3542G01:5	3.50	9.50	6.50	13.11	92	0.031	3.89E-03	5.1E-08	2.1E-05	1.3E-05	2	61.7	43.4
KA3542G02:1	28.20	30.01	29.11	21.72	230	0.034	5.54E-03	-	-	-	2	30.9	19.6
KA3542G02:2	25.60	27.20	26.40	19.54	230	0.028	4.48E-03	-	-	-	2	43.4	27.7
KA3542G02:3	21.50	24.60	23.05	17.08	-	-	-	-	-	-	1	5.2	-1.0
KA3542G02:4	9.00	20.50	14.75	12.81	147	0.019	2.67E-03	-	-	-	2	156.0	134.6
KA3542G02:5	2.00	8.00	5.00	13.79	1.2	2.643	1.15E-01	3.2E-07	1.1E-06	2.8E-06	2	889.6	902.1
KA3543A01:1	0.65	2.06	1.36	19.51	-	-	-	-	-	-	-		
KA3543I01:1	0.65	2.06	1.36	23.05	-	-	-	-	-	-	-		
KA3544G01:1	11.65	12.00	11.83	5.91	-	-	-	-	-	-	-		
KA3544G01:2	8.90	10.65	9.78	7.70	-	-	-	-	-	-	-		
KA3544G01:3	3.50	7.90	5.70	11.52	-	-	-	-	-	-	-		
KA3546G01:1	9.30	12.00	10.65	7.90	-	-	-	-	-	-	1	3.4	12.5
KA3546G01:2	6.75	8.30	7.53	10.51	100	0.018	2.36E-03	2.9E-07	1.8E-04	1.2E-04	2	17.7	13.5
KA3546G01:3	1.50	5.75	3.63	14.07	100	0.033	4.23E-03	-	-	-	2	14.5	10.6
KA3548A01:1	21.50	30.00	25.75	34.10	-	-	-	-	-	-	1	1.6	19.7
KA3548A01:2	11.75	20.50	16.13	27.03	-	-	-	-	-	-	1	3.7	21.7
KA3548A01:3	8.80	10.75	9.78	23.38	35	0.260	2.45E-02	3.4E-07	1.3E-05	1.4E-05	2	50.9	75.6
KA3548A01:4	3.00	7.80	5.40	21.60	60	0.130	1.43E-02	-	-	-	2	44.4	71.2
KA3548D01:1	0.65	2.06	1.36	21.17	-	-	-	-	-	-	-		
KA3548G01:1	6.00	12.00	9.00	10.45	-	-	-	-	-	-	1	8.2	1.8
KA3548G01:2	2.00	5.00	3.50	14.97	-	-	-	-	-	-	0	-6.3	10.0
KA3550G01:1	8.30	12.03	10.17	11.54	-	-	-	-	-	-	-		
KA3550G01:2	5.20	7.30	6.25	14.16	-	-	-	-	-	-	-		
KA3550G01:3	1.80	4.20	3.00	16.73	-	-	-	-	-	-	-		
KA3550G05:1	1.50	3.00	2.25	15.30	-	-	-	-	-	-	-		
KA3551G05:1	1.50	3.10	2.30	18.29	-	-	-	-	-	-	-		
KA3552A01:1	0.65	2.06	1.36	23.17	-	-	-	-	-	-	-		
KA3552G01:1	7.05	12.00	9.53	13.13	-	-	-	-	-	-	0	-0.8	-0.6
KA3552G01:2	4.35	6.05	5.20	15.99	117	0.036	4.89E-03	1.5E-07	5.4E-05	3.1E-05	2	15.5	11.9
KA3552G01:3	1.50	3.35	2.43	18.13	-	-	-	-	-	-	0	0.6	2.3
KA3552H01:1	0.65	2.10	1.38	26.16	-	-	-	-	-	-	-		
KA3553B01:1	0.65	2.02	1.34	22.39	-	-	-	-	-	-	-		
KA3554G01:1	25.15	30.01	27.58	24.05	-	-	-	-	-	-	1	4.7	22.7
KA3554G01:2	22.60	24.15	23.38	21.48	-	-	-	-	-	-	1	4.1	22.3
KA3554G01:3	14.00	21.60	17.80	18.98	-	-	-	-	-	-	2	10.0	28.0
KA3554G01:4	5.00	13.00	9.00	18.09	-	-	-	-	-	-	2	10.4	28.6
KA3554G01:5	1.50	4.00	2.75	19.96	-	-	-	-	-	-	2	39.7	12.7
KA3554G02:1	22.00	30.01	26.01	22.99	70	0.126	1.45E-02	2.3E-08	2.2E-06	1.6E-06	2	244.7	226.5
KA3554G02:2	15.90	21.00	18.45	19.18	30	0.204	1.84E-02	5.5E-08	3.8E-06	3.0E-06	2	233.6	221.5
KA3554G02:3	13.20	14.90	14.05	18.07	19	0.287	2.27E-02	1.4E-07	7.0E-06	6.2E-06	2	236.6	224.7
KA3554G02:4	10.50	12.20	11.35	17.91	2.4	2.227	1.10E-01	1.0E-07	6.9E-07	9.4E-07	2	903.5	913.8
KA3554G02:5	1.50	9.50	5.50	18.91	9	0.662	4.35E-02	1.1E-07	2.2E-06	2.6E-06	2	392.0	387.7
KA3557G:1	15.00	30.04	22.52	19.27	-	-	-	-	-	-	-		
KA3557G:2	1.50	14.00	7.75	18.72	-	-	-	-	-	-	-		
KA3563A01:1	0.65	2.06	1.36	30.16	-	-	-	-	-	-	-		
KA3563D01:1	0.65	2.01	1.33	29.64	-	-	-	-	-	-	-		
KA3563G:1	15.00	30.01	22.51	25.67	-	-	-	-	-	-	1	1.7	-0.5
KA3563G:2	10.00	13.00	11.50	23.91	-	-	-	-	-	-	1	1.2	1.0
KA3563G:3	4.00	8.00	6.00	24.87	-	-	-	-	-	-	2	13.5	33.7
KA3563G:4	1.50	3.00	2.25	26.18	-	-	-	-	-	-	0	-0.5	1.5
KA3563I01:1	0.65	2.15	1.40	32.47	-	-	-	-	-	-	-		
KA3566C01:1	0.65	2.1	1.38	33.52	-	-	-	-	-	-	-		

Table 6-3 Interference test results for KA3539G, 15.85 - 17.60 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3566G01:1	23.50	30.01	26.76	31.95	-	-	-	-	-	-	1	1.5	1.7
KA3566G01:2	20.00	21.50	20.75	29.56	-	-	-	-	-	-	0	-2.7	6.2
KA3566G01:3	12.00	18.00	15.00	28.29	-	-	-	-	-	-	0	-4.7	3.7
KA3566G01:4	7.30	10.00	8.65	28.22	-	-	-	-	-	-	1	3.4	5.4
KA3566G01:5	1.50	6.30	3.90	29.09	-	-	-	-	-	-	0	-2.9	9.3
KA3566G02:1	19.00	30.10	24.55	31.05	16.3	0.986	7.51E-02	4.6E-08	6.6E-07	6.2E-07	2	422.0	411.1
KA3566G02:2	16.00	18.00	17.00	28.67	21.8	0.628	5.17E-02	8.0E-08	1.6E-06	1.6E-06	2	200.6	193.5
KA3566G02:3	12.00	14.00	13.00	28.15	40	0.330	3.23E-02	5.1E-08	2.1E-06	1.6E-06	2	168.1	161.2
KA3566G02:4	8.00	11.00	9.50	28.16	225	0.059	9.46E-03	-	-	-	2	17.0	13.8
KA3566G02:5	1.30	6.00	3.65	29.15	21	0.674	5.50E-02	1.3E-06	1.4E-05	2.4E-05	2	10.3	9.9
KA3568D01:1	0.65	2.30	1.48	33.50	-	-	-	-	-	-	-		
KA3572G01:1	7.30	12.03	9.67	31.95	155	0.110	1.60E-02	-	-	-	1	3.4	2.7
KA3572G01:2	2.70	5.30	4.00	33.71	-	-	-	-	-	-	0	-92.6	95.3
KA3573A:1	26.00	40.07	33.04	50.85	-	-	-	-	-	-	0	-0.5	2.7
KA3573A:2	21.00	24.00	22.50	44.27	-	-	-	-	-	-	0	-0.2	6.4
KA3573A:3	14.50	19.00	16.75	41.35	-	-	-	-	-	-	0	-1.7	5.7
KA3573A:4	10.50	12.50	11.50	39.26	-	-	-	-	-	-	1	2.7	21.4
KA3573A:5	1.30	8.50	4.90	37.51	-	-	-	-	-	-	0	-0.7	-0.2
KA3573C01:1	0.65	2.05	1.35	39.56	-	-	-	-	-	-	1	4.7	14.7
KA3574D01:1	0.65	2.05	1.35	39.23	-	-	-	-	-	-	-		
KA3574G01:1	8.00	12.03	10.02	34.15	-	-	-	-	-	-	-		
KA3574G01:2	5.10	7.00	6.05	35.17	-	-	-	-	-	-	-		
KA3574G01:3	1.80	4.10	2.95	36.26	-	-	-	-	-	-	-		
KA3576G01:1	8.00	12.01	10.01	35.72	-	-	-	-	-	-	-		
KA3576G01:2	4.00	6.00	5.00	37.05	-	-	-	-	-	-	-		
KA3576G01:3	1.30	3.00	2.15	38.08	-	-	-	-	-	-	-		
KA3578C01:1	0.65	2.09	1.37	43.59	-	-	-	-	-	-	-		
KA3578G01:1	6.50	12.58	9.54	37.98	-	-	-	-	-	-	-		
KA3578G01:2	4.30	5.50	4.90	39.13	-	-	-	-	-	-	-		
KA3578H01:1	0.65	1.90	1.28	44.93	-	-	-	-	-	-	0	-2.5	5.2
KA3579D01:1	0.65	2.00	1.33	42.97	-	-	-	-	-	-	-		
KA3579G:1	14.70	22.65	18.68	38.43	-	-	-	-	-	-	-		
KA3579G:2	12.50	13.70	13.10	38.58	-	-	-	-	-	-	-		
KA3579G:3	2.30	11.50	6.90	39.68	-	-	-	-	-	-	-		
KA3584G01:1	7.00	12.00	9.50	43.83	-	-	-	-	-	-	-		
KA3584G01:2	1.30	5.00	3.15	45.39	-	-	-	-	-	-	-		
KA3588C01:1	0.65	2.04	1.35	52.74	-	-	-	-	-	-	-		
KA3588D01:1	0.65	1.90	1.28	50.96	-	-	-	-	-	-	-		
KA3588I01:1	0.65	1.96	1.31	53.08	-	-	-	-	-	-	-		
KA3590G01:1	16.00	30.00	23.00	51.50	-	-	-	-	-	-	0	-4.4	19.0
KA3590G01:2	7.00	15.00	11.00	50.52	-	-	-	-	-	-	0	-4.2	18.0
KA3590G01:3	1.30	6.00	3.65	51.32	-	-	-	-	-	-	0	-2.5	2.0
KA3590G02:1	25.50	30.01	27.76	53.23	55	0.858	9.21E-02	1.7E-07	2.2E-06	1.8E-06	2	45.7	46.5
KA3590G02:2	15.20	23.50	19.35	51.32	120	0.366	4.95E-02	3.1E-08	1.2E-06	6.2E-07	2	41.3	37.6
KA3590G02:3	11.90	13.20	12.55	50.76	-	-	-	-	-	-	1	1.5	0.2
KA3590G02:4	1.30	9.90	5.60	51.11	85	0.512	6.26E-02	1.7E-06	2.4E-05	2.8E-05	1	5.2	4.9
KA3592C01:1	0.65	2.01	1.33	56.72	-	-	-	-	-	-	-		
KA3593G:1	25.20	30.02	27.61	56.84	-	-	-	-	-	-	-		
KA3593G:2	23.50	24.20	23.85	55.68	-	-	-	-	-	-	-		
KA3593G:3	9.00	22.50	15.75	53.99	-	-	-	-	-	-	-		
KA3593G:4	3.00	7.00	5.00	53.58	-	-	-	-	-	-	-		
KA3597D01:1	0.65	2.22	1.44	59.11	-	-	-	-	-	-	-		
KA3597H01:1	0.65	2.06	1.36	61.85	-	-	-	-	-	-	-		
KA3600F:1	43.00	50.10	46.55	104.01	-	-	-	-	-	-	0	0.7	2.2
KA3600F:2	40.50	42.00	41.25	99.03	-	-	-	-	-	-	0	0.5	2.0
KA3600F:3	20.00	39.50	29.75	88.36	-	-	-	-	-	-	0	0.0	2.2
KA3600F:4	1.30	18.00	9.65	70.36	-	-	-	-	-	-	1	1.5	4.4
KG0021A01:1	42.50	48.82	45.66	36.54	31	0.718	6.52E-02	1.0E-07	1.6E-06	1.6E-06	2	100.7	113.7
KG0021A01:2	37.00	41.50	39.25	33.33	32	0.578	5.30E-02	1.0E-07	2.2E-06	1.9E-06	2	83.4	94.5
KG0021A01:3	35.00	36.00	35.50	31.90	32	0.530	4.86E-02	2.1E-07	3.9E-06	4.2E-06	2	59.5	62.7
KG0021A01:4	19.00	34.00	26.50	30.16	26	0.583	5.04E-02	2.9E-07	5.7E-06	5.7E-06	2	49.4	52.4
KG0021A01:5	5.00	18.00	11.50	32.99	40	0.453	4.43E-02	3.0E-07	8.5E-06	6.7E-06	2	27.3	28.8
KG0048A01:1	49.00	54.69	51.85	54.62	-	-	-	-	-	-	-		
KG0048A01:2	34.8	48	41.40	48.46	-	-	-	-	-	-	1	3.9	16.2
KG0048A01:3	32.80	33.80	33.30	44.80	60	0.557	6.14E-02	2.3E-07	4.8E-06	3.8E-06	2	15.7	24.6
KG0048A01:4	13.00	31.80	22.40	41.87	36	0.812	7.69E-02	2.4E-07	3.4E-06	3.2E-06	2	42.9	45.3
KG0048A01:5	5.00	12.00	8.50	42.13	134	0.221	3.08E-02	5.3E-08	3.5E-06	1.7E-06	2	16.7	17.4

6.2.2 Test 5:22 – KA3542G02:5

General test data for the pressure build-up test in the interval 2.00-8.00 m of borehole KA3542G02 are presented in Table 6-4.

Table 6-4 General test data for the pressure build-up test in section 2.00-8.00 m of borehole KA3542G02

General test data			
Borehole section	KA3542G02:5		
Test No	5:22		
Field crew	J. Magnusson, A. Blom (SWECO VIAK)		
Test equipment system	HMS		
General comment	Interference test		
	Nomen-clature	Unit	Value
Test section- secup	Secup	m	2.00
Test section- seclow	Seclow	m	8.00
Test section length	L_w	m	6.00
Test section diameter	$2 \cdot r_w$	mm	76
Test start (start of pressure registration)		yymmdd hh:mm	20050124 13:00:00
Packer expanded		yymmdd hh:mm:ss	-
Start of flow period		yymmdd hh:mm:ss	20050124 15:00:00
Stop of flow period		yymmdd hh:mm:ss	20050124 21:00:00
Test stop (stop of pressure registration)		yymmdd hh:mm	20050125 15:00:00
Total flow time	t_p	min	360
Total recovery time	t_F	min	1080

Pressure data

Pressure data	**Nomen-clature**	**Unit**	**Value**	**Comment**
Absolute pressure in borehole before start of flow period	p_0	kPa	1859	
Absolute pressure in test section before stop of flow	p_p	kPa	117	
Max absolute pressure in test section during recovery period	p_f	kPa	1891	
Maximal pressure change during flow period	dp_p	kPa	1742	

Flow data

Flow data	**Nomen-clature**	**Unit**	**Value**
Flow rate from test section just before stop of flowing	Q_p	m^3/s	$1.52 \cdot 10^{-6}$
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	$1.536 \cdot 10^{-6}$
Total volume discharged during flow period	V_p	m^3	0.03317

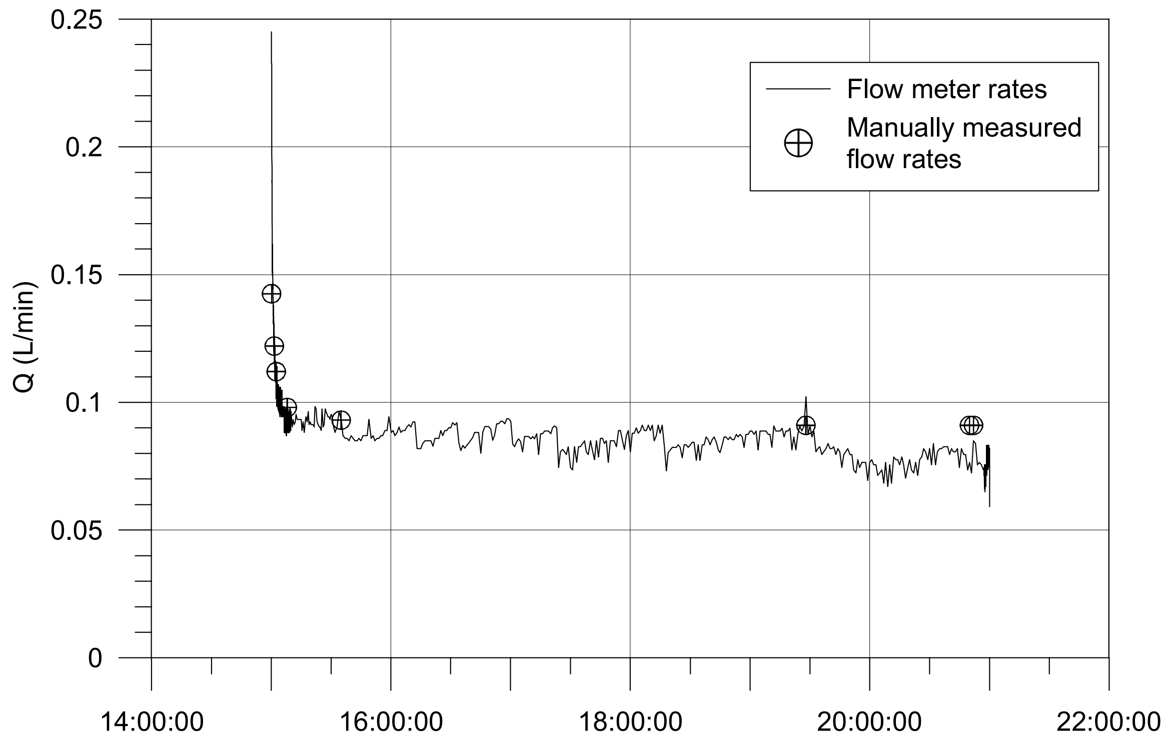


Figure 6-4 *Flow rates during draw down in KA3542G02:5. Time in minutes.*

Comments to the test

The test was successful in regard to pressure response.

Interpreted flow regimes – flowing section

0 – 0.3	minutes	Well Bore Storage (WBS)
0.3 – 0.7	minutes	Transition period
0.7 – 1.3	minutes	Radial flow period
1.3 –		Transition period

Calculated parameters

Quantitative analysis was made for recovery phases in lin-log- and log-log diagrams according to the methods described in Section 5.4.1.

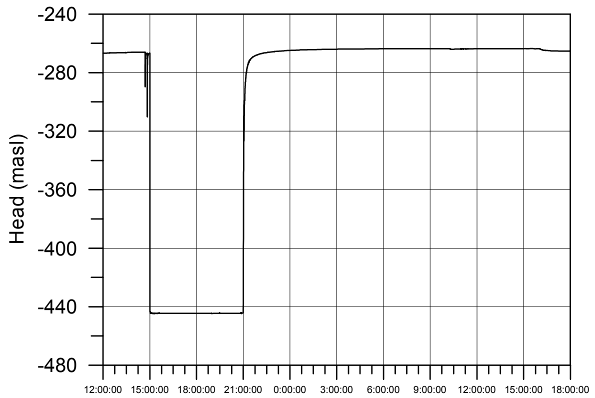
Selected representative parameters

The selected representative parameters from the test in the interval 2.00-8.00 m in KA3542G02 are presented in the Test Summary Sheet below. The selected parameters are derived from the recovery period.

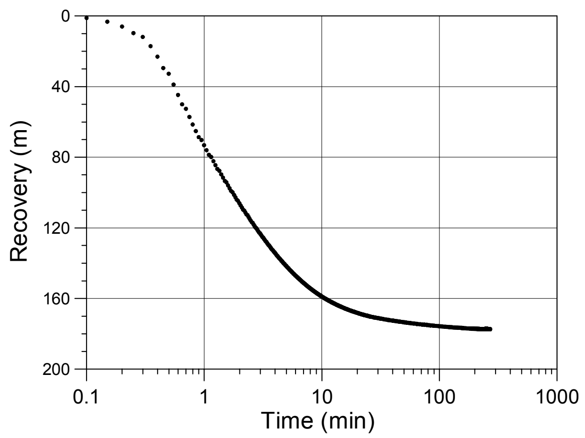
Test Summary Sheet

Project:	PROTOTYPE	Test type:	PBT
Area:	ÄSPÖ	Test no:	5:22
Borehole ID:	KA3542G02	Test start:	2005-01-24 13:00
Test section (m):	2.00-8.00	Responsible for test performance:	SWECO VIAK AB J. Magnusson/A. Blom
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	SWECO VIAK AB T. Forsmark

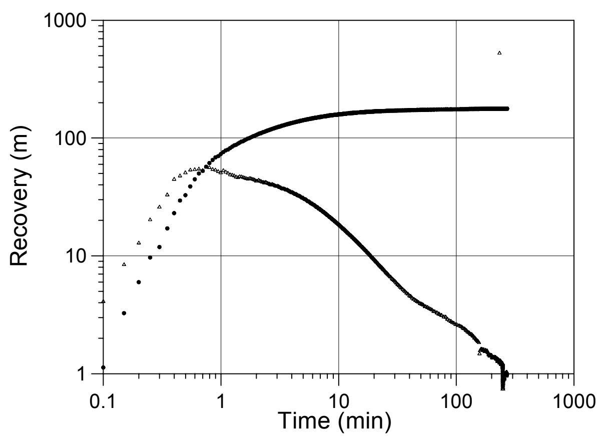
Linear plot Head



Lin-Log plot



Log-Log plot incl. derivative- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)	1859		
p_i (kPa)			
p_p(kPa)	117	p_F (kPa)	1891
Q_p (m^3/s)	$1.52 \cdot 10^{-6}$		
tp (min)	360	t_F (min)	1080
S*		S*	$1 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(gr C)			
Derivative fact.		Derivative fact.	0.2
Results		**Results**	
Q/s (m^2/s)	$8.7 \cdot 10^{-9}$	Flow regime:	Radial
T_{Moye}(m^2/s)	$7.5 \cdot 10^{-9}$	dt_{e1} (min)	0.7
Flow regime:		dt_{e2} (min)	1.3
dt_1 (min)		T (m^2/s)	$2.4 \cdot 10^{-9}$
dt_2 (min)		S (-)	
T (m^2/s)		K_s (m/s)	
S (-)		S_s (1/m)	
K_s (m/s)		C (m^3/Pa)	
S_s (1/m)		C_D (-)	
C (m^3/Pa)		ξ (-)	-2
C_D (-)			
ξ (-)			

Interpreted formation and well parameters.

Flow regime:	Radial	C (m^3/Pa)	
dt_1 (min)	0.7	C_D (-)	
dt_2 (min)	1.3	ξ (-)	-2
T_T (m^2/s)	$2.4 \cdot 10^{-9}$		
S (-)			
K_s (m/s)			
S_s (1/m)			

Comments: Only a short period of radial flow occurs.

The test was carried out in KA3542G02, section 2.00 - 8.00 metres. The flow period was for 360 minutes with a final flow of 0.09 l/min, while the pressure build-up time was 1080 minutes. In Figure 6-5 and Figure 6-6 the r^2/t_L recordings are shown and in Table 6-5 and Table 6-6 the interference test results are presented. Diagrams of evaluated bore hole sections are presented in Appendix 2.

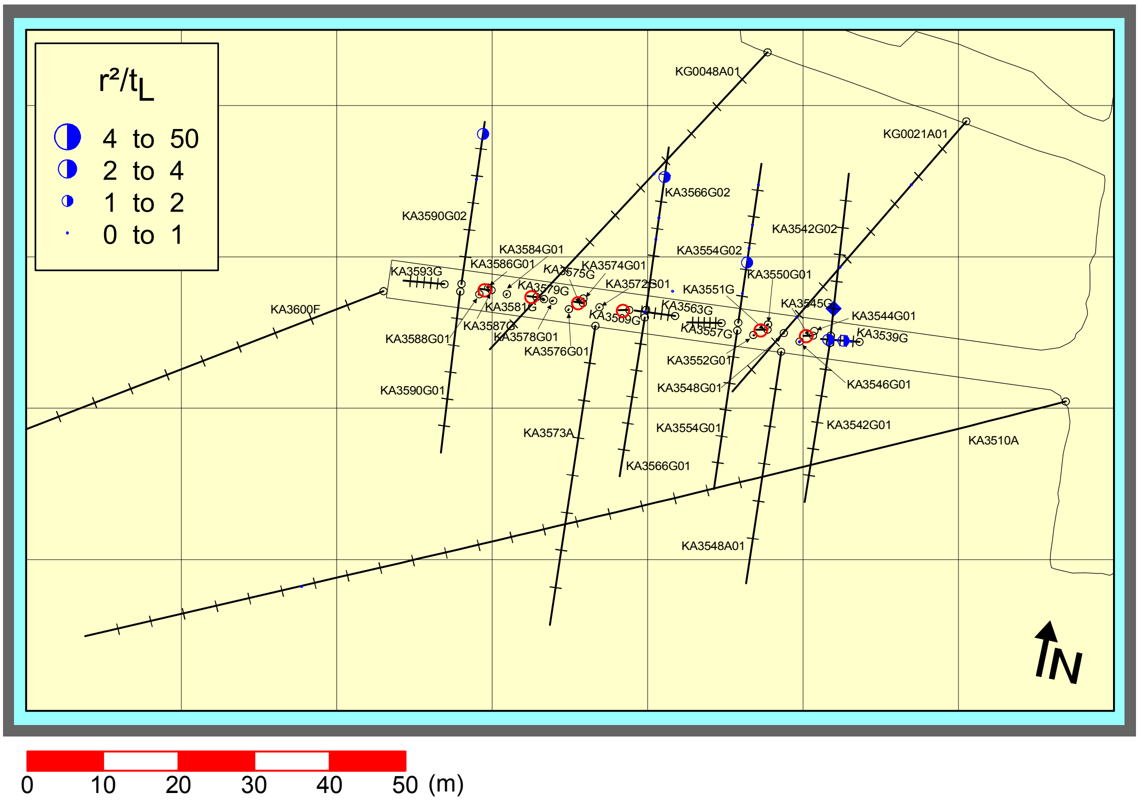


Figure 6-5 *Plot showing r^2/t_L during recovery of KA3542G02:5 (Interference test 5:22) - plan view*

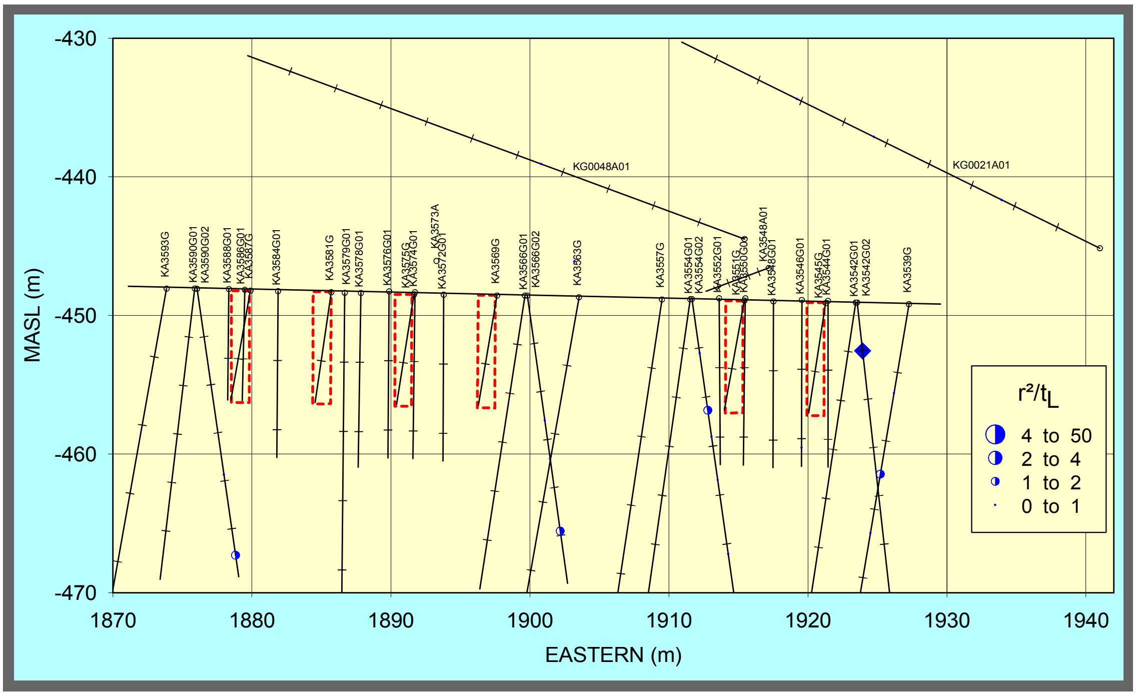


***Figure 6-6** Plot showing r^2/t_L during recovery of KA3542G02:5 (Interference test 5:22) - vertical view*

This test indicates a **rather good** ($1 < r^2/t_L < 2$) hydraulic connection between the flow section and KA3590G02:1, KA3566G02:1, KA3554G02:4, KG3539G:3 and KG3539G:1.

The transmissivity of the observation sections with $r^2/t_L > 1$, i.e. the sections mentioned above is within the range $1.2 \cdot 10^{-8} - 4.8 \cdot 10^{-7}$ m^2/s. The transmissivity of the flowing section is evaluated to be $2.4 \cdot 10^{-9}$ m^2/s with the evaluation period 0.7 – 1.3 minutes.

In this test only a few rather good hydraulic connections are made on the north side of the repository.

Table 6-5 Interference test results for KA3542G02, 2.00 - 8.00 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3510A:1	125.00	150.00	137.50	115.01	-	-	-	-	-	-	0	0.2	0.6
KA3510A:2	110.00	124.00	117.00	94.98	200	0.752	1.17E-01	-	-	-	0	0.2	1.6
KA3510A:3	75.00	109.00	92.00	70.91	-	-	-	-	-	-	0	-1.2	2.9
KA3510A:4	51.00	74.00	62.50	43.80	-	-	-	-	-	-	0	-3.9	3.7
KA3510A:5	4.50	50.00	27.25	21.81	-	-	-	-	-	-	0	-4.1	6.3
KA3539G:1	18.60	30.00	24.30	21.01	5.8	1.268	7.53E-02	3.3E-08	3.4E-07	4.4E-07	2	59.6	64.5
KA3539G:2	15.85	17.60	16.73	13.79	3.9	0.813	4.43E-02	4.6E-08	6.3E-07	1.0E-06	2	60.3	65.0
KA3539G:3	10.00	14.85	12.43	9.94	1	1.646	6.97E-02	1.6E-08	2.4E-07	2.3E-07	2	114.5	146.2
KA3539G:4	4.00	9.00	6.50	5.75	2.5	0.220	1.10E-02	5.5E-08	2.0E-06	5.0E-06	2	65.8	73.9
KA3542G01:1	27.00	30.00	28.50	29.83	-	-	-	-	-	-	0	-2.2	3.7
KA3542G01:2	21.30	26.00	23.65	25.09	-	-	-	-	-	-	0	-13.0	9.6
KA3542G01:3	18.60	20.30	19.45	21.03	-	-	-	-	-	-	0	-10.3	8.8
KA3542G01:4	10.50	17.60	14.05	15.89	-	-	-	-	-	-	0	-13.5	9.3
KA3542G01:5	3.50	9.50	6.50	9.25	-	-	-	-	-	-	0	-0.2	9.3
KA3542G02:1	28.20	30.01	29.11	24.11	-	-	-	-	-	-	0	-0.7	11.0
KA3542G02:2	25.60	27.20	26.40	21.39	-	-	-	-	-	-	0	-1.0	24.1
KA3542G02:3	21.50	24.60	23.05	18.05	0.4	13.568	4.98E-01	-	-	-	1	1.2	9.3
KA3542G02:4	9.00	20.50	14.75	9.75	0.5	3.166	1.20E-01	-	-	-	1	6.4	18.7
KA3542G02:5	**2.00**	**8.00**	**5.00**	**0.00**	-	-	-	**-**	-	-	2	1742.3	1773.7
KA3543A01:1	0.65	2.06	1.36	9.77	-	-	-	-	-	-	0	0.2	0.4
KA3543I01:1	0.65	2.06	1.36	10.83	-	-	-	-	-	-	-		
KA3544G01:1	11.65	12.00	11.83	9.08	-	-	-	-	-	-	-		
KA3544G01:2	8.90	10.65	9.78	7.27	-	-	-	-	-	-	-		
KA3544G01:3	3.50	7.90	5.70	4.38	-	-	-	-	-	-	-		
KA3546G01:1	9.30	12.00	10.65	9.34	15	0.097	7.23E-03	-	-	-	1	2.2	13.5
KA3546G01:2	6.75	8.30	7.53	7.30	-	-	-	-	-	-	0	-1.5	13.8
KA3546G01:3	1.50	5.75	3.63	6.19	-	-	-	-	-	-	1	2.9	6.4
KA3548A01:1	21.50	30.00	25.75	33.18	-	-	-	-	-	-	0	-2.3	3.5
KA3548A01:2	11.75	20.50	16.13	24.02	-	-	-	-	-	-	0	-2.3	3.5
KA3548A01:3	8.80	10.75	9.78	18.24	-	-	-	-	-	-	0	-10.0	7.8
KA3548A01:4	3.00	7.80	5.40	14.52	-	-	-	-	-	-	0	-14.1	10.4
KA3548D01:1	0.65	2.06	1.36	8.60	-	-	-	-	-	-	-		
KA3548G01:1	6.00	12.00	9.00	9.03	-	-	-	-	-	-	0	-1.0	5.3
KA3548G01:2	2.00	5.00	3.50	7.20	-	-	-	-	-	-	0	-3.1	8.4
KA3550G01:1	8.30	12.03	10.17	10.89	-	-	-	-	-	-	-		
KA3550G01:2	5.20	7.30	6.25	9.11	-	-	-	-	-	-	-		
KA3550G01:3	1.80	4.20	3.00	8.76	-	-	-	-	-	-	-		
KA3550G05:1	1.50	3.00	2.25	5.51	-	-	-	-	-	-	-		
KA3551G05:1	1.50	3.10	2.30	10.79	-	-	-	-	-	-	-		
KA3552A01:1	0.65	2.06	1.36	15.07	-	-	-	-	-	-	-		
KA3552G01:1	7.05	12.00	9.53	12.28	-	-	-	-	-	-	0	-0.6	3.7
KA3552G01:2	4.35	6.05	5.20	10.97	-	-	-	-	-	-	0	-3.1	14.1
KA3552G01:3	1.50	3.35	2.43	10.98	-	-	-	-	-	-	0	0.8	1.8
KA3552H01:1	0.65	2.10	1.38	15.87	-	-	-	-	-	-	-		
KA3553B01:1	0.65	2.02	1.34	12.41	-	-	-	-	-	-	0	-0.8	4.9
KA3554G01:1	25.15	30.01	27.58	31.17	-	-	-	-	-	-	0	-2.3	3.5
KA3554G01:2	22.60	24.15	23.38	27.43	-	-	-	-	-	-	0	-2.3	3.5
KA3554G01:3	14.00	21.60	17.80	22.70	-	-	-	-	-	-	0	-8.8	9.6
KA3554G01:4	5.00	13.00	9.00	16.38	-	-	-	-	-	-	0	-9.4	10.8
KA3554G01:5	1.50	4.00	2.75	13.68	-	-	-	-	-	-	0	-14.1	8.0
KA3554G02:1	22.00	30.01	26.01	23.98	75	0.128	1.50E-02	1.6E-08	1.5E-06	1.0E-06	1	9.2	20.5
KA3554G02:2	15.90	21.00	18.45	17.81	17	0.311	2.40E-02	5.5E-08	1.7E-06	2.3E-06	2	21.9	31.3
KA3554G02:3	13.20	14.90	14.05	14.82	14	0.262	1.92E-02	9.3E-08	2.5E-06	4.9E-06	2	22.3	31.5
KA3554G02:4	10.50	12.20	11.35	13.39	2.5	1.194	5.96E-02	1.2E-08	1.3E-07	2.0E-07	2	105.2	134.0
KA3554G02:5	1.50	9.50	5.50	11.89	10	0.236	1.59E-02	5.3E-08	2.9E-06	3.3E-06	2	22.9	35.4
KA3557G:1	15.00	30.04	22.52	25.76	-	-	-	-	-	-	0	0.0	2.7
KA3557G:2	1.50	14.00	7.75	16.18	-	-	-	-	-	-	0	0.2	0.8
KA3563A01:1	0.65	2.06	1.36	24.24	-	-	-	-	-	-	0	0.3	0.5
KA3563D01:1	0.65	2.01	1.33	21.82	18	0.441	3.45E-02	-	-	-	2	12.3	24.9
KA3563G:1	15.00	30.01	22.51	30.42	180	0.086	1.30E-02	-	-	-	0	0.5	3.2
KA3563G:2	10.00	13.00	11.50	23.61	-	-	-	-	-	-	0	1.0	0.2
KA3563G:3	4.00	8.00	6.00	21.55	-	-	-	-	-	-	0	-15.7	8.6
KA3563G:4	1.50	3.00	2.25	20.88	-	-	-	-	-	-	0	-1.5	2.5
KA3563I01:1	0.65	2.15	1.40	24.36	-	-	-	-	-	-	0	-0.2	2.0
KA3566C01:1	0.65	2.1	1.38	27.38	-	-	-	-	-	-	0	-1.0	0.5

Table 6-6 Interference test results for KA3542G02, 2.00 - 8.00 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3566G01:1	23.50	30.01	26.76	36.84	-	-	-	-	-	-	0	-0.2	3.2
KA3566G01:2	20.00	21.50	20.75	32.62	-	-	-	-	-	-	0	-1.5	6.6
KA3566G01:3	12.00	18.00	15.00	29.18	-	-	-	-	-	-	0	-1.5	2.7
KA3566G01:4	7.30	10.00	8.65	26.33	-	-	-	-	-	-	0	-2.0	4.2
KA3566G01:5	1.50	6.30	3.90	25.06	-	-	-	-	-	-	0	-12.0	10.3
KA3566G02:1	19.00	30.10	24.55	30.73	11.5	1.369	9.54E-02	2.3E-08	1.9E-07	2.4E-07	2	41.1	58.8
KA3566G02:2	16.00	18.00	17.00	26.64	25	0.473	4.04E-02	1.0E-07	1.5E-06	2.6E-06	1	9.4	20.4
KA3566G02:3	12.00	14.00	13.00	25.12	61	0.172	1.91E-02	3.0E-08	1.7E-06	1.6E-06	1	4.4	18.7
KA3566G02:4	8.00	11.00	9.50	24.26	-	-	-	-	-	-	0	-7.1	14.3
KA3566G02:5	1.30	6.00	3.65	23.94	-	-	-	-	-	-	0	-3.9	10.6
KA3568D01:1	0.65	2.30	1.48	26.49	-	-	-	-	-	-	0	0.2	0.2
KA3572G01:1	7.30	12.03	9.67	30.70	-	-	-	-	-	-	0	0.0	3.7
KA3572G01:2	2.70	5.30	4.00	30.15	-	-	-	-	-	-	0	-0.5	3.0
KA3573A:1	26.00	40.07	33.04	50.08	-	-	-	-	-	-	0	0.2	3.0
KA3573A:2	21.00	24.00	22.50	42.26	-	-	-	-	-	-	0	-0.3	2.7
KA3573A:3	14.50	19.00	16.75	38.54	-	-	-	-	-	-	0	-1.0	2.7
KA3573A:4	10.50	12.50	11.50	35.61	-	-	-	-	-	-	0	-2.0	3.7
KA3573A:5	1.30	8.50	4.90	32.78	-	-	-	-	-	-	0	-1.0	0.7
KA3573C01:1	0.65	2.05	1.35	33.91	-	-	-	-	-	-	0	-1.0	1.0
KA3574D01:1	0.65	2.05	1.35	32.84	-	-	-	-	-	-	0	-0.2	0.7
KA3574G01:1	8.00	12.03	10.02	32.87	-	-	-	-	-	-	-		
KA3574G01:2	5.10	7.00	6.05	32.36	-	-	-	-	-	-	-		
KA3574G01:3	1.80	4.10	2.95	32.29	-	-	-	-	-	-	-		
KA3576G01:1	8.00	12.01	10.01	34.62	-	-	-	-	-	-	1	1.2	0.0
KA3576G01:2	4.00	6.00	5.00	34.11	-	-	-	-	-	-	0	0.5	0.2
KA3576G01:3	1.30	3.00	2.15	34.14	-	-	-	-	-	-	0	0.5	0.0
KA3578C01:1	0.65	2.09	1.37	38.71	-	-	-	-	-	-	0	-0.5	1.0
KA3578G01:1	6.50	12.58	9.54	36.65	-	-	-	-	-	-	1	2.5	0.0
KA3578G01:2	4.30	5.50	4.90	36.19	-	-	-	-	-	-	0	0.5	0.0
KA3578H01:1	0.65	1.90	1.28	38.84	-	-	-	-	-	-	0	-1.7	2.7
KA3579D01:1	0.65	2.00	1.33	37.29	-	-	-	-	-	-	0	0.2	0.2
KA3579G:1	14.70	22.65	18.68	40.16	-	-	-	-	-	-	0	0.0	2.0
KA3579G:2	12.50	13.70	13.10	38.45	-	-	-	-	-	-	0	0.3	1.0
KA3579G:3	2.30	11.50	6.90	37.44	-	-	-	-	-	-	0	0.2	0.2
KA3584G01:1	7.00	12.00	9.50	42.48	-	-	-	-	-	-	1	2.2	0.2
KA3584G01:2	1.30	5.00	3.15	42.14	-	-	-	-	-	-	0	-0.2	0.7
KA3588C01:1	0.65	2.04	1.35	48.57	-	-	-	-	-	-	0	-0.3	7.4
KA3588D01:1	0.65	1.90	1.28	46.00	-	-	-	-	-	-	0	-0.2	1.2
KA3588I01:1	0.65	1.96	1.31	47.68	-	-	-	-	-	-	0	0.0	0.7
KA3590G01:1	16.00	30.00	23.00	53.17	-	-	-	-	-	-	0	-2.2	4.7
KA3590G01:2	7.00	15.00	11.00	49.37	-	-	-	-	-	-	0	-2.5	4.9
KA3590G01:3	1.30	6.00	3.65	48.38	-	-	-	-	-	-	0	-0.7	2.0
KA3590G02:1	25.50	30.01	27.76	52.77	40	1.160	1.13E-01	4.8E-07	1.2E-06	4.3E-06	1	2.2	7.9
KA3590G02:2	15.20	23.50	19.35	49.82	53	0.781	8.29E-02	2.7E-07	1.9E-06	3.3E-06	0	1.0	8.4
KA3590G02:3	11.90	13.20	12.55	48.39	-	-	-	-	-	-	0	-1.5	4.7
KA3590G02:4	1.30	9.90	5.60	47.87	-	-	-	-	-	-	1	3.4	0.2
KA3592C01:1	0.65	2.01	1.33	52.66	-	-	-	-	-	-	0	0.0	0.7
KA3593G:1	25.20	30.02	27.61	59.53	-	-	-	-	-	-	0	0.2	0.2
KA3593G:2	23.50	24.20	23.85	57.59	-	-	-	-	-	-	0	-1.5	2.2
KA3593G:3	9.00	22.50	15.75	54.08	-	-	-	-	-	-	0	0.3	0.3
KA3593G:4	3.00	7.00	5.00	51.06	-	-	-	-	-	-	0	-1.2	4.2
KA3597D01:1	0.65	2.22	1.44	54.64	-	-	-	-	-	-	0	0.0	1.2
KA3597H01:1	0.65	2.06	1.36	57.22	-	-	-	-	-	-	0	-0.5	0.7
KA3600F:1	43.00	50.10	46.55	102.42	-	-	-	-	-	-	0	0.0	1.7
KA3600F:2	40.50	42.00	41.25	97.28	-	-	-	-	-	-	0	0.0	1.7
KA3600F:3	20.00	39.50	29.75	86.21	-	-	-	-	-	-	0	0.2	2.5
KA3600F:4	1.30	18.00	9.65	67.22	-	-	-	-	-	-	0	-1.7	3.2
KG0021A01:1	42.50	48.82	45.66	25.40	-	-	-	-	-	-	0	-1.2	9.6
KG0021A01:2	37.00	41.50	39.25	20.92	-	-	-	-	-	-	0	-0.2	9.1
KG0021A01:3	35.00	36.00	35.50	18.82	24	0.246	2.08E-02	3.3E-07	5.5E-06	1.6E-05	1	3.2	8.9
KG0021A01:4	19.00	34.00	26.50	16.40	16	0.280	2.12E-02	5.0E-07	5.1E-06	2.4E-05	1	3.9	8.8
KG0021A01:5	5.00	18.00	11.50	22.06	80	0.101	1.22E-02	1.2E-07	7.8E-06	9.6E-06	1	1.5	5.2
KG0048A01:1	49.00	54.69	51.85	47.24	-	-	-	-	-	-	-		
KG0048A01:2	34.8	48	41.40	40.10	-	-	-	-	-	-	0	-1.2	1.2
KG0048A01:3	32.80	33.80	33.30	35.70	-	-	-	-	-	-	0	-0.2	4.4
KG0048A01:4	13.00	31.80	22.40	32.15	33	0.522	4.82E-02	4.6E-07	2.4E-06	9.6E-06	1	2.7	8.1
KG0048A01:5	5.00	12.00	8.50	32.71	-	-	-	-	-	-	0	-0.5	4.7

6.2.3 Test 5:23 – KA3554G01:2

General test data for the pressure build-up test in the interval 22.60-24.15 m of borehole KA3554G01 are presented in Table 6-7.

Table 6-7 General test data for the pressure build-up test in section 22.60-24.15 m of borehole KA3554G01

General test data			
Borehole section	KA3554G01:2		
Test No	5:23 (Also tested as single hole test 5:2c)		
Field crew	J. Magnusson, A. Blom (SWECO VIAK)		
Test equipment system	HMS		
General comment	Interference test		
	Nomen-clature	Unit	Value
Test section- secup	Secup	m	22.60
Test section- seclow	Seclow	m	24.15
Test section length	L_w	m	1.55
Test section diameter	$2 \cdot r_w$	mm	76
Test start (start of pressure registration)		yymmdd hh:mm	20050122 13:00:00
Packer expanded		yymmdd hh:mm:ss	-
Start of flow period		yymmdd hh:mm:ss	20050122 15:00:00
Stop of flow period		yymmdd hh:mm:ss	20050122 21:00:00
Test stop (stop of pressure registration)		yymmdd hh:mm	20050123 15:00:00
Total flow time	t_p	min	360
Total recovery time	t_F	min	1080

Pressure data

Pressure data	**Nomen-clature**	**Unit**	**Value**	**Comment**
Absolute pressure in borehole before start of flow period	p_0	kPa	3567	
Absolute pressure in test section before stop of flow	p_p	kPa	617	
Max absolute pressure in test section during recovery period	p_f	kPa	3570	
Maximal pressure change during flow period	dp_p	kPa	2950	

Flow data

Flow data	**Nomen-clature**	**Unit**	**Value**
Flow rate from test section just before stop of flowing	Q_p	m^3/s	$2.27 \cdot 10^{-5}$
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	$2.30 \cdot 10^{-5}$
Total volume discharged during flow period	V_p	m^3	0.497

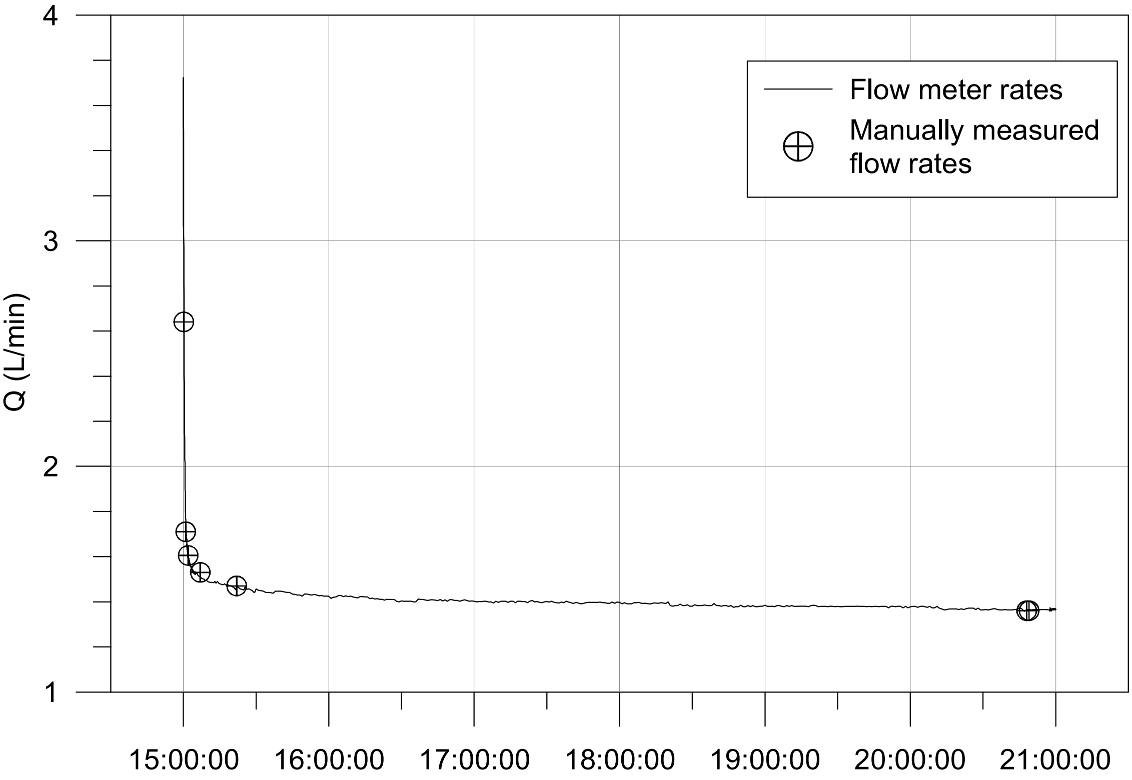


Figure 6-7 *Flow rates during draw down in KA3554G01:2. Time in minutes.*

Comments to the test

The test was successful in regard to pressure response.

Interpreted flow regimes – flowing section

0 – 0.3	minutes	Well Bore Storage (WBS)
0.3 – 9	minutes	Transition period
9 – 13	minutes	Radial flow period
13 –		Transition period

Calculated parameters

Quantitative analysis was made for recovery phases in lin-log- and log-log diagrams according to the methods described in Section 5.4.1.

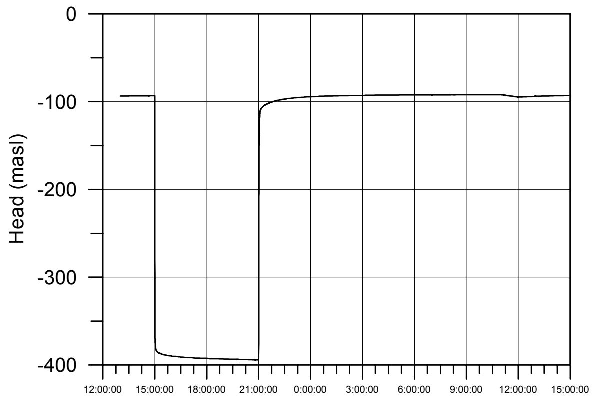
Selected representative parameters

The selected representative parameters from the test in the interval 22.60-24.15 m in KA3554G01 are presented in the Test Summary Sheet below. The selected parameters are derived from the recovery period.

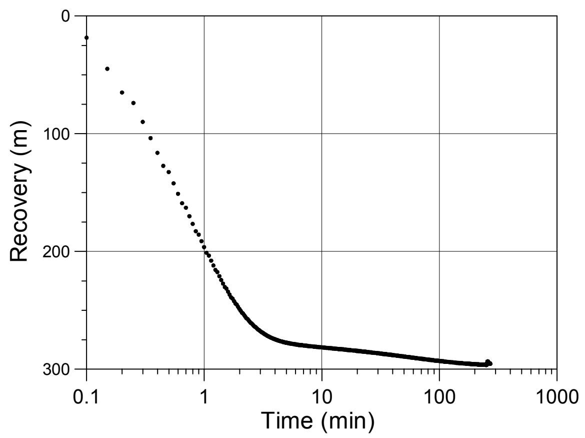
Test Summary Sheet

Project:	PROTOTYPE	Test type:	PBT
Area:	ÄSPÖ	Test no:	5:23 (Also tested as single hole test 5:2c)
Borehole ID:	KA3554G01	Test start:	2005-01-22 13:00
Test section (m):	22.60-24.15	Responsible for test performance:	SWECO VIAK AB J. Magnusson/A. Blom
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	SWECO VIAK AB T. Forsmark

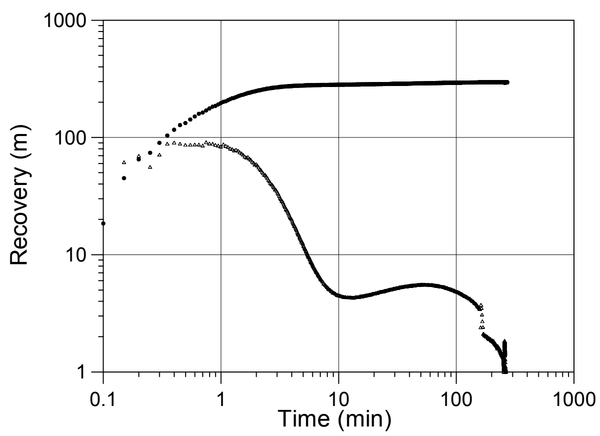
Linear plot Head



Lin-Log plot



Log-Log plot incl. derivative- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)	3567		
p_i (kPa)			
p_p(kPa)	617	p_F (kPa)	3570
Q_p (m^3/s)	$2.26 \cdot 10^{-5}$		
tp (min)	360	t_F (min)	1080
S*		S*	$1 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(gr C)			
Derivative fact.		Derivative fact.	0.2
Results		**Results**	
Q/s (m^2/s)	$7.7 \cdot 10^{-8}$	Flow regime:	Radial
T_{Moye}(m^2/s)	$4.9 \cdot 10^{-8}$	dt_{e1} (min)	9
Flow regime:		dt_{e2} (min)	13
dt_1 (min)		T (m^2/s)	$4.3 \cdot 10^{-7}$
dt_2 (min)		S (-)	
T (m^2/s)		K_s (m/s)	
S (-)		S_s (1/m)	
K_s (m/s)		C (m^3/Pa)	
S_s (1/m)		C_D (-)	
C (m^3/Pa)		ξ (-)	27
C_D (-)			
ξ (-)			

Interpreted formation and well parameters.			
Flow regime:	Radial	C (m^3/Pa)	
dt_1 (min)	9	C_D (-)	
dt_2 (min)	13	ξ (-)	27
T_T (m^2/s)	$4.3 \cdot 10^{-7}$		
S (-)			
K_s (m/s)			
S_s (1/m)			

Comments: The test was successful in regard to pressure response.

The test was carried out in KA3554G01, section 22.60 - 24.15 metres. The flow period was for 360 minutes with a final flow of 1.36 l/min, while the pressure build-up time was 1080 minutes. In Figure 6-8 and Figure 6-9 the r^2/t_L recordings are shown and in Table 6-8 and Table 6-9 the interference test results are presented. Diagrams of evaluated bore hole sections are presented in Appendix 3.

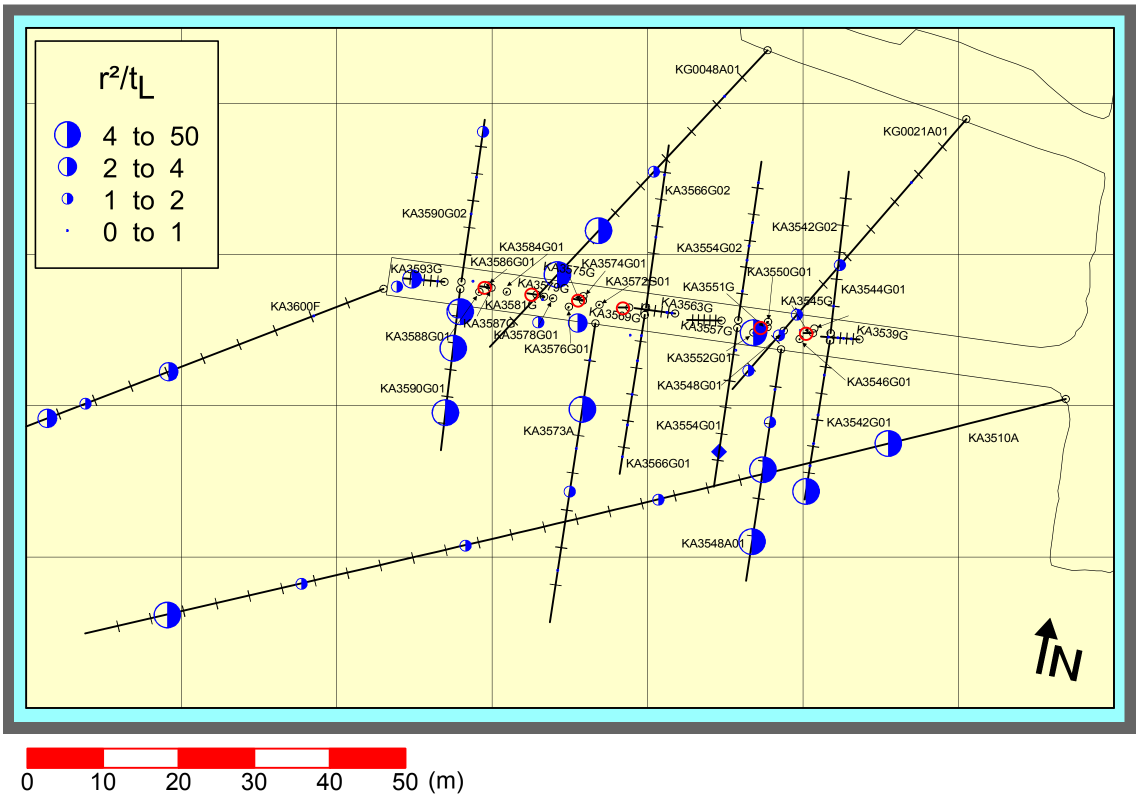


Figure 6-8 *Plot showing r^2/t_L during recovery of KA3554G01:2 (Interference test 5:23) - plan view*

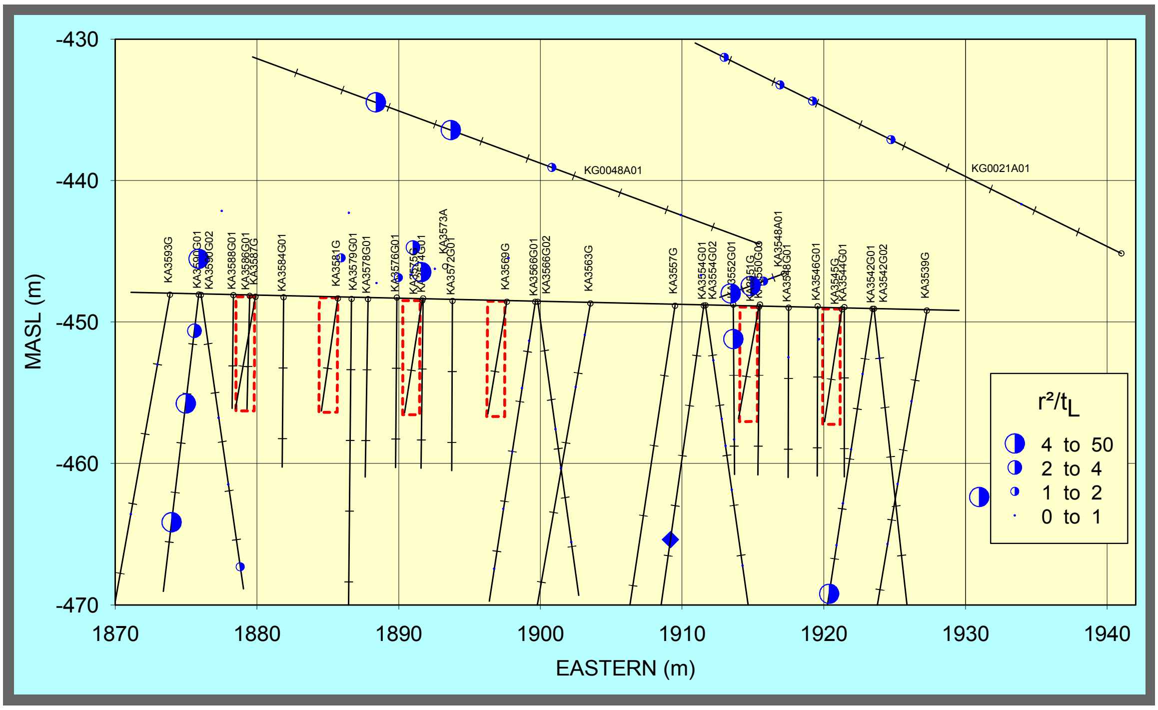


***Figure 6-9** Plot showing r^2/t_L during recovery of KA3554G01:2 (Interference test 5:23) - vertical view*

This test indicates a **rather good** ($1 < r^2/t_L < 2$) hydraulic connection between the flow section and KA3600F:2, KA3597H01:1, KA3590G02:1, KA3578C01:1, KA3573A:2, KA3548A01:3 and KA3510A:2-4.

A **good** ($2 < r^2/t_L < 4$) hydraulic connection is established between the flow section and KA3600F:1&3, KA3593G:2, KA3590G01:3 and KA3573C01:1 .

A **very good** ($4 < r^2/t_L$) hydraulic connection is apparent between the flow section and KA3590G01:1&2, KA3588C01:1, KA3573A:4, KA3548A01:1-2, KA3542G01:1, KG0048A01:2&3 and KA3510:1&5.

The transmissivity of the observation sections with $r^2/t_L > 1$, i.e. the sections mentioned above is within the range $1.8 \cdot 10^{-7} – 5.5 \cdot 10^{-6}$ m^2/s. The transmissivity of the flowing section is evaluated to be $4.3 \cdot 10^{-7}$ m^2/s with the evaluation period 9 – 13 minutes.

In this test a section on the south side is the flow section. Noteworthy hydraulic connections are with the sections on KG0021A01 and KG0048A01, indicating features with also a vertical extension upwards. Also worth to note is the lack of hydraulic connection between the flow section and one of the closest located boreholes, KA3566G01. Apparently the horizontal extension is not a continuous one, but rather a set of interconnecting features wandering up and down in the vertical direction.

Table 6-8 Interference test results for KA3554G01, 22.60 - 24.15 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3510A:1	125.00	150.00	137.50	90.63	5	27.381	1.57E+00	5.5E-06	9.7E-07	3.5E-06	1	9.6	11.2
KA3510A:2	110.00	124.00	117.00	70.28	55	1.497	1.61E-01	1.5E-06	5.9E-06	9.5E-06	1	9.2	9.6
KA3510A:3	75.00	109.00	92.00	45.63	18	1.928	1.51E-01	4.1E-07	2.5E-06	2.7E-06	2	44.8	47.7
KA3510A:4	51.00	74.00	62.50	17.77	4	1.315	7.21E-02	8.2E-07	5.0E-06	1.1E-05	2	161.5	174.4
KA3510A:5	4.50	50.00	27.25	22.02	1.8	4.491	2.11E-01	1.8E-07	4.8E-07	8.6E-07	2	177.1	193.6
KA3539G:1	18.60	30.00	24.30	22.09	55	0.148	1.59E-02	5.2E-07	3.4E-05	3.3E-05	2	19.6	28.2
KA3539G:2	15.85	17.60	16.73	21.48	42	0.183	1.82E-02	6.2E-07	3.4E-05	3.4E-05	2	20.6	28.7
KA3539G:3	10.00	14.85	12.43	22.30	55	0.151	1.62E-02	4.5E-07	3.0E-05	2.8E-05	2	18.4	25.5
KA3539G:4	4.00	9.00	6.50	24.66	50	0.203	2.11E-02	3.8E-07	2.1E-05	1.8E-05	2	18.9	27.0
KA3542G01:1	27.00	30.00	28.50	12.95	0.6	4.658	1.82E-01	7.8E-07	1.9E-06	4.3E-06	2	167.0	179.3
KA3542G01:2	21.30	26.00	23.65	11.87	8	0.294	1.88E-02	1.2E-06	3.0E-05	6.5E-05	2	104.3	124.5
KA3542G01:3	18.60	20.30	19.45	12.48	8.5	0.306	1.98E-02	9.4E-07	2.5E-05	4.8E-05	2	98.9	116.8
KA3542G01:4	10.50	17.60	14.05	15.06	12	0.315	2.22E-02	3.8E-07	1.5E-05	1.7E-05	2	96.3	116.7
KA3542G01:5	3.50	9.50	6.50	20.59	25	0.283	2.42E-02	9.8E-06	7.2E-05	4.0E-04	1	9.3	10.8
KA3542G02:1	28.20	30.01	29.11	40.24	-	-	-	-	-	-	0	-70.7	17.9
KA3542G02:2	25.60	27.20	26.40	38.26	-	-	-	-	-	-	0	-89.1	20.9
KA3542G02:3	21.50	24.60	23.05	35.95	-	-	-	-	-	-	0	-0.5	5.9
KA3542G02:4	9.00	20.50	14.75	31.03	-	-	-	-	-	-	0	-9.1	13.8
KA3542G02:5	2.00	8.00	5.00	27.43	52	0.241	2.55E-02	3.1E-07	1.5E-05	1.2E-05	2	18.4	27.0
KA3543A01:1	0.65	2.06	1.36	24.89	-	-	-	-	-	-	0	0.2	0.2
KA3543I01:1	0.65	2.06	1.36	29.93	-	-	-	-	-	-	0	0.0	0.2
KA3544G01:1	11.65	12.00	11.83	20.91	-	-	-	-	-	-	0	-2.0	6.4
KA3544G01:2	8.90	10.65	9.78	21.46	-	-	-	-	-	-	0	-1.7	6.6
KA3544G01:3	3.50	7.90	5.70	23.05	-	-	-	-	-	-	0	-2.0	6.6
KA3546G01:1	9.30	12.00	10.65	19.03	-	-	-	-	-	-	0	-2.0	7.1
KA3546G01:2	6.75	8.30	7.53	20.22	-	-	-	-	-	-	0	-0.2	7.4
KA3546G01:3	1.50	5.75	3.63	22.23	-	-	-	-	-	-	0	-0.7	3.4
KA3548A01:1	21.50	30.00	25.75	21.50	1.8	4.280	2.01E-01	1.9E-06	2.2E-06	9.3E-06	2	141.9	153.2
KA3548A01:2	11.75	20.50	16.13	18.95	0.72	8.312	3.34E-01	2.6E-06	1.7E-06	7.7E-06	2	158.6	171.3
KA3548A01:3	8.80	10.75	9.78	19.80	4.5	1.452	8.16E-02	1.0E-06	5.4E-06	1.2E-05	2	110.0	127.8
KA3548A01:4	3.00	7.80	5.40	21.50	18	0.428	3.35E-02	3.3E-07	8.8E-06	1.0E-05	2	80.2	97.6
KA3548D01:1	0.65	2.06	1.36	29.08	-	-	-	-	-	-	0	0.2	0.2
KA3548G01:1	6.00	12.00	9.00	19.46	-	-	-	-	-	-	0	-1.6	6.3
KA3548G01:2	2.00	5.00	3.50	22.16	10	0.819	5.52E-02	6.4E-06	2.8E-05	1.2E-04	1	2.0	15.3
KA3550G01:1	8.30	12.03	10.17	19.31	-	-	-	-	-	-	0	-2.0	5.9
KA3550G01:2	5.20	7.30	6.25	20.98	-	-	-	-	-	-	0	-2.0	6.1
KA3550G01:3	1.80	4.20	3.00	22.78	-	-	-	-	-	-	0	-1.8	6.1
KA3550G05:1	1.50	3.00	2.25	23.83	50	0.189	1.97E-02	1.8E-05	8.4E-05	9.1E-04	1	1.2	2.9
KA3551G05:1	1.50	3.10	2.30	22.49	-	-	-	-	-	-	0	-1.8	6.1
KA3552A01:1	0.65	2.06	1.36	23.11	40	0.223	2.17E-02	-	-	-	1	1.2	1.8
KA3552G01:1	7.05	12.00	9.53	17.80	20	0.264	2.12E-02	9.0E-06	8.5E-05	4.2E-04	1	2.9	5.5
KA3552G01:2	4.35	6.05	5.20	19.94	-	-	-	-	-	-	1	1.0	54.6
KA3552G01:3	1.50	3.35	2.43	21.65	0.7	11.156	4.46E-01	-	-	-	2	13.9	27.6
KA3552H01:1	0.65	2.10	1.38	27.77	-	-	-	-	-	-	0	0.4	1.0
KA3553B01:1	0.65	2.02	1.34	27.31	-	-	-	-	-	-	0	-2.2	6.3
KA3554G01:1	25.15	30.01	27.58	4.19	0.07	4.186	1.22E-01	-	-	-	2	175.6	180.5
KA3554G01:2	**22.60**	**24.15**	**23.38**	**0.00**	-	-	-	4.3E-07	-	-	2	2950.4	2962.7
KA3554G01:3	14.00	21.60	17.80	5.59	0.03	17.336	4.61E-01	-	-	-	2	218.2	237.4
KA3554G01:4	5.00	13.00	9.00	14.39	0.03	114.966	3.06E+00	-	-	-	2	209.9	229.1
KA3554G01:5	1.50	4.00	2.75	20.64	0.01	709.931	1.69E+01	-	-	-	2	17.0	148.6
KA3554G02:1	22.00	30.01	26.01	36.00	118	0.183	2.46E-02	-	-	-	1	2.5	16.2
KA3554G02:2	15.90	21.00	18.45	30.81	80	0.198	2.37E-02	-	-	-	1	8.6	16.6
KA3554G02:3	13.20	14.90	14.05	28.28	70	0.190	2.20E-02	-	-	-	1	9.0	16.8
KA3554G02:4	10.50	12.20	11.35	26.97	56	0.217	2.34E-02	-	-	-	2	18.4	24.8
KA3554G02:5	1.50	9.50	5.50	24.92	100	0.103	1.33E-02	-	-	-	2	11.5	25.0
KA3557G:1	15.00	30.04	22.52	18.58	-	-	-	-	-	-	0	0.0	1.6
KA3557G:2	1.50	14.00	7.75	19.51	-	-	-	-	-	-	0	0.6	1.2
KA3563A01:1	0.65	2.06	1.36	25.11	-	-	-	-	-	-	0	0.0	0.3
KA3563D01:1	0.65	2.01	1.33	29.52	-	-	-	-	-	-	0	-1.0	2.5
KA3563G:1	15.00	30.01	22.51	21.80	-	-	-	-	-	-	0	-0.5	1.0
KA3563G:2	10.00	13.00	11.50	20.77	-	-	-	-	-	-	0	1.0	0.5
KA3563G:3	4.00	8.00	6.00	22.37	19	0.439	3.48E-02	1.3E-06	2.0E-05	3.7E-05	2	36.1	51.4
KA3563G:4	1.50	3.00	2.25	24.12	200	0.048	7.57E-03	-	-	-	0	0.2	2.2
KA3563I01:1	0.65	2.15	1.40	29.94	-	-	-	-	-	-	0	-0.5	1.5
KA3566C01:1	0.65	2.1	1.38	27.64	28	0.455	4.01E-02	1.2E-06	2.1E-05	3.1E-05	1	8.6	9.1

Table 6-9 Interference test results for KA3554G01, 22.60 - 24.15 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3566G01:1	23.50	30.01	26.76	12.63	100	0.027	3.41E-03	4.5E-07	1.9E-04	1.3E-04	2	10.8	8.1
KA3566G01:2	20.00	21.50	20.75	12.50	8	0.326	2.08E-02	5.6E-07	1.6E-05	2.7E-05	2	60.5	66.2
KA3566G01:3	12.00	18.00	15.00	14.87	8	0.460	2.94E-02	9.5E-07	1.7E-05	3.2E-05	2	47.5	51.6
KA3566G01:4	7.30	10.00	8.65	19.22	49	0.126	1.30E-02	-	-	-	2	37.4	38.6
KA3566G01:5	1.50	6.30	3.90	23.08	105	0.085	1.10E-02	6.4E-08	1.2E-05	5.9E-06	2	15.5	23.8
KA3566G02:1	19.00	30.10	24.55	37.30	105	0.221	2.87E-02	-	-	-	1	7.9	19.2
KA3566G02:2	16.00	18.00	17.00	32.57	70	0.253	2.91E-02	-	-	-	2	15.3	27.6
KA3566G02:3	12.00	14.00	13.00	30.53	105	0.148	1.92E-02	-	-	-	1	4.9	24.8
KA3566G02:4	8.00	11.00	9.50	29.08	-	-	-	-	-	-	0	-11.3	25.3
KA3566G02:5	1.30	6.00	3.65	27.50	-	-	-	-	-	-	0	-2.5	8.4
KA3568D01:1	0.65	2.30	1.48	31.50	-	-	-	-	-	-	0	0.2	0.2
KA3572G01:1	7.30	12.03	9.67	25.80	-	-	-	-	-	-	0	-3.7	5.2
KA3572G01:2	2.70	5.30	4.00	27.93	-	-	-	-	-	-	0	-15.0	15.8
KA3573A:1	26.00	40.07	33.04	31.70	20	0.838	6.74E-02	1.8E-06	1.5E-05	2.7E-05	2	14.5	14.8
KA3573A:2	21.00	24.00	22.50	27.19	10	1.232	8.30E-02	6.9E-07	5.2E-06	8.4E-06	2	40.3	41.8
KA3573A:3	14.50	19.00	16.75	26.22	14	0.818	5.99E-02	4.5E-07	6.0E-06	7.5E-06	2	47.3	50.0
KA3573A:4	10.50	12.50	11.50	26.42	1.1	10.578	4.55E-01	1.5E-06	9.3E-07	3.3E-06	2	151.2	164.0
KA3573A:5	1.30	8.50	4.90	28.10	15	0.877	6.54E-02	1.9E-06	1.3E-05	3.0E-05	2	14.7	15.5
KA3573C01:1	0.65	2.05	1.35	32.35	4.5	3.875	2.18E-01	3.7E-07	1.2E-06	1.7E-06	2	87.2	96.8
KA3574D01:1	0.65	2.05	1.35	35.16	-	-	-	-	-	-	0	0.0	0.5
KA3574G01:1	8.00	12.03	10.02	27.93	-	-	-	-	-	-	0	0.0	0.2
KA3574G01:2	5.10	7.00	6.05	29.17	-	-	-	-	-	-	0	0.0	0.0
KA3574G01:3	1.80	4.10	2.95	30.46	-	-	-	-	-	-	0	0.2	0.2
KA3576G01:1	8.00	12.01	10.01	28.10	-	-	-	-	-	-	0	0.7	0.2
KA3576G01:2	4.00	6.00	5.00	29.78	-	-	-	-	-	-	0	0.2	0.2
KA3576G01:3	1.30	3.00	2.15	31.05	-	-	-	-	-	-	0	0.0	0.0
KA3578C01:1	0.65	2.09	1.37	35.06	19	1.078	8.55E-02	2.6E-06	1.2E-05	3.0E-05	2	10.8	11.6
KA3578G01:1	6.50	12.58	9.54	30.46	-	-	-	-	-	-	1	2.0	0.2
KA3578G01:2	4.30	5.50	4.90	31.88	-	-	-	-	-	-	0	0.7	0.2
KA3578H01:1	0.65	1.90	1.28	38.12	34	0.712	6.64E-02	2.2E-07	3.4E-06	3.3E-06	2	34.2	39.8
KA3579D01:1	0.65	2.00	1.33	37.77	-	-	-	-	-	-	0	0.0	0.5
KA3579G:1	14.70	22.65	18.68	30.68	-	-	-	-	-	-	0	0.5	0.0
KA3579G:2	12.50	13.70	13.10	30.83	-	-	-	-	-	-	0	0.3	0.0
KA3579G:3	2.30	11.50	6.90	32.15	-	-	-	-	-	-	0	0.2	0.2
KA3584G01:1	7.00	12.00	9.50	35.36	-	-	-	-	-	-	1	2.0	0.2
KA3584G01:2	1.30	5.00	3.15	37.26	-	-	-	-	-	-	0	-0.5	1.5
KA3588C01:1	0.65	2.04	1.35	42.96	5	6.152	3.54E-01	1.0E-06	1.2E-06	2.8E-06	2	37.1	40.8
KA3588D01:1	0.65	1.90	1.28	44.11	-	-	-	-	-	-	0	-0.2	0.7
KA3588I01:1	0.65	1.96	1.31	45.28	100	0.342	4.38E-02	-	-	-	1	1.2	2.0
KA3590G01:1	16.00	30.00	23.00	35.60	3.4	6.212	3.29E-01	3.3E-07	7.6E-07	1.0E-06	2	108.3	120.6
KA3590G01:2	7.00	15.00	11.00	38.07	4	6.039	3.31E-01	3.2E-07	6.1E-07	9.7E-07	2	108.3	120.6
KA3590G01:3	1.30	6.00	3.65	41.27	8.5	3.340	2.16E-01	1.7E-06	3.4E-06	7.9E-06	2	32.2	35.4
KA3590G02:1	25.50	30.01	27.76	52.13	30	1.510	1.36E-01	4.2E-07	2.8E-06	3.1E-06	2	29.2	35.1
KA3590G02:2	15.20	23.50	19.35	48.04	50	0.769	8.03E-02	2.6E-07	3.6E-06	3.2E-06	2	20.6	31.7
KA3590G02:3	11.90	13.20	12.55	45.61	170	0.204	3.05E-02	-	-	-	1	5.4	9.8
KA3590G02:4	1.30	9.90	5.60	44.08	-	-	-	-	-	-	1	3.9	0.0
KA3592C01:1	0.65	2.01	1.33	46.63	-	-	-	-	-	-	0	0.0	1.2
KA3593G:1	25.20	30.02	27.61	47.27	-	-	-	-	-	-	0	0.0	0.2
KA3593G:2	23.50	24.20	23.85	46.04	12.5	2.827	2.01E-01	9.5E-07	2.8E-06	4.7E-06	2	39.8	43.5
KA3593G:3	9.00	22.50	15.75	44.37	200	0.164	2.56E-02	-	-	-	1	1.5	1.2
KA3593G:4	3.00	7.00	5.00	44.40	130	0.253	3.50E-02	-	-	-	1	7.9	11.5
KA3597D01:1	0.65	2.22	1.44	51.18	-	-	-	-	-	-	0	-0.2	0.0
KA3597H01:1	0.65	2.06	1.36	52.32	39	1.170	1.13E-01	1.4E-06	8.4E-06	1.3E-05	1	6.4	8.4
KA3600F:1	43.00	50.10	46.55	88.48	63	2.071	2.31E-01	1.2E-06	4.9E-06	5.3E-06	1	7.1	7.1
KA3600F:2	40.50	42.00	41.25	83.83	63.5	1.844	2.07E-01	1.5E-06	6.0E-06	7.4E-06	1	6.9	6.9
KA3600F:3	20.00	39.50	29.75	74.05	32	2.856	2.62E-01	1.9E-06	4.0E-06	7.1E-06	2	11.6	11.8
KA3600F:4	1.30	18.00	9.65	58.49	105	0.543	7.06E-02	-	-	-	2	23.8	25.1
KG0021A01:1	42.50	48.82	45.66	35.94	17	1.266	9.75E-02	2.7E-07	2.6E-06	2.8E-06	2	61.5	72.9
KG0021A01:2	37.00	41.50	39.25	36.46	13	1.705	1.23E-01	9.1E-07	4.4E-06	7.4E-06	2	55.5	65.3
KG0021A01:3	35.00	36.00	35.50	37.28	19	1.219	9.67E-02	6.0E-07	5.1E-06	6.2E-06	2	34.2	38.9
KG0021A01:4	19.00	34.00	26.50	40.63	20	1.375	1.11E-01	9.4E-07	5.6E-06	8.5E-06	2	29.7	33.7
KG0021A01:5	5.00	18.00	11.50	49.43	61	0.668	7.39E-02	4.3E-07	6.8E-06	5.8E-06	2	10.8	13.8
KG0048A01:1	49.00	54.69	51.85	46.20	-	-	-	-	-	-	-		
KG0048A01:2	34.8	48	41.40	44.01	4.1	7.872	4.34E-01	4.1E-07	6.0E-07	9.4E-07	2	90.8	99.9
KG0048A01:3	32.80	33.80	33.30	43.96	6.3	5.113	3.09E-01	5.1E-07	1.0E-06	1.6E-06	2	66.9	73.8
KG0048A01:4	13.00	31.80	22.40	46.21	23	1.547	1.29E-01	4.5E-07	3.1E-06	3.5E-06	2	31.5	36.2
KG0048A01:5	5.00	12.00	8.50	52.32	120	0.380	5.14E-02	-	-	-	1	7.4	12.0

6.2.4 Test 5:24 – KA3590G02:1

General test data for the pressure build-up test in the interval 25.50-30.01 m of borehole KA3590G02 are presented in Table 6-10.

Table 6-10 General test data for the pressure build-up test in section 25.50-30.01 m of borehole KA3590G02

General test data			
Borehole section	KA3590G02:1		
Test No	5:24		
Field crew	J. Magnusson, A. Blom (SWECO VIAK)		
Test equipment system	HMS		
General comment	Interference test		
	Nomen-clature	Unit	Value
Test section- secup	Secup	m	25.50
Test section- seclow	Seclow	m	30.01
Test section length	L_w	m	4.51
Test section diameter	$2 \cdot r_w$	mm	76
Test start (start of pressure registration)		yymmdd hh:mm	20050121 13:00:00
Packer expanded		yymmdd hh:mm:ss	-
Start of flow period		yymmdd hh:mm:ss	20050121 15:00:00
Stop of flow period		yymmdd hh:mm:ss	20050121 21:00:00
Test stop (stop of pressure registration)		yymmdd hh:mm	20050122 15:00:00
Total flow time	t_p	min	360
Total recovery time	t_F	min	1080

Pressure data

Pressure data	**Nomen-clature**	**Unit**	**Value**	**Comment**
Absolute pressure in borehole before start of flow period	p_0	kPa	3014	
Absolute pressure in test section before stop of flow	p_p	kPa	857	
Max absolute pressure in test section during recovery period	p_f	kPa	3049	
Maximal pressure change during flow period	dp_p	kPa	2157	

Flow data

Flow data	**Nomen-clature**	**Unit**	**Value**
Flow rate from test section just before stop of flowing	Q_p	m^3/s	$1.63 \cdot 10^{-5}$
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	$1.64 \cdot 10^{-5}$
Total volume discharged during flow period	V_p	m^3	0.35508

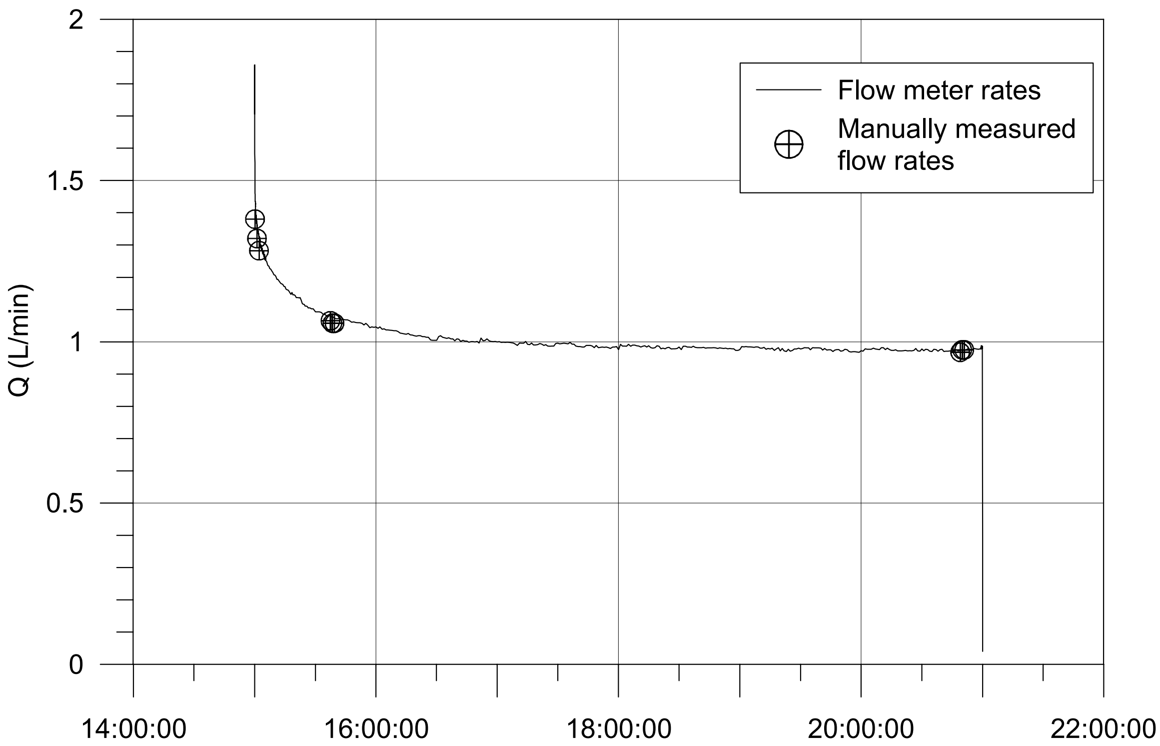


Figure 6-10 *Flow rates during drawdown in KA3590G02:1. Time in minutes.*

Comments to the test

The test was successful in regard to pressure response.

Interpreted flow regimes – flowing section

0 – 0.15	minutes	Well Bore Storage (WBS)
0.15 – 0.4	minutes	Transition period
0.4 – 0.9	minutes	Radial flow period
0.9 – 9	minutes	Linear channel flow period
9 – 300	minutes	Transition period followed possibly by a positive boundary or high conductivity feature

Calculated parameters

Quantitative analysis was made for recovery phases in lin-log- and log-log diagrams according to the methods described in Section 5.4.1.

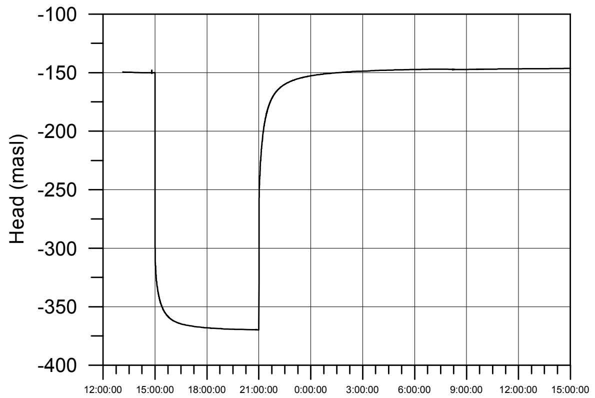
Selected representative parameters

The selected representative parameters from the test in the interval 25.50-30.01 m in KA3590G02 are presented in the Test Summary Sheet below. The selected parameters are derived from the recovery period.

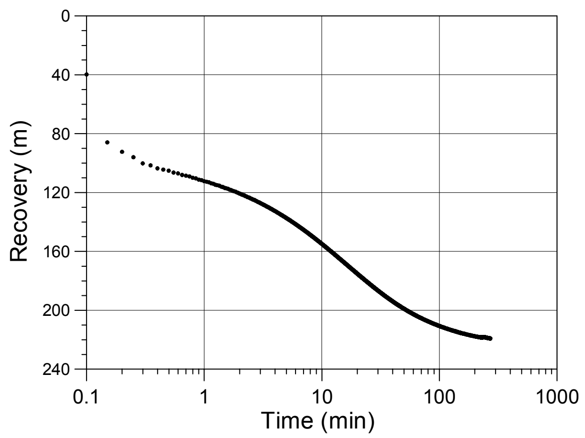
Test Summary Sheet

Project:	PROTOTYPE	Test type:	PBT
Area:	ÄSPÖ	Test no:	5:24
Borehole ID:	KA3590G02	Test start:	2005-01-21 13:00
Test section (m):	25.50-30.01	Responsible for test performance:	SWECO VIAK AB J. Magnusson/A. Blom
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	SWECO VIAK AB T. Forsmark

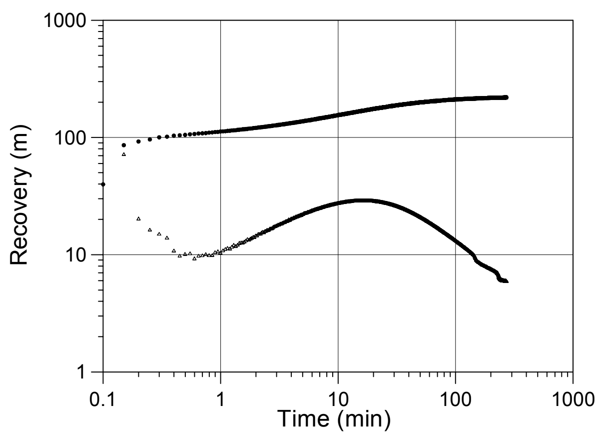
Linear plot Head



Lin-Log plot



Log-Log plot incl. derivative- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)	3014		
p_i (kPa)			
p_p(kPa)	857	p_F (kPa)	3049
Q_p (m^3/s)	$1.63 \cdot 10^{-5}$		
tp (min)	360	t_F (min)	1080
S*		S*	$1 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(gr C)			
Derivative fact.		Derivative fact.	0.2
Results		**Results**	
Q/s (m^2/s)	$6.1 \cdot 10^{-8}$	Flow regime:	Radial
T_{Moye}(m^2/s)	$6.1 \cdot 10^{-8}$	dt_{e1} (min)	0.4
Flow regime:		dt_{e2} (min)	0.9
dt_1 (min)		T (m^2/s)	$1.3 \cdot 10^{-7}$
dt_2 (min)		S (-)	
T (m^2/s)		K_s (m/s)	
S (-)		S_s (1/m)	
K_s (m/s)		C (m^3/Pa)	
S_s (1/m)		C_D (-)	
C (m^3/Pa)		ξ (-)	1.0
C_D (-)			
ξ (-)			

Interpreted formation and well parameters.

Flow regime:	Radial	C (m^3/Pa)	
dt_1 (min)	0.4	C_D (-)	
dt_2 (min)	0.9	ξ (-)	1.0
T_T (m^2/s)	$1.3 \cdot 10^{-7}$		
S (-)			
K_s (m/s)			
S_s (1/m)			

Comments: A linear flow phase occurs during this test.

The test was carried out in KA3590G02, section 25.50 - 30.01 metres. The flow period was for 360 minutes with a final flow of 0.98 l/min, while the pressure build-up time was 1080 minutes. In Figure 6-11 and Figure 6-12 the r^2/t_L recordings are shown and in Table 6-11 and Table 6-12 the interference test results are presented. Diagrams of evaluated bore hole sections are presented in Appendix 4.

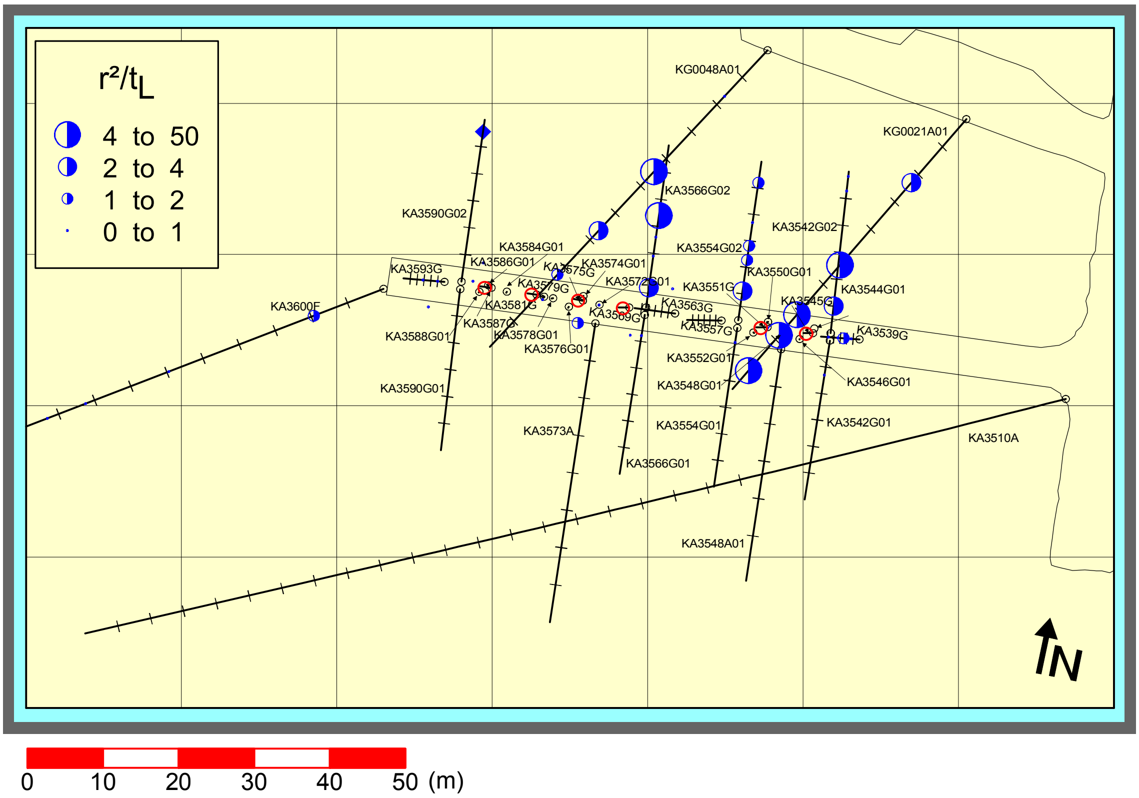


Figure 6-11 *Plot showing r^2/t_L during recovery of KA3590G02:1 (Interference test 5:24) - plan view*

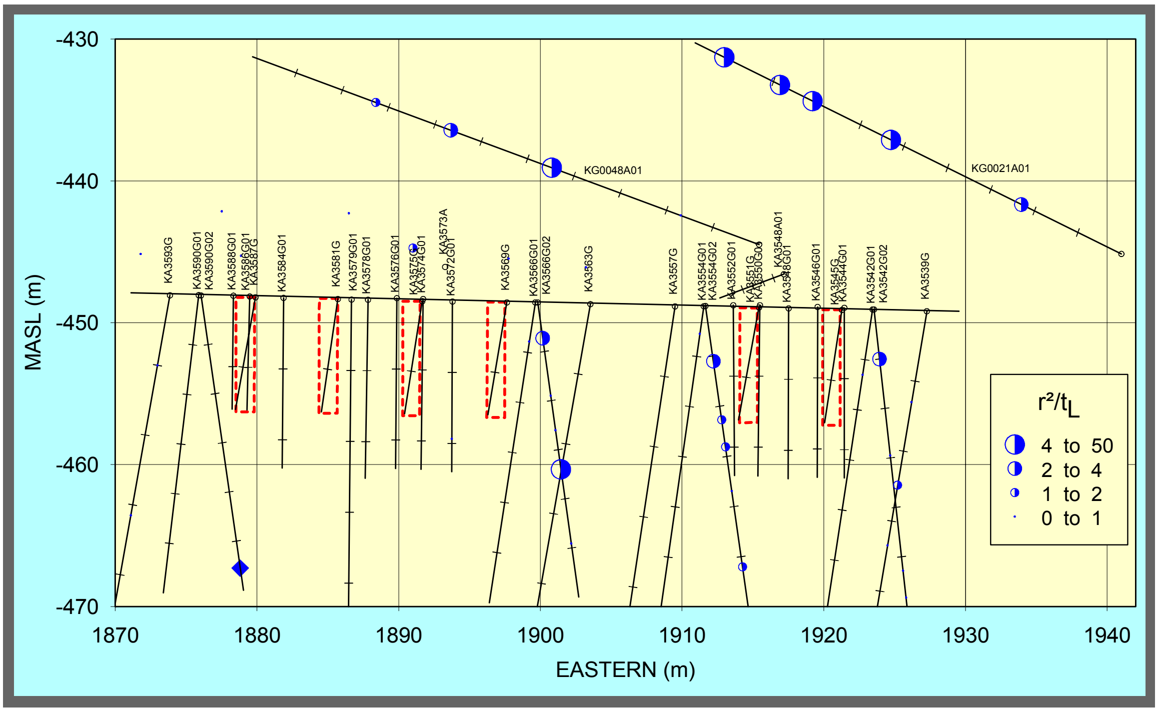


***Figure 6-12** Plot showing r^2/t_L during recovery of KA3590G02:1 (Interference test 5:24) - vertical view*

This test indicates a **rather good** ($1 < r^2/t_L < 2$) hydraulic connection between the flow section and KA3600F:4, KA3573C01:1, KA3554G02:1, 2&4, KA3539G:3 and KG0048A01:2.

A **good** ($2 < r^2/t_L < 4$) hydraulic connection is established between the flow section and KA3566G02:5, KA3554G02:5, KA3542G02:5, KG0021A01:5 and KG0048A01:3.

A **very good** ($4 < r^2/t_L$) hydraulic connection is apparent between the flow section and KA3566G02:2, KG0021A01:1-4 and KG0048A01:4.

The transmissivity of the observation sections with $r^2/t_L > 1$, i.e. the sections mentioned above is within the range $3.1 \cdot 10^{-8} – 6.5 \cdot 10^{-7}$ m^2/s. The transmissivity of the flowing section is evaluated to be $1.3 \cdot 10^{-7}$ m^2/s with the evaluation period 0.4 – 0.9 minutes.

The flow section is as indicated in earlier tests located in connection with the northern system of hydraulic features. It is in very good hydraulic connection with some of the sections of KG0021A01 and KG0048A01. At the same time it is in very good connection with KA3566G02:2, located almost directly below, approximately 30 meters, KG0021A01 and KG0048A01 respectively. This is an indication of the vertical extension of the hydraulic features system.

Table 6-11 Interference test results for KA3590G02, 25.50 - 30.01 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3510A:1	125.00	150.00	137.50	90.83	-	-	-	-	-	-	0	-0.8	2.5
KA3510A:2	110.00	124.00	117.00	75.59	-	-	-	-	-	-	0	-1.2	3.3
KA3510A:3	75.00	109.00	92.00	61.30	-	-	-	-	-	-	0	-8.8	9.0
KA3510A:4	51.00	74.00	62.50	55.15	-	-	-	-	-	-	0	-43.4	20.4
KA3510A:5	4.50	50.00	27.25	66.67	-	-	-	-	-	-	0	-20.4	24.3
KA3539G:1	18.60	30.00	24.30	52.41	65	0.704	7.94E-02	8.1E-08	1.4E-06	1.0E-06	2	22.6	43.4
KA3539G:2	15.85	17.60	16.73	53.23	54	0.874	9.33E-02	9.7E-08	1.5E-06	1.0E-06	2	23.5	44.6
KA3539G:3	10.00	14.85	12.43	54.16	26	1.880	1.63E-01	2.6E-07	1.5E-06	1.6E-06	2	34.6	54.0
KA3539G:4	4.00	9.00	6.50	55.96	54	0.967	1.03E-01	1.3E-07	1.6E-06	1.3E-06	2	23.3	43.2
KA3542G01:1	27.00	30.00	28.50	63.20	-	-	-	-	-	-	0	-17.7	24.6
KA3542G01:2	21.30	26.00	23.65	61.04	-	-	-	-	-	-	0	-32.7	28.7
KA3542G01:3	18.60	20.30	19.45	59.42	-	-	-	-	-	-	0	-26.0	30.2
KA3542G01:4	10.50	17.60	14.05	57.72	-	-	-	-	-	-	0	-31.0	29.2
KA3542G01:5	3.50	9.50	6.50	56.13	100	0.525	6.73E-02	-	-	-	1	9.8	61.7
KA3542G02:1	28.20	30.01	29.11	47.40	150	0.250	3.60E-02	-	-	-	2	24.5	31.7
KA3542G02:2	25.60	27.20	26.40	47.43	150	0.250	3.60E-02	-	-	-	2	31.4	40.0
KA3542G02:3	21.50	24.60	23.05	47.68	-	-	-	-	-	-	1	1.5	0.2
KA3542G02:4	9.00	20.50	14.75	49.27	85	0.476	5.82E-02	1.7E-08	5.3E-07	2.9E-07	2	74.3	97.4
KA3542G02:5	2.00	8.00	5.00	52.77	17	2.730	2.10E-01	2.8E-07	8.7E-07	1.3E-06	2	47.4	68.0
KA3543A01:1	0.65	2.06	1.36	55.41	-	-	-	-	-	-	0	-0.2	0.0
KA3543I01:1	0.65	2.06	1.36	56.51	-	-	-	-	-	-	0	-0.2	0.2
KA3544G01:1	11.65	12.00	11.83	50.37	-	-	-	-	-	-	0	-1.7	9.1
KA3544G01:2	8.90	10.65	9.78	50.68	-	-	-	-	-	-	0	-1.7	9.1
KA3544G01:3	3.50	7.90	5.70	51.53	-	-	-	-	-	-	0	-1.5	9.3
KA3546G01:1	9.30	12.00	10.65	49.73	-	-	-	-	-	-	0	-3.4	11.5
KA3546G01:2	6.75	8.30	7.53	50.31	-	-	-	-	-	-	0	-1.2	9.1
KA3546G01:3	1.50	5.75	3.63	51.29	-	-	-	-	-	-	0	-2.7	7.6
KA3548A01:1	21.50	30.00	25.75	67.16	-	-	-	-	-	-	0	-19.7	22.3
KA3548A01:2	11.75	20.50	16.13	60.74	-	-	-	-	-	-	0	-17.6	24.6
KA3548A01:3	8.80	10.75	9.78	57.00	-	-	-	-	-	-	0	-25.8	29.4
KA3548A01:4	3.00	7.80	5.40	54.70	-	-	-	-	-	-	0	-24.1	45.6
KA3548D01:1	0.65	2.06	1.36	50.76	-	-	-	-	-	-	0	0.0	0.0
KA3548G01:1	6.00	12.00	9.00	47.72	-	-	-	-	-	-	0	-3.7	7.6
KA3548G01:2	2.00	5.00	3.50	49.09	-	-	-	-	-	-	0	-7.2	12.9
KA3550G01:1	8.30	12.03	10.17	45.18	-	-	-	-	-	-	0	-2.3	8.2
KA3550G01:2	5.20	7.30	6.25	46.10	-	-	-	-	-	-	0	-2.5	8.0
KA3550G01:3	1.80	4.20	3.00	47.09	-	-	-	-	-	-	0	-2.5	8.2
KA3550G05:1	1.50	3.00	2.25	51.16	-	-	-	-	-	-	0	-1.6	1.8
KA3551G05:1	1.50	3.10	2.30	45.89	-	-	-	-	-	-	0	-2.5	8.2
KA3552A01:1	0.65	2.06	1.36	48.14	-	-	-	-	-	-	0	-0.4	0.2
KA3552G01:1	7.05	12.00	9.53	44.77	-	-	-	-	-	-	0	-3.5	2.0
KA3552G01:2	4.35	6.05	5.20	45.80	-	-	-	-	-	-	0	-1.4	8.4
KA3552G01:3	1.50	3.35	2.43	46.66	-	-	-	-	-	-	0	-3.7	1.4
KA3552H01:1	0.65	2.10	1.38	48.84	-	-	-	-	-	-	0	-1.2	0.2
KA3553B01:1	0.65	2.02	1.34	45.10	-	-	-	-	-	-	0	-2.9	7.2
KA3554G01:1	25.15	30.01	27.58	54.28	-	-	-	-	-	-	0	-17.2	24.1
KA3554G01:2	22.60	24.15	23.38	52.13	-	-	-	-	-	-	0	-17.6	24.4
KA3554G01:3	14.00	21.60	17.80	49.66	-	-	-	-	-	-	0	-19.0	22.7
KA3554G01:4	5.00	13.00	9.00	46.90	-	-	-	-	-	-	0	-18.0	22.7
KA3554G01:5	1.50	4.00	2.75	45.85	140	0.250	3.54E-02	-	-	-	2	37.5	8.0
KA3554G02:1	22.00	30.01	26.01	36.09	19	1.142	9.06E-02	1.0E-07	1.2E-06	1.1E-06	2	120.3	157.8
KA3554G02:2	15.90	21.00	18.45	37.12	30	0.765	6.89E-02	7.0E-08	1.2E-06	1.0E-06	2	107.8	134.2
KA3554G02:3	13.20	14.90	14.05	38.40	23	1.068	8.93E-02	9.4E-08	1.2E-06	1.1E-06	2	108.4	136.0
KA3554G02:4	10.50	12.20	11.35	39.41	17	1.523	1.17E-01	2.6E-07	1.9E-06	2.3E-06	2	51.6	71.2
KA3554G02:5	1.50	9.50	5.50	42.10	13	2.272	1.63E-01	3.1E-08	2.1E-07	1.9E-07	2	326.3	368.4
KA3557G:1	15.00	30.04	22.52	37.19	-	-	-	-	-	-	0	-0.2	0.2
KA3557G:2	1.50	14.00	7.75	40.15	-	-	-	-	-	-	0	-0.8	0.6
KA3563A01:1	0.65	2.06	1.36	40.23	-	-	-	-	-	-	0	0.2	0.5
KA3563D01:1	0.65	2.01	1.33	38.43	207	0.119	1.87E-02	-	-	-	1	2.5	4.4
KA3563G:1	15.00	30.01	22.51	31.60	-	-	-	-	-	-	0	1.0	0.0
KA3563G:2	10.00	13.00	11.50	33.68	-	-	-	-	-	-	0	-0.7	0.7
KA3563G:3	4.00	8.00	6.00	35.96	-	-	-	-	-	-	0	-19.4	18.2
KA3563G:4	1.50	3.00	2.25	37.90	-	-	-	-	-	-	0	-0.7	1.7
KA3563I01:1	0.65	2.15	1.40	41.11	-	-	-	-	-	-	0	0.0	1.7
KA3566C01:1	0.65	2.1	1.38	39.50	82	0.317	3.83E-02	8.6E-07	2.1E-05	2.3E-05	0	0.7	6.4

Table 6-12 Interference test results for KA3590G02, 25.50 - 30.01 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3566G01:1	23.50	30.01	26.76	46.58	-	-	-	-	-	-	0	-0.3	3.4
KA3566G01:2	20.00	21.50	20.75	43.19	-	-	-	-	-	-	0	-11.8	9.1
KA3566G01:3	12.00	18.00	15.00	40.52	-	-	-	-	-	-	0	-9.8	7.9
KA3566G01:4	7.30	10.00	8.65	38.38	-	-	-	-	-	-	0	-3.9	10.8
KA3566G01:5	1.50	6.30	3.90	37.40	100	0.233	2.99E-02	-	-	-	1	1.2	16.2
KA3566G02:1	19.00	30.10	24.55	24.11	18.5	0.524	4.12E-02	9.7E-08	2.4E-06	2.3E-06	2	126.0	159.0
KA3566G02:2	16.00	18.00	17.00	26.14	2.6	4.382	2.20E-01	1.0E-07	3.1E-07	4.5E-07	2	564.7	618.1
KA3566G02:3	12.00	14.00	13.00	28.01	16	0.817	6.19E-02	2.6E-08	4.8E-07	4.2E-07	2	429.6	466.0
KA3566G02:4	8.00	11.00	9.50	29.98	107	0.140	1.83E-02	-	-	-	2	204.7	218.3
KA3566G02:5	1.30	6.00	3.65	33.83	6.1	3.126	1.88E-01	6.5E-07	1.8E-06	3.5E-06	2	21.2	23.4
KA3568D01:1	0.65	2.30	1.48	35.29	-	-	-	-	-	-	0	0.2	0.0
KA3572G01:1	7.30	12.03	9.67	28.85	230	0.060	9.77E-03	-	-	-	1	2.9	5.7
KA3572G01:2	2.70	5.30	4.00	31.10	-	-	-	-	-	-	0	-74.1	156.4
KA3573A:1	26.00	40.07	33.04	62.13	-	-	-	-	-	-	0	-1.2	4.9
KA3573A:2	21.00	24.00	22.50	52.99	-	-	-	-	-	-	0	-5.4	9.1
KA3573A:3	14.50	19.00	16.75	48.24	-	-	-	-	-	-	0	-9.1	10.8
KA3573A:4	10.50	12.50	11.50	44.11	-	-	-	-	-	-	0	-15.0	25.5
KA3573A:5	1.30	8.50	4.90	39.30	-	-	-	-	-	-	0	0.0	6.1
KA3573C01:1	0.65	2.05	1.35	36.03	16	1.352	1.03E-01	3.6E-07	2.7E-06	3.5E-06	2	18.2	46.4
KA3574D01:1	0.65	2.05	1.35	32.57	-	-	-	-	-	-	0	0.2	0.5
KA3574G01:1	8.00	12.03	10.02	26.81	-	-	-	-	-	-	0	0.2	0.2
KA3574G01:2	5.10	7.00	6.05	28.39	-	-	-	-	-	-	0	0.0	0.0
KA3574G01:3	1.80	4.10	2.95	29.93	-	-	-	-	-	-	0	0.2	0.2
KA3576G01:1	8.00	12.01	10.01	27.26	-	-	-	-	-	-	1	1.5	0.2
KA3576G01:2	4.00	6.00	5.00	29.27	-	-	-	-	-	-	0	0.0	0.0
KA3576G01:3	1.30	3.00	2.15	30.72	-	-	-	-	-	-	0	0.0	0.2
KA3578C01:1	0.65	2.09	1.37	34.12	-	-	-	-	-	-	0	-0.2	4.7
KA3578G01:1	6.50	12.58	9.54	25.58	-	-	-	-	-	-	1	2.7	0.2
KA3578G01:2	4.30	5.50	4.90	27.62	-	-	-	-	-	-	0	0.0	0.0
KA3578H01:1	0.65	1.90	1.28	34.33	50	0.393	4.10E-02	1.2E-07	3.7E-06	3.0E-06	2	13.5	33.0
KA3579D01:1	0.65	2.00	1.33	30.00	-	-	-	-	-	-	0	0.0	0.2
KA3579G:1	14.70	22.65	18.68	23.05	-	-	-	-	-	-	1	1.7	0.0
KA3579G:2	12.50	13.70	13.10	23.82	-	-	-	-	-	-	1	2.2	0.5
KA3579G:3	2.30	11.50	6.90	26.08	-	-	-	-	-	-	0	0.5	0.2
KA3584G01:1	7.00	12.00	9.50	23.52	-	-	-	-	-	-	1	2.9	0.2
KA3584G01:2	1.30	5.00	3.15	26.68	-	-	-	-	-	-	0	-0.7	1.5
KA3588C01:1	0.65	2.04	1.35	32.39	-	-	-	-	-	-	0	-5.7	17.7
KA3588D01:1	0.65	1.90	1.28	28.05	200	0.066	1.02E-02	-	-	-	0	0.5	2.2
KA3588I01:1	0.65	1.96	1.31	32.03	200	0.086	1.33E-02	-	-	-	0	0.5	1.7
KA3590G01:1	16.00	30.00	23.00	37.61	-	-	-	-	-	-	0	-16.3	20.2
KA3590G01:2	7.00	15.00	11.00	31.12	-	-	-	-	-	-	0	-16.2	19.9
KA3590G01:3	1.30	6.00	3.65	28.94	-	-	-	-	-	-	0	-6.4	5.4
KA3590G02:1	**25.50**	**30.01**	**27.76**	**0.00**	-	-	-	-	-	-	2	2156.4	2191.8
KA3590G02:2	15.20	23.50	19.35	8.41	0.01	117.830	2.81E+00	-	-	-	2	984.0	1045.2
KA3590G02:3	11.90	13.20	12.55	15.21	0.03	128.527	3.42E+00	-	-	-	2	17.5	23.9
KA3590G02:4	1.30	9.90	5.60	22.16	0.02	409.254	1.04E+01	-	-	-	2	643.8	693.2
KA3592C01:1	0.65	2.01	1.33	32.82	50	0.359	3.75E-02	-	-	-	0	0.2	1.5
KA3593G:1	25.20	30.02	27.61	23.17	-	-	-	-	-	-	0	-0.5	0.0
KA3593G:2	23.50	24.20	23.85	21.94	-	-	-	-	-	-	0	-8.4	6.9
KA3593G:3	9.00	22.50	15.75	21.41	40	0.191	1.87E-02	1.3E-05	9.5E-05	6.9E-04	1	1.7	2.5
KA3593G:4	3.00	7.00	5.00	25.10	20	0.525	4.22E-02	-	-	-	1	6.9	9.1
KA3597D01:1	0.65	2.22	1.44	28.76	-	-	-	-	-	-	0	0.2	0.2
KA3597H01:1	0.65	2.06	1.36	34.35	-	-	-	-	-	-	0	-1.7	3.2
KA3600F:1	43.00	50.10	46.55	70.68	140	0.595	8.41E-02	3.8E-07	6.2E-06	4.5E-06	0	0.5	3.4
KA3600F:2	40.50	42.00	41.25	65.80	130	0.555	7.68E-02	4.0E-07	7.2E-06	5.3E-06	0	0.7	3.9
KA3600F:3	20.00	39.50	29.75	55.48	100	0.513	6.58E-02	-	-	-	0	0.5	5.2
KA3600F:4	1.30	18.00	9.65	39.07	20	1.272	1.02E-01	-	-	-	1	1.2	9.3
KG0021A01:1	42.50	48.82	45.66	58.85	14	4.122	3.02E-01	2.3E-07	6.5E-07	7.7E-07	2	40.9	82.2
KG0021A01:2	37.00	41.50	39.25	57.76	8.2	6.782	4.36E-01	4.6E-07	6.0E-07	1.1E-06	2	66.3	107.2
KG0021A01:3	35.00	36.00	35.50	57.46	3.4	16.182	8.58E-01	3.0E-07	2.1E-07	3.5E-07	2	196.8	226.8
KG0021A01:4	19.00	34.00	26.50	57.72	1.9	29.225	1.38E+00	5.0E-07	1.7E-07	3.6E-07	2	215.3	240.9
KG0021A01:5	5.00	18.00	11.50	61.16	16	3.896	2.95E-01	2.4E-07	7.1E-07	8.1E-07	2	69.9	79.2
KG0048A01:1	49.00	54.69	51.85	44.20	-	-	-	-	-	-	-		
KG0048A01:2	34.8	48	41.40	39.07	14	1.817	1.33E-01	3.7E-07	2.1E-06	2.8E-06	2	19.1	48.8
KG0048A01:3	32.80	33.80	33.30	36.68	7.5	2.990	1.88E-01	2.2E-07	8.4E-07	1.2E-06	2	99.1	125.7
KG0048A01:4	13.00	31.80	22.40	36.17	0.8	27.258	1.11E+00	3.4E-07	1.4E-07	3.1E-07	2	337.1	368.4
KG0048A01:5	5.00	12.00	8.50	40.08	61	0.439	4.86E-02	4.8E-08	1.6E-06	9.9E-07	2	59.6	65.3

6.2.5 Test 5:25 – KG0021A01:3

General test data for the pressure build-up test in the interval 35.00-36.00 m of borehole KG0021A01 are presented in Table 6-13.

Table 6-13 General test data for the pressure build-up test in section 35.00-36.00 m of borehole KG0021A01

General test data			
Borehole section	KG0021A01:3		
Test No	5:25		
Field crew	J. Magnusson, A. Blom (SWECO VIAK)		
Test equipment system	HMS		
General comment	Interference test		
	Nomen-clature	Unit	Value
Test section- secup	Secup	m	35.00
Test section- seclow	Seclow	m	36.00
Test section length	L_w	m	1.00
Test section diameter	$2 \cdot r_w$	mm	76
Test start (start of pressure registration)		yymmdd hh:mm	20050119 14:00:00
Packer expanded		yymmdd hh:mm:ss	-
Start of flow period		yymmdd hh:mm:ss	20050119 16:00:00
Stop of flow period		yymmdd hh:mm:ss	20050119 22:00:00
Test stop (stop of pressure registration)		yymmdd hh:mm	20050119 16:00:00
Total flow time	t_p	min	360
Total recovery time	t_F	min	1080

Pressure data

Pressure data	**Nomen-clature**	**Unit**	**Value**	**Comment**
Absolute pressure in borehole before start of flow period	p_0	kPa	2895	
Absolute pressure in test section before stop of flow	p_p	kPa	216	
Max absolute pressure in test section during recovery period	p_f	kPa	2925	
Maximal pressure change during flow period	dp_p	kPa	2679	

Flow data

Flow data	**Nomen-clature**	**Unit**	**Value**
Flow rate from test section just before stop of flowing	Q_p	m^3/s	$1.38 \cdot 10^{-5}$
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	$1.42 \cdot 10^{-5}$
Total volume discharged during flow period	V_p	m^3	0.3083

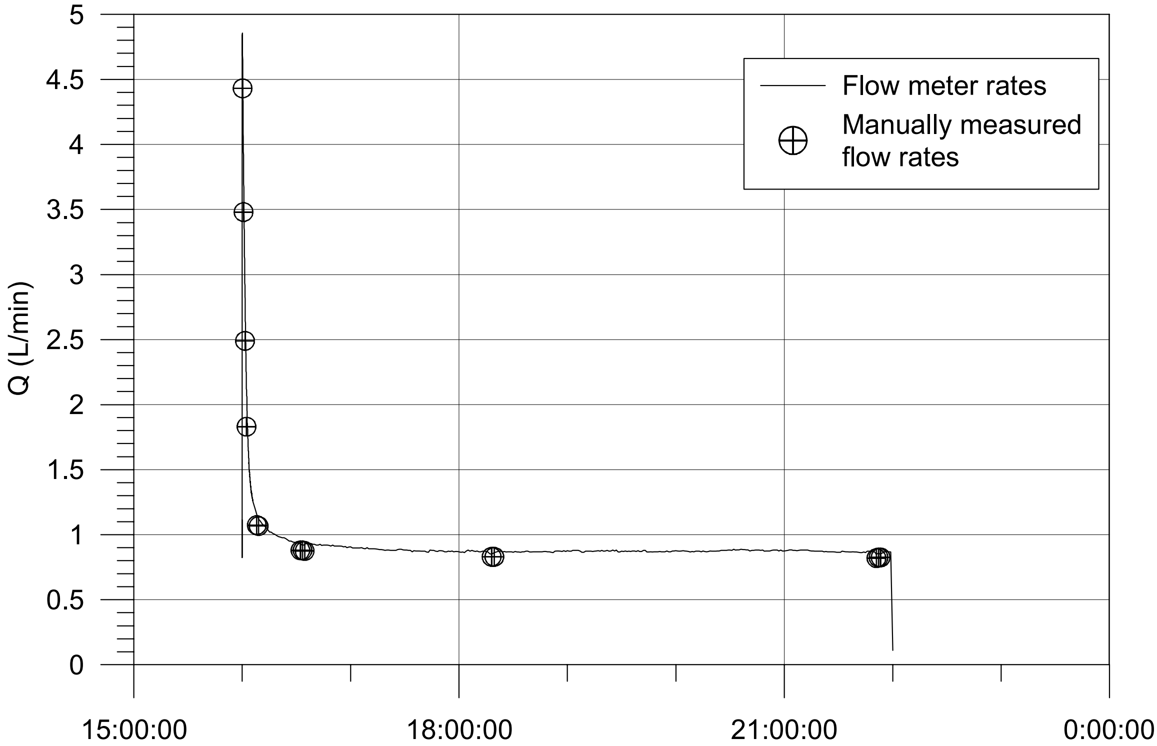


Figure 6-13 *Flow rates during draw down in KG0021A01:3. Time in minutes.*

Comments to the test

The test was successful in regard to pressure responses.

Interpreted flow regimes – flowing section

0 – 0.3	minutes	Well Bore Storage (WBS)
0.3 – 1	minutes	Radial flow period
1 –	minutes	Transition period

Calculated parameters

Quantitative analysis was made for recovery phases in lin-log- and log-log diagrams according to the methods described in Section 5.4.1.

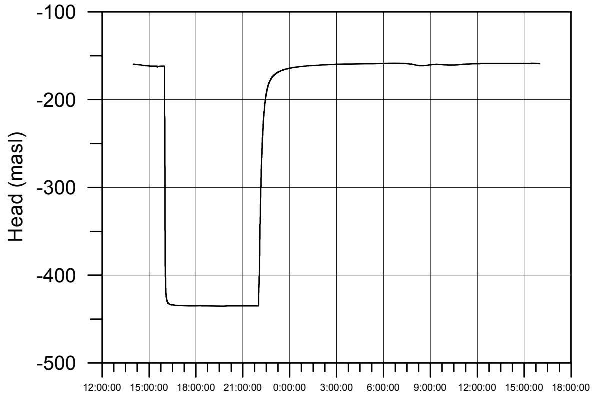
Selected representative parameters

The selected representative parameters from the test in the interval 35.00-36.00 m in KG0021A01 are presented in the Test Summary Sheet below. The selected parameters are derived from the recovery period.

Test Summary Sheet

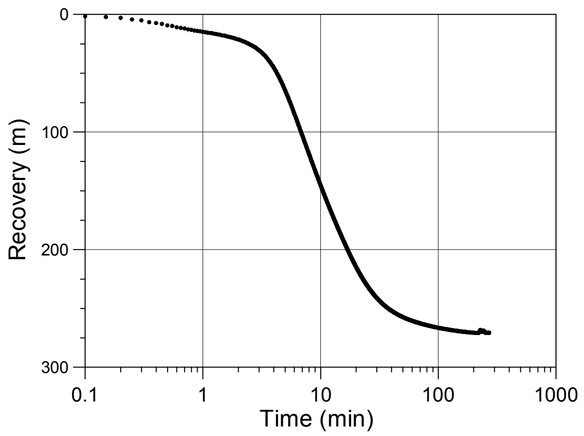
Project:	PROTOTYPE	Test type:	PBT
Area:	ÄSPÖ	Test no:	5:25
Borehole ID:	KG0021A01	Test start:	2005-01-19 13:00
Test section (m):	35.00-36.00	Responsible for test performance:	SWECO VIAK AB J. Magnusson/A. Blom
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	SWECO VIAK AB T. Forsmark

Linear plot Head

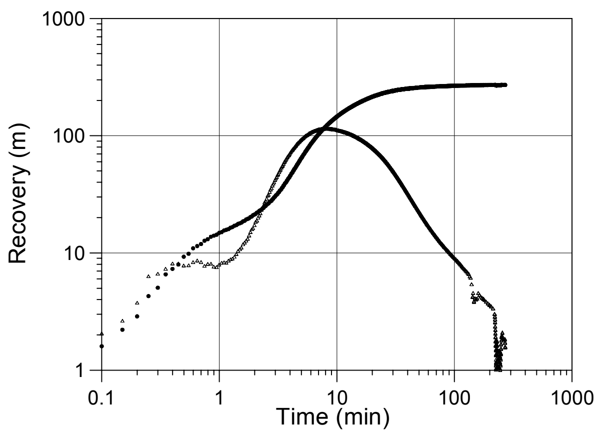


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)	2896		
p_i (kPa)			
p_p(kPa)	216	p_F (kPa)	2925
Q_p (m^3/s)	$1.38 \cdot 10^{-5}$		
tp (min)	360	t_F (min)	1080
S*		S*	$1 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(gr C)			
Derivative fact.		Derivative fact.	0.2
Results		**Results**	
Q/s (m^2/s)	$5.1 \cdot 10^{-8}$	Flow regime:	Radial
T_{Moye}(m^2/s)	$2.9 \cdot 10^{-8}$	dt_{e1} (min)	0.3
Flow regime:		dt_{e2} (min)	1
dt_1 (min)		T (m^2/s)	$1.5 \cdot 10^{-7}$
dt_2 (min)		S (-)	
T (m^2/s)		K_s (m/s)	
S (-)		S_s (1/m)	
K_s (m/s)		C (m^3/Pa)	
S_s (1/m)		C_D (-)	
C (m^3/Pa)		ξ (-)	-3.8
C_D (-)			
ξ (-)			

Lin-Log plot



Log-Log plot incl. derivative- recovery period



Interpreted formation and well parameters.

Flow regime:	Radial	C (m^3/Pa)	
dt_1 (min)	0.3	C_D (-)	
dt_2 (min)	1	ξ (-)	-3.8
T_T (m^2/s)	$1.5 \cdot 10^{-7}$		
S (-)			
K_s (m/s)			
S_s (1/m)			

Comments: The result may be uncertain. The change of shape of the derivative curve at 0.3 – 1 min could also be a result of a possible storativity change.

The test was carried out in KG0021A01, section 35.00 - 36.00 metres. The flow period was for 360 minutes with a final flow of 0.82 l/min, while the pressure build-up time was 1080 minutes. In Figure 6-14 and Figure 6-15 the r^2/t_L recordings are shown and in Table 6-14 and Table 6-15 the interference test results are presented. Diagrams of evaluated bore hole sections are presented in Appendix 5.

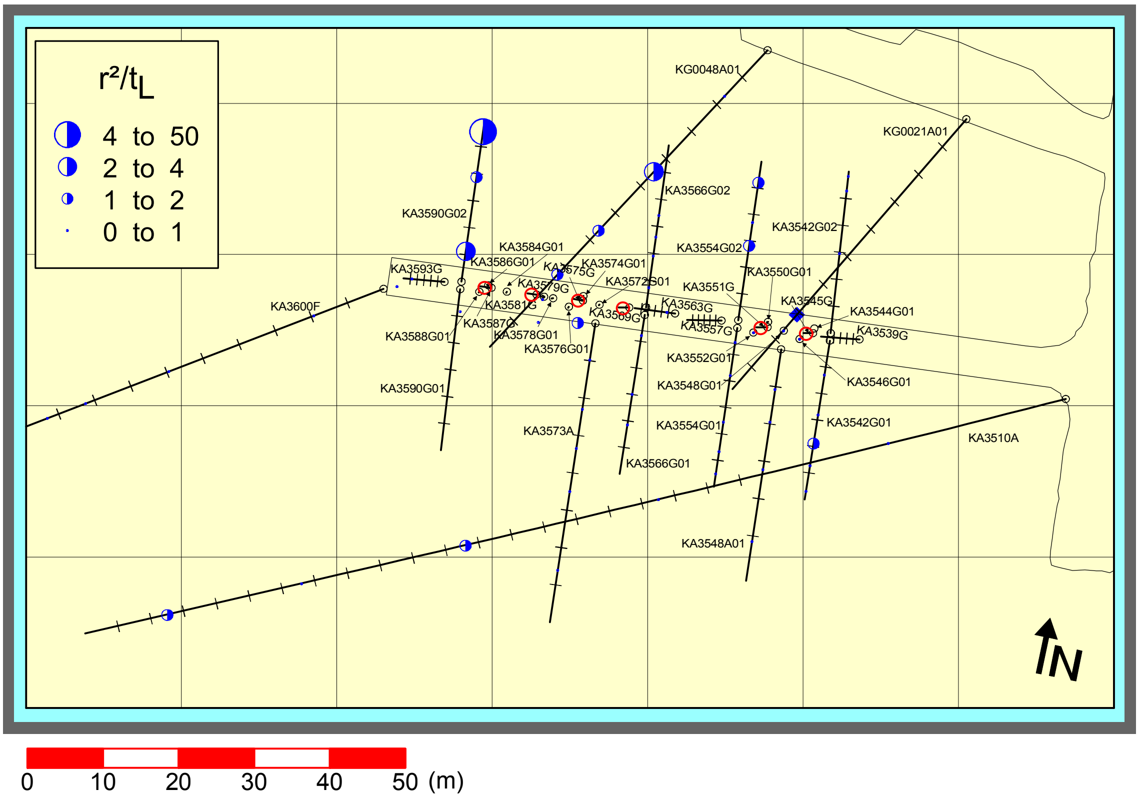


***Figure 6-14** Plot showing r^2/t_L during recovery of KG0021A01:3 (Interference test 5:25) - plan view*

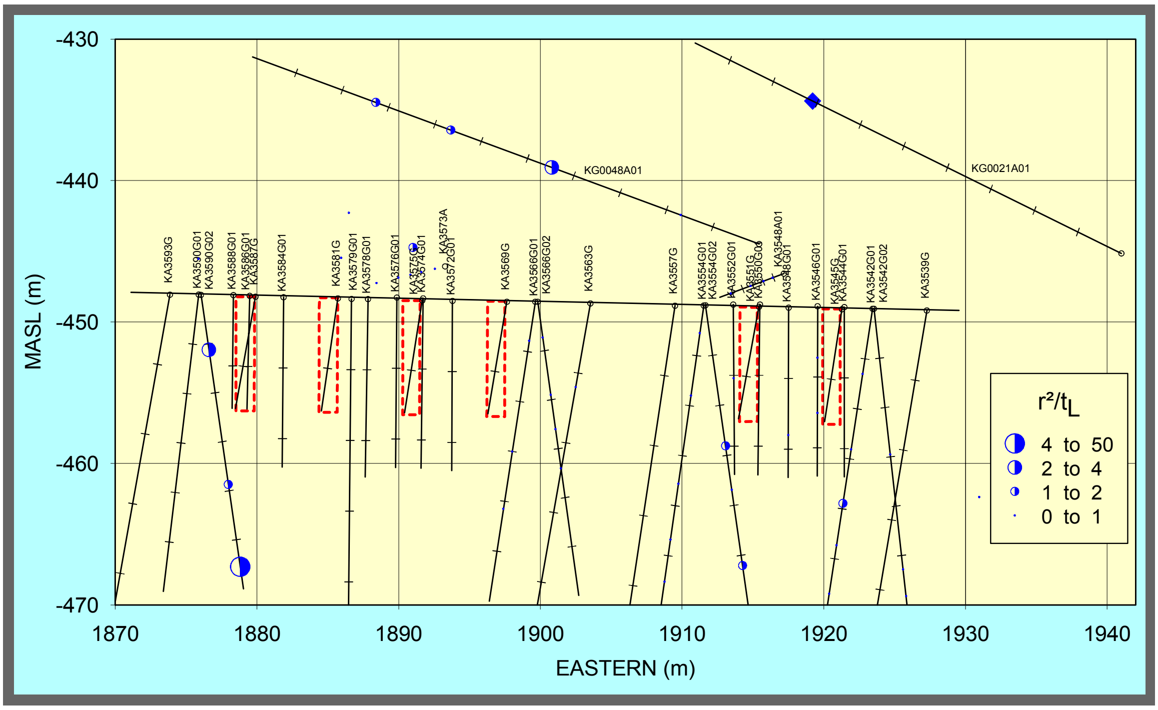


***Figure 6-15** Plot showing r^2/t_L during recovery of KG0021A01:3 (Interference test 5:25) – vertical view*

This test indicates a **rather good** ($1 < r^2/t_L < 2$) hydraulic connection between the flow section and KA3590G02:2, KA3573C01:1, KA3554G02:1&3, KA3542G01:3, KA3510A:1&3 and KG0048A01:2&3.

A **good** ($2 < r^2/t_L < 4$) hydraulic connection is established between the flow section and KA3590G02:4 and KG0048A01:4.

A **very good** ($4 < r^2/t_L$) hydraulic connection is apparent between the flow section and KA3590G02:1.

The transmissivity of the observation sections with $r^2/t_L > 1$, i.e. the sections mentioned above is within the range $3.7 \cdot 10^{-8} – 7.8 \cdot 10^{-7}$ m²/s. The transmissivity of the flowing section is evaluated to be $1.5 \cdot 10^{-7}$ m²/s with the evaluation period 0.3 – 1 minutes.

The flow section is situated right above the repository. It has good connection with a KG0048A01 on the same horizontal level and also with the lower sections of KA3590G02, on the north side of the repository, some 30 meters below the level of KG0048A01. To be noted is also the rather good connection with the three lower sections of KA3542G01 on the south of the repository.

Also noteworthy is the rather good connection with the bottom section of KA3510A approximately 120 meters from the flow section.

Due to unknown causes the highest logging frequency of 2 seconds was not initiated for this test. Therefor fewer observation responses were registered than otherwise expected.

Table 6-14 Interference test results for KG0021A01, 35.00 - 36.00 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3510A:1	125.00	150.00	137.50	122.63	179	1.400	2.12E-01	-	-	-	1	1.4	1.0
KA3510A:2	110.00	124.00	117.00	103.12	179	0.990	1.50E-01	-	-	-	1	2.0	1.2
KA3510A:3	75.00	109.00	92.00	79.99	100	1.067	1.37E-01	3.4E-07	3.2E-06	2.5E-06	1	6.7	4.9
KA3510A:4	51.00	74.00	62.50	54.77	77	0.649	7.70E-02	1.8E-07	2.9E-06	2.3E-06	2	15.7	13.3
KA3510A:5	4.50	50.00	27.25	34.81	35	0.577	5.42E-02	3.5E-07	6.2E-06	6.5E-06	2	17.4	19.6
KA3539G:1	18.60	30.00	24.30	39.09	-	-	-	-	-	-	0	-169.1	48.1
KA3539G:2	15.85	17.60	16.73	31.90	-	-	-	-	-	-	0	-151.6	47.3
KA3539G:3	10.00	14.85	12.43	27.90	-	-	-	-	-	-	0	-125.8	58.4
KA3539G:4	4.00	9.00	6.50	22.57	-	-	-	-	-	-	0	-143.3	45.2
KA3542G01:1	27.00	30.00	28.50	41.96	35	0.838	7.88E-02	3.5E-07	4.1E-06	4.5E-06	2	18.4	19.2
KA3542G01:2	21.30	26.00	23.65	37.26	27	0.857	7.48E-02	1.9E-07	2.7E-06	2.6E-06	2	33.1	42.2
KA3542G01:3	18.60	20.30	19.45	33.22	17	1.082	8.34E-02	2.0E-07	1.9E-06	2.4E-06	2	42.2	60.4
KA3542G01:4	10.50	17.60	14.05	28.10	26	0.506	4.37E-02	1.8E-07	3.9E-06	4.1E-06	2	37.3	48.9
KA3542G01:5	3.50	9.50	6.50	21.17	54	0.138	1.48E-02	1.8E-07	1.5E-05	1.2E-05	2	13.7	19.6
KA3542G02:1	28.20	30.01	29.11	40.04	143	0.187	2.66E-02	2.3E-08	1.7E-06	8.8E-07	2	33.4	23.8
KA3542G02:2	25.60	27.20	26.40	37.48	140	0.167	2.36E-02	1.5E-08	1.4E-06	6.4E-07	2	40.5	29.7
KA3542G02:3	21.50	24.60	23.05	34.34	-	-	-	-	-	-	1	2.9	-1.0
KA3542G02:4	9.00	20.50	14.75	26.82	66	0.182	2.06E-02	4.8E-08	3.8E-06	2.3E-06	2	42.8	52.4
KA3542G02:5	2.00	8.00	5.00	18.82	-	-	-	-	-	-	0	-99.4	75.6
KA3543A01:1	0.65	2.06	1.36	13.87	-	-	-	-	-	-	-	-	-
KA3543I01:1	0.65	2.06	1.36	9.34	-	-	-	-	-	-	-	-	-
KA3544G01:1	11.65	12.00	11.83	26.56	-	-	-	-	-	-	-	-	-
KA3544G01:2	8.90	10.65	9.78	24.52	-	-	-	-	-	-	-	-	-
KA3544G01:3	3.50	7.90	5.70	20.47	-	-	-	-	-	-	-	-	-
KA3546G01:1	9.30	12.00	10.65	25.37	-	-	-	-	-	-	0	-2.9	5.4
KA3546G01:2	6.75	8.30	7.53	22.28	100	0.083	1.06E-02	5.0E-07	4.9E-05	4.7E-05	1	4.2	5.4
KA3546G01:3	1.50	5.75	3.63	18.43	100	0.057	7.26E-03	-	-	-	1	1.2	2.9
KA3548A01:1	21.50	30.00	25.75	33.45	34	0.549	5.11E-02	4.6E-07	7.8E-06	8.9E-06	2	17.0	18.0
KA3548A01:2	11.75	20.50	16.13	24.70	30	0.339	3.05E-02	3.9E-07	1.2E-05	1.3E-05	2	18.6	20.9
KA3548A01:3	8.80	10.75	9.78	19.40	15	0.418	3.12E-02	2.5E-07	6.7E-06	8.0E-06	2	38.2	58.9
KA3548A01:4	3.00	7.80	5.40	16.19	12	0.364	2.56E-02	1.8E-07	7.6E-06	7.0E-06	2	55.7	70.0
KA3548D01:1	0.65	2.06	1.36	11.50	-	-	-	-	-	-	-	-	-
KA3548G01:1	6.00	12.00	9.00	23.77	260	0.036	6.05E-03	-	-	-	1	2.0	2.0
KA3548G01:2	2.00	5.00	3.50	18.31	-	-	-	-	-	-	0	-2.2	7.0
KA3550G01:1	8.30	12.03	10.17	24.88	-	-	-	-	-	-	-	-	-
KA3550G01:2	5.20	7.30	6.25	21.01	-	-	-	-	-	-	-	-	-
KA3550G01:3	1.80	4.20	3.00	17.82	-	-	-	-	-	-	-	-	-
KA3550G05:1	1.50	3.00	2.25	16.97	-	-	-	-	-	-	-	-	-
KA3551G05:1	1.50	3.10	2.30	17.82	-	-	-	-	-	-	-	-	-
KA3552A01:1	0.65	2.06	1.36	15.35	-	-	-	-	-	-	-	-	-
KA3552G01:1	7.05	12.00	9.53	24.67	-	-	-	-	-	-	0	-0.2	0.0
KA3552G01:2	4.35	6.05	5.20	20.51	120	0.058	7.90E-03	-	-	-	1	3.7	3.9
KA3552G01:3	1.50	3.35	2.43	17.88	-	-	-	-	-	-	0	0.0	0.0
KA3552H01:1	0.65	2.10	1.38	11.40	-	-	-	-	-	-	-	-	-
KA3553B01:1	0.65	2.02	1.34	14.68	-	-	-	-	-	-	-	-	-
KA3554G01:1	25.15	30.01	27.58	41.31	31	0.917	8.33E-02	4.1E-07	4.3E-06	4.9E-06	2	18.4	19.2
KA3554G01:2	22.60	24.15	23.38	37.28	30	0.772	6.95E-02	4.2E-07	5.5E-06	6.1E-06	2	18.4	19.2
KA3554G01:3	14.00	21.60	17.80	31.99	51	0.334	3.51E-02	1.9E-07	6.2E-06	5.4E-06	2	21.5	21.3
KA3554G01:4	5.00	13.00	9.00	23.92	51	0.187	1.96E-02	1.7E-07	1.0E-05	8.5E-06	2	21.9	22.1
KA3554G01:5	1.50	4.00	2.75	18.60	130	0.044	6.14E-03	6.1E-08	1.9E-05	9.9E-06	1	9.6	6.8
KA3554G02:1	22.00	30.01	26.01	37.52	14	1.675	1.23E-01	7.8E-08	2.4E-06	6.4E-07	2	10.6	50.3
KA3554G02:2	15.90	21.00	18.45	30.59	17	0.918	7.07E-02	7.8E-08	1.2E-06	1.1E-06	2	70.6	119.4
KA3554G02:3	13.20	14.90	14.05	26.73	11	1.082	7.46E-02	1.2E-07	1.6E-06	1.5E-06	2	71.2	119.6
KA3554G02:4	10.50	12.20	11.35	24.44	-	-	-	-	-	-	0	-109.5	72.8
KA3554G02:5	1.50	9.50	5.50	19.87	-	-	-	-	-	-	0	-2.0	98.0
KA3557G:1	15.00	30.04	22.52	39.00	-	-	-	-	-	-	-	-	-
KA3557G:2	1.50	14.00	7.75	24.66	-	-	-	-	-	-	-	-	-
KA3563A01:1	0.65	2.06	1.36	22.79	-	-	-	-	-	-	-	-	-
KA3563D01:1	0.65	2.01	1.33	20.12	-	-	-	-	-	-	-	-	-
KA3563G:1	15.00	30.01	22.51	41.40	-	-	-	-	-	-	0	0.5	-0.5
KA3563G:2	10.00	13.00	11.50	31.14	-	-	-	-	-	-	0	0.5	-0.2
KA3563G:3	4.00	8.00	6.00	26.24	72	0.159	1.85E-02	8.4E-07	6.8E-05	4.6E-05	2	19.2	20.2
KA3563G:4	1.50	3.00	2.25	23.05	-	-	-	-	-	-	0	-0.2	1.5
KA3563I01:1	0.65	2.15	1.40	19.59	-	-	-	-	-	-	-	-	-
KA3566C01:1	0.65	2.1	1.38	24.30	-	-	-	-	-	-	-	-	-

Table 6-15 Interference test results for KG0021A01, 35.00 - 36.00 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3566G01:1	23.50	30.01	26.76	44.17	-	-	-	-	-	-	1	2.0	-0.2
KA3566G01:2	20.00	21.50	20.75	38.97	75	0.338	3.97E-02	6.5E-07	1.4E-05	1.6E-05	1	7.4	5.7
KA3566G01:3	12.00	18.00	15.00	34.26	105	0.186	2.42E-02	1.1E-06	3.4E-05	4.4E-05	1	5.4	3.7
KA3566G01:4	7.30	10.00	8.65	29.49	-	-	-	-	-	-	0	-0.5	2.0
KA3566G01:5	1.50	6.30	3.90	26.36	170	0.068	1.02E-02	-	-	-	1	9.8	2.5
KA3566G02:1	19.00	30.10	24.55	40.06	-	-	-	-	-	-	0	-22.4	79.0
KA3566G02:2	16.00	18.00	17.00	34.08	26	0.745	6.43E-02	4.6E-08	8.3E-07	7.1E-07	2	79.0	123.8
KA3566G02:3	12.00	14.00	13.00	31.18	57	0.284	3.08E-02	-	-	-	2	64.4	95.9
KA3566G02:4	8.00	11.00	9.50	28.85	157	0.088	1.29E-02	-	-	-	2	55.1	39.9
KA3566G02:5	1.30	6.00	3.65	25.59	75	0.146	1.71E-02	-	-	-	1	7.6	2.5
KA3568D01:1	0.65	2.30	1.48	24.08	-	-	-	-	-	-	-	-	-
KA3572G01:1	7.30	12.03	9.67	34.87	-	-	-	-	-	-	-	-	-
KA3572G01:2	2.70	5.30	4.00	31.26	-	-	-	-	-	-	-	-	-
KA3573A:1	26.00	40.07	33.04	47.48	127	0.296	4.07E-02	-	-	-	1	3.4	2.2
KA3573A:2	21.00	24.00	22.50	39.46	65	0.399	4.50E-02	9.1E-07	1.5E-05	2.0E-05	1	6.6	5.9
KA3573A:3	14.50	19.00	16.75	35.63	65	0.326	3.67E-02	9.1E-07	1.8E-05	2.5E-05	1	7.1	5.7
KA3573A:4	10.50	12.50	11.50	32.63	30	0.592	5.32E-02	4.8E-07	6.9E-06	9.0E-06	2	19.9	20.1
KA3573A:5	1.30	8.50	4.90	29.78	54	0.274	2.92E-02	3.3E-06	3.8E-05	1.1E-04	1	3.4	3.9
KA3573C01:1	0.65	2.05	1.35	30.06	15	1.004	7.49E-02	4.2E-07	3.7E-06	5.6E-06	2	36.8	33.9
KA3574D01:1	0.65	2.05	1.35	29.33	-	-	-	-	-	-	-	-	-
KA3574G01:1	8.00	12.03	10.02	36.64	-	-	-	-	-	-	-	-	-
KA3574G01:2	5.10	7.00	6.05	34.14	-	-	-	-	-	-	-	-	-
KA3574G01:3	1.80	4.10	2.95	32.39	-	-	-	-	-	-	-	-	-
KA3576G01:1	8.00	12.01	10.01	37.92	-	-	-	-	-	-	-	-	-
KA3576G01:2	4.00	6.00	5.00	34.94	-	-	-	-	-	-	-	-	-
KA3576G01:3	1.30	3.00	2.15	33.46	-	-	-	-	-	-	-	-	-
KA3578C01:1	0.65	2.09	1.37	35.08	72	0.285	3.31E-02	4.2E-06	4.2E-05	1.3E-04	1	2.5	2.7
KA3578G01:1	6.50	12.58	9.54	39.40	-	-	-	-	-	-	-	-	-
KA3578G01:2	4.30	5.50	4.90	36.76	-	-	-	-	-	-	-	-	-
KA3578H01:1	0.65	1.90	1.28	33.72	64	0.296	3.32E-02	1.6E-07	5.6E-06	4.7E-06	2	20.4	17.0
KA3579D01:1	0.65	2.00	1.33	33.96	-	-	-	-	-	-	-	-	-
KA3579G:1	14.70	22.65	18.68	46.30	-	-	-	-	-	-	-	-	-
KA3579G:2	12.50	13.70	13.10	42.50	-	-	-	-	-	-	-	-	-
KA3579G:3	2.30	11.50	6.90	38.79	-	-	-	-	-	-	-	-	-
KA3584G01:1	7.00	12.00	9.50	44.20	-	-	-	-	-	-	-	-	-
KA3584G01:2	1.30	5.00	3.15	41.16	-	-	-	-	-	-	-	-	-
KA3588C01:1	0.65	2.04	1.35	44.74	64	0.521	5.85E-02	-	-	-	1	3.9	5.4
KA3588D01:1	0.65	1.90	1.28	42.34	-	-	-	-	-	-	0	0.0	23.8
KA3588I01:1	0.65	1.96	1.31	42.63	-	-	-	-	-	-	0	0.5	0.7
KA3590G01:1	16.00	30.00	23.00	55.68	-	-	-	-	-	-	0	-67.2	246.4
KA3590G01:2	7.00	15.00	11.00	49.33	-	-	-	-	-	-	0	-67.4	247.3
KA3590G01:3	1.30	6.00	3.65	46.55	-	-	-	-	-	-	1	2.2	8.4
KA3590G02:1	25.50	30.01	27.76	57.46	6.8	8.091	4.98E-01	5.4E-08	1.0E-07	1.1E-07	2	195.1	204.7
KA3590G02:2	15.20	23.50	19.35	52.59	24	1.921	1.62E-01	3.7E-08	2.4E-07	2.3E-07	2	147.7	147.0
KA3590G02:3	11.90	13.20	12.55	49.35	-	-	-	-	-	-	1	5.7	0.5
KA3590G02:4	1.30	9.90	5.60	46.84	16	2.285	1.73E-01	7.8E-07	2.3E-06	4.5E-06	2	15.7	17.4
KA3592C01:1	0.65	2.01	1.33	48.64	-	-	-	-	-	-	-	-	-
KA3593G:1	25.20	30.02	27.61	64.90	-	-	-	-	-	-	0	-0.2	0.0
KA3593G:2	23.50	24.20	23.85	62.11	132	0.487	6.77E-02	4.8E-07	8.9E-06	7.0E-06	1	4.4	2.7
KA3593G:3	9.00	22.50	15.75	56.46	-	-	-	-	-	-	0	0.5	-0.2
KA3593G:4	3.00	7.00	5.00	50.03	-	-	-	-	-	-	1	3.4	0.0
KA3597D01:1	0.65	2.22	1.44	50.74	-	-	-	-	-	-	-	-	-
KA3597H01:1	0.65	2.06	1.36	52.17	143	0.317	4.51E-02	4.8E-06	4.0E-05	1.1E-04	1	1.7	1.2
KA3600F:1	43.00	50.10	46.55	98.24	180	0.894	1.36E-01	9.6E-07	7.2E-06	7.1E-06	1	2.0	1.2
KA3600F:2	40.50	42.00	41.25	93.12	180	0.803	1.22E-01	-	-	-	1	2.2	1.2
KA3600F:3	20.00	39.50	29.75	82.09	160	0.702	1.03E-01	-	-	-	1	3.2	2.0
KA3600F:4	1.30	18.00	9.65	63.22	200	0.333	5.20E-02	-	-	-	1	5.2	1.5
KG0021A01:1	42.50	48.82	45.66	10.15	-	-	-	-	-	-	2	285.0	340.1
KG0021A01:2	37.00	41.50	39.25	3.75	-	-	-	-	-	-	2	406.8	452.7
KG0021A01:3	**35.00**	**36.00**	**35.50**	**0.00**	-	-	-	-	-	-	2	2679.7	2708.7
KG0021A01:4	19.00	34.00	26.50	9.00	-	-	-	-	-	-	2	276.5	298.9
KG0021A01:5	5.00	18.00	11.50	24.00	-	-	-	-	-	-	2	87.1	93.0
KG0048A01:1	49.00	54.69	51.85	37.80	-	-	-	-	-	-	-	-	-
KG0048A01:2	34.8	48	41.40	31.27	14	1.164	8.53E-02	3.7E-07	3.0E-06	4.3E-06	2	38.5	36.1
KG0048A01:3	32.80	33.80	33.30	27.92	9	1.443	9.48E-02	1.1E-07	9.5E-07	1.2E-06	2	100.8	97.9
KG0048A01:4	13.00	31.80	22.40	26.81	5	2.396	1.38E-01	6.1E-08	3.8E-07	4.4E-07	2	211.7	222.0
KG0048A01:5	5.00	12.00	8.50	31.40	58	0.283	3.09E-02	-	-	-	2	65.5	63.0

6.2.6 Test 5:26 – KG0048A01:3

General test data for the pressure build-up test in the interval 32.80-33.80 m of borehole KG0048A01 are presented in Table 6-16.

Table 6-16 General test data for the pressure build-up test in section 32.80-33.80 m of borehole KG0048A01

General test data			
Borehole section	KG0048A01:3		
Test No	5:26		
Field crew	J. Magnusson, A. Blom (SWECO VIAK)		
Test equipment system	HMS		
General comment	Interference test		
	Nomen-clature	Unit	Value
Test section- secup	Secup	m	32.80
Test section- seclow	Seclow	m	33.80
Test section length	L_w	m	1.00
Test section diameter	$2 \cdot r_w$	mm	76
Test start (start of pressure registration)		yymmdd hh:mm	20050123 14:00:00
Packer expanded		yymmdd hh:mm:ss	-
Start of flow period		yymmdd hh:mm:ss	20050123 16:00:00
Stop of flow period		yymmdd hh:mm:ss	20050123 22:00:00
Test stop (stop of pressure registration)		yymmdd hh:mm	20050124 16:00:00
Total flow time	t_p	min	360
Total recovery time	t_F	min	1080

Pressure data

Pressure data	**Nomen-clature**	**Unit**	**Value**	**Comment**
Absolute pressure in borehole before start of flow period	p_0	kPa	3239	
Absolute pressure in test section before stop of flow	p_p	kPa	232	
Max absolute pressure in test section during recovery period	p_f	kPa	3270	
Maximal pressure change during flow period	dp_p	kPa	3007	

Flow data

Flow data	**Nomen-clature**	**Unit**	**Value**
Flow rate from test section just before stop of flowing	Q_p	m^3/s	$1.49 \cdot 10^{-5}$
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	$1.48 \cdot 10^{-5}$
Total volume discharged during flow period	V_p	m^3	0.3207

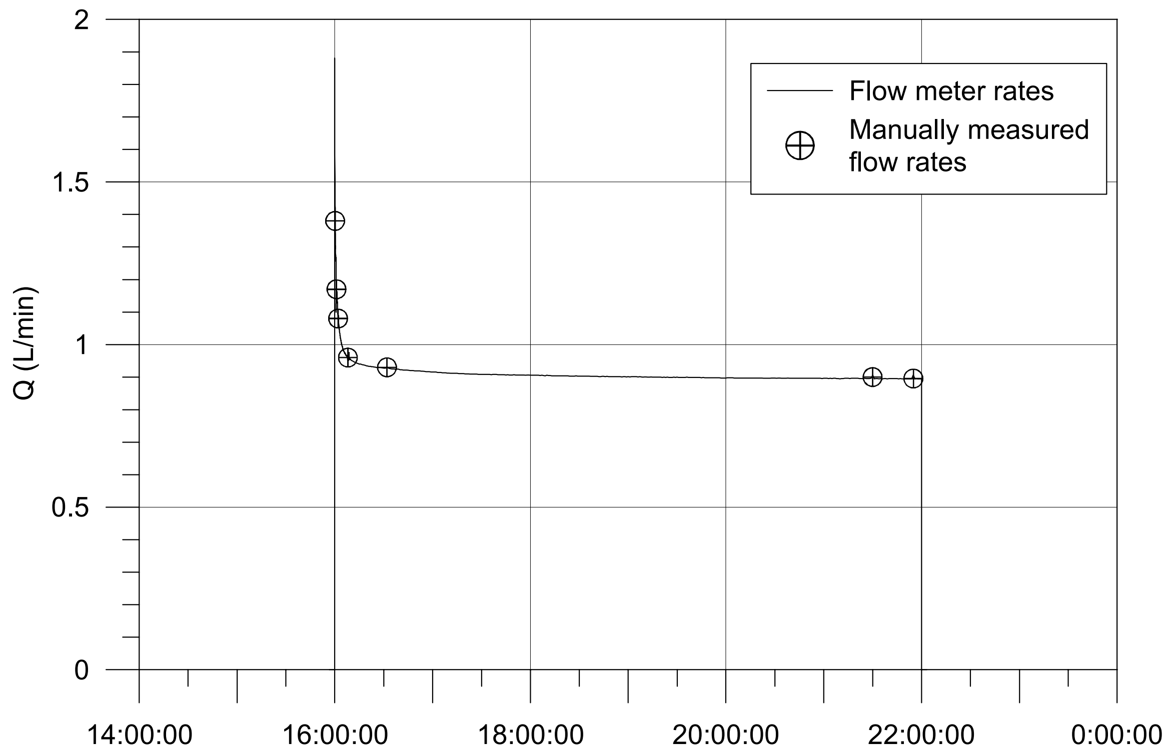


Figure 6-16 *Flow rates during draw down in KG0048A01:3.Time in minutes.*

Comments to the test

The test was successful in regard to pressure responses.

Interpreted flow regimes – flowing section

0 – 0.1	minutes	Well Bore Storage (WBS)
0.1 – 0.3	minutes	Transition period
0.3 – 0.8	minutes	Radial flow period
0.8 – 35	minutes	Transition period
35 – 70	minutes	Spherical flow period
70 –		Transition period

Calculated parameters

Quantitative analysis was made for recovery phases in lin-log- and log-log diagrams according to the methods described in Section 5.4.1.

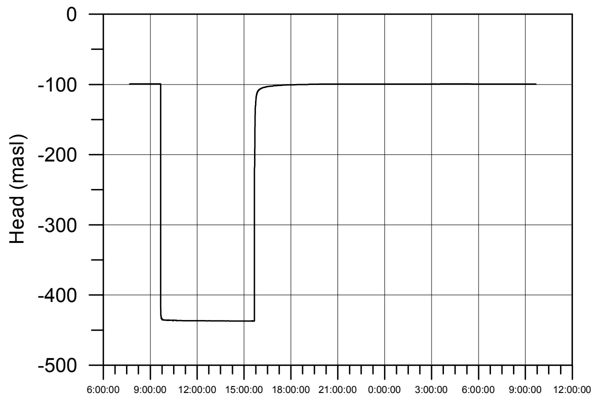
Selected representative parameters

The selected representative parameters from the test in the interval 32.80-33.80 m in KG0048A01 are presented in the Test Summary Sheet below. The selected parameters are derived from the recovery period.

Test Summary Sheet

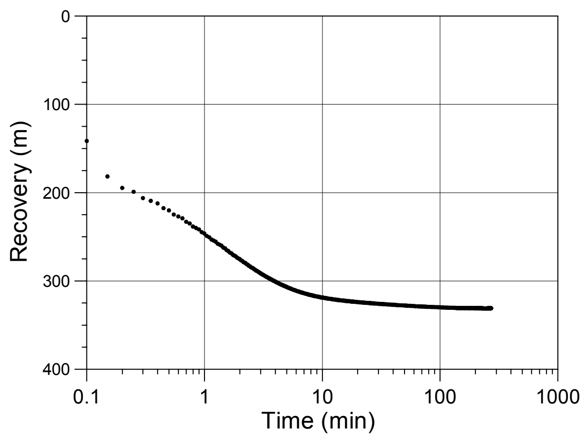
Project:	PROTOTYPE	Test type:	PBT
Area:	ÄSPÖ	Test no:	5:26
Borehole ID:	KG0048A01	Test start:	2005-01-23 14:00
Test section (m):	32.80-33.80	Responsible for test performance:	SWECO VIAK AB J. Magnusson/A. Blom
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	SWECO VIAK AB T. Forsmark

Linear plot Head



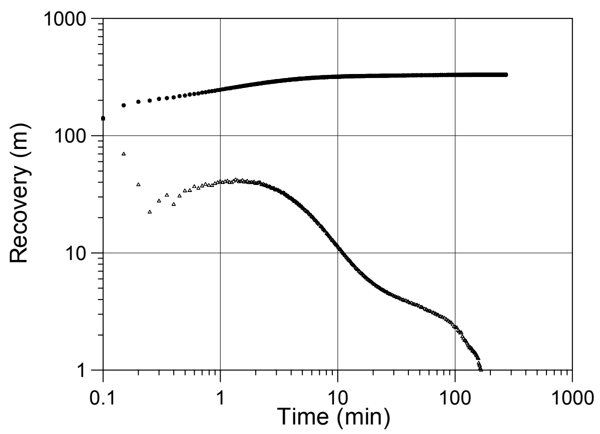
Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)	3239		
p_i (kPa)			
p_p(kPa)	232	p_F (kPa)	3270
Q_p (m^3/s)	$1.70 \cdot 10^{-5}$		
tp (min)	360	t_F (min)	1080
S*		S*	$1 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(gr C)			
Derivative fact.		Derivative fact.	0.2

Lin-Log plot



Results		Results	
Q/s (m^2/s)	$5.0 \cdot 10^{-8}$	Flow regime:	Radial
T_{Moye}(m^2/s)	$2.8 \cdot 10^{-8}$	dt_{e1} (min)	0.3
Flow regime:		dt_{e2} (min)	0.8
dt_1 (min)		T (m^2/s)	$4.1 \cdot 10^{-8}$
dt_2 (min)		S (-)	
T (m^2/s)		K_s (m/s)	
S (-)		S_s (1/m)	
K_s (m/s)		C (m^3/Pa)	
S_s (1/m)		C_D (-)	
C (m^3/Pa)		ξ (-)	-0.4
C_D (-)			
ξ (-)			

Log-Log plot incl. derivative- recovery period



Interpreted formation and well parameters.

Flow regime:	Radial	C (m^3/Pa)	
dt_1 (min)	0.3	C_D (-)	
dt_2 (min)	0.8	ξ (-)	-0.4
T_T (m^2/s)	$4.1 \cdot 10^{-8}$		
S (-)			
K_s (m/s)			
S_s (1/m)			

Comments: The test indicates a possible high conductivity feature during the later part of the period.

The test was carried out in KG0048A01, section 32.80 - 33.80 metres. The flow period was for 360 minutes with a final flow of 0.89 l/min, while the pressure build-up time was 1080 minutes. In Figure 6-17 and Figure 6-18 the r^2/t_L recordings are shown and in Table 6-17 and Table 6-18 the interference test results are presented. Diagrams of evaluated bore hole sections are presented in Appendix 6.

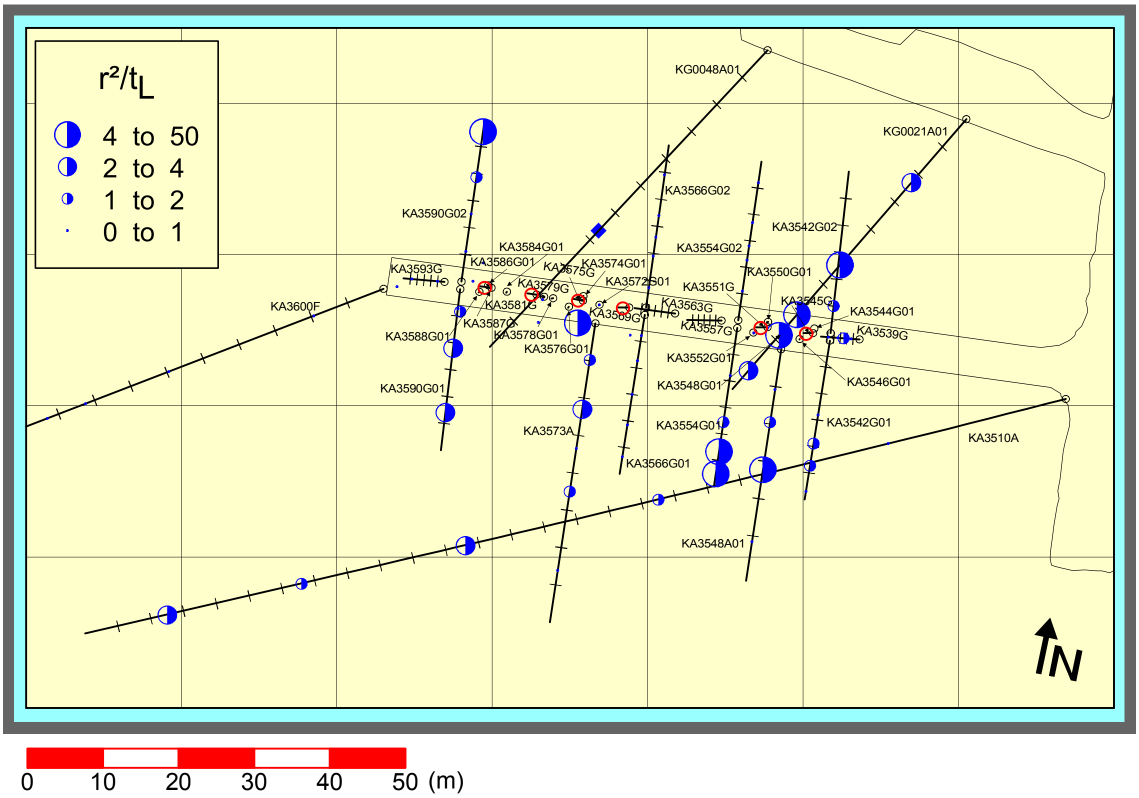


Figure 6-17 Plot showing r^2/t_L *during recovery of KG0048A01:3 (Interference test 5:26) - plan view*

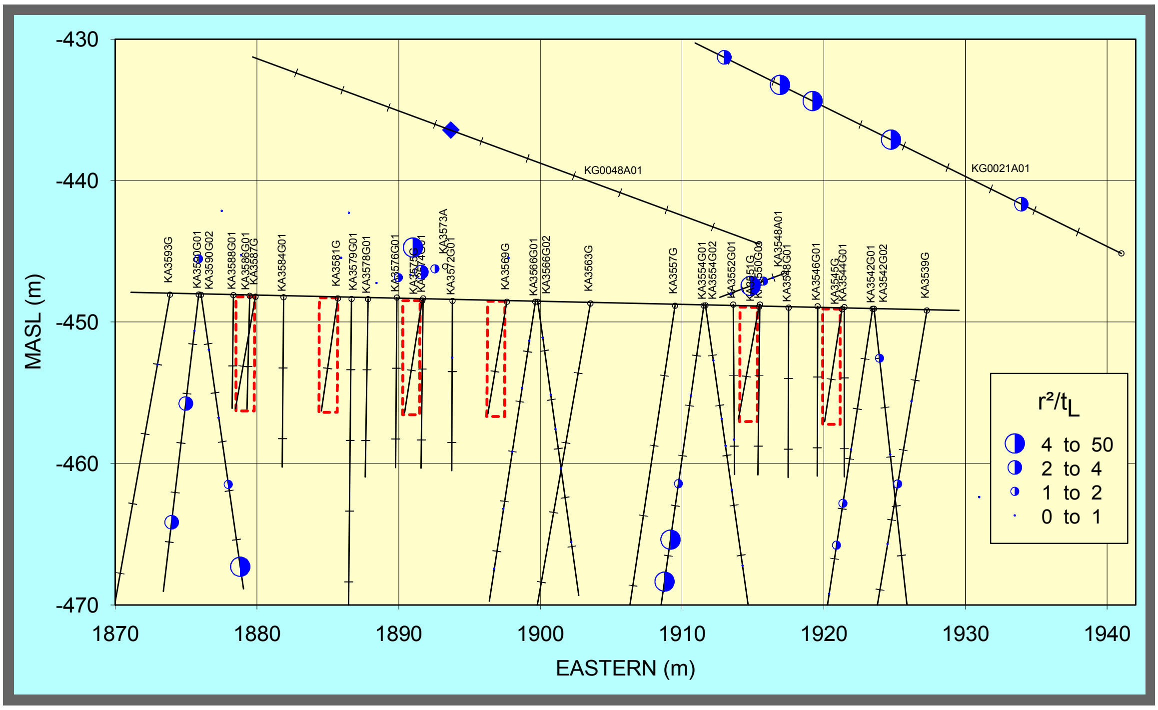


***Figure 6-18** Plot showing r^2/t_L during recovery of KG0048A01:3 (Interference test 5:26) - vertical view*

This test indicates a **rather good** ($1 < r^2/t_L < 2$) hydraulic connection between the flow section and KA3590G02:2, KA3588C01:1, KA3573A:2 & 5, KA3542G02:5, KA3542G01:2-3, KA3539G:3 and KA3510A2&4.

A **good** ($2 < r^2/t_L < 4$) hydraulic connection is established between the flow section and KA3590G01:1-2, KA3573A:4, KA3510 A:1&3 and KG0021A01:1 & 5.

A **very good** ($4 < r^2/t_L$) hydraulic connection is apparent between the flow section and KA3590G02:1, KA3573C01:1, KA3554G01:1&2, KA3548A01:2 and KG0021A01:2-4.

The transmissivity of the observation sections with $r^2/t_L > 1$, i.e. the sections mentioned above is within the range $2.2 \cdot 10^{-8} – 3.9 \cdot 10^{-6}$ m^2/s. The transmissivity of the flowing section is evaluated to be $4.1 \cdot 10^{-8}$ m^2/s with the evaluation period 0.3 – 0.8 minutes.

The flow section is located above and slightly north of the repository. It is in very good connection with KA3590G02:1 on a lower level and KG0021A01 on the same level. It also has very good connection with several sections of KA3554G01 and KA3548A01 on the south side of the repository. This fits the idea of a pattern of parallel hydraulic features with interconnecting fracture systems wandering up and down in the vertical direction.

Table 6-17 Interference test results for KG0048A01, 32.80 - 33.80 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response)	Po - Pp (kPa)	Pf - Pp (kPa)
KA3510A:1	125.00	150.00	137.50	110.55	70	2.910	3.36E-01	3.9E-06	4.2E-06	1.2E-05	1	3.1	3.5
KA3510A:2	110.00	124.00	117.00	93.01	100	1.442	1.85E-01	7.7E-07	3.9E-06	4.2E-06	1	3.5	4.5
KA3510A:3	75.00	109.00	92.00	73.70	39	2.321	2.25E-01	5.2E-07	2.0E-06	2.3E-06	2	14.7	16.0
KA3510A:4	51.00	74.00	62.50	56.80	30	1.792	1.61E-01	1.7E-07	1.1E-06	1.0E-06	2	38.4	41.3
KA3510A:5	4.50	50.00	27.25	53.43	97	0.491	6.23E-02	4.2E-07	7.1E-07	6.8E-06	2	45.2	49.9
KA3539G:1	18.60	30.00	24.30	49.20	69	0.585	6.71E-02	1.6E-07	3.1E-06	2.3E-06	2	11.0	18.4
KA3539G:2	15.85	17.60	16.73	44.80	54	0.619	6.61E-02	2.3E-07	4.1E-06	3.4E-06	2	12.0	19.4
KA3539G:3	10.00	14.85	12.43	42.69	28	1.085	9.57E-02	2.2E-08	8.1E-08	2.3E-07	2	15.7	22.6
KA3539G:4	4.00	9.00	6.50	40.36	50	0.543	5.66E-02	4.2E-07	7.2E-06	7.5E-06	2	12.0	18.9
KA3542G01:1	27.00	30.00	28.50	54.56	63	0.787	8.80E-02	4.9E-07	5.6E-07	5.6E-06	2	51.8	53.5
KA3542G01:2	21.30	26.00	23.65	50.68	26	1.647	1.42E-01	3.5E-07	2.1E-06	2.4E-06	2	13.5	48.1
KA3542G01:3	18.60	20.30	19.45	47.48	22	1.708	1.41E-01	3.7E-07	2.1E-06	2.6E-06	2	17.9	42.7
KA3542G01:4	10.50	17.60	14.05	43.60	32	0.990	9.07E-02	1.9E-07	2.2E-06	2.1E-06	2	11.5	41.0
KA3542G01:5	3.50	9.50	6.50	38.81	-	-	-	-	-	-	0	-45.8	15.2
KA3542G02:1	28.20	30.01	29.11	46.57	-	-	-	-	-	-	0	-35.3	29.0
KA3542G02:2	25.60	27.20	26.40	44.84	-	-	-	-	-	-	0	-40.7	35.3
KA3542G02:3	21.50	24.60	23.05	42.84	-	-	-	-	-	-	0	-0.5	6.1
KA3542G02:4	9.00	20.50	14.75	38.69	108	0.231	3.03E-02	3.6E-08	2.4E-06	1.2E-06	1	7.9	21.6
KA3542G02:5	2.00	8.00	5.00	35.70	17	1.250	9.63E-02	9.1E-07	5.3E-06	9.5E-06	2	21.4	18.2
KA3543A01:1	0.65	2.06	1.36	33.47	-	-	-	-	-	-	0	0.2	0.4
KA3543I01:1	0.65	2.06	1.36	32.15	-	-	-	-	-	-	0	0.0	0.4
KA3544G01:1	11.65	12.00	11.83	39.13	-	-	-	-	-	-	0	-1.0	5.1
KA3544G01:2	8.90	10.65	9.78	37.89	-	-	-	-	-	-	0	-1.0	5.7
KA3544G01:3	3.50	7.90	5.70	35.64	-	-	-	-	-	-	0	-1.0	5.4
KA3546G01:1	9.30	12.00	10.65	37.54	-	-	-	-	-	-	0	-5.4	11.8
KA3546G01:2	6.75	8.30	7.53	35.71	-	-	-	-	-	-	0	-52.6	8.9
KA3546G01:3	1.50	5.75	3.63	33.68	-	-	-	-	-	-	0	-3.4	8.1
KA3548A01:1	21.50	30.00	25.75	47.06	75	0.492	5.79E-02	4.9E-07	9.6E-07	8.5E-06	2	46.7	48.5
KA3548A01:2	11.75	20.50	16.13	39.60	5.4	4.839	2.83E-01	5.2E-07	1.0E-06	1.8E-06	2	52.2	53.6
KA3548A01:3	8.80	10.75	9.78	35.26	17	1.219	9.39E-02	4.6E-07	3.5E-06	4.9E-06	2	22.3	44.2
KA3548A01:4	3.00	7.80	5.40	32.65	34	0.523	4.87E-02	1.6E-07	3.7E-06	3.2E-06	1	8.6	39.7
KA3548D01:1	0.65	2.06	1.36	28.43	-	-	-	-	-	-	0	0.2	0.4
KA3548G01:1	6.00	12.00	9.00	34.76	-	-	-	-	-	-	0	-9.8	10.0
KA3548G01:2	2.00	5.00	3.50	31.64	-	-	-	-	-	-	0	-5.1	11.0
KA3550G01:1	8.30	12.03	10.17	33.52	-	-	-	-	-	-	0	-1.6	5.1
KA3550G01:2	5.20	7.30	6.25	31.05	-	-	-	-	-	-	0	-1.6	5.1
KA3550G01:3	1.80	4.20	3.00	29.25	-	-	-	-	-	-	0	-1.4	5.1
KA3550G05:1	1.50	3.00	2.25	32.67	-	-	-	-	-	-	0	-0.4	1.2
KA3551G05:1	1.50	3.10	2.30	27.60	-	-	-	-	-	-	0	-1.6	4.9
KA3552A01:1	0.65	2.06	1.36	25.82	-	-	-	-	-	-	0	0.2	0.4
KA3552G01:1	7.05	12.00	9.53	32.57	240	0.074	1.21E-02	-	-	-	1	2.0	3.1
KA3552G01:2	4.35	6.05	5.20	29.80	-	-	-	-	-	-	0	-67.9	11.3
KA3552G01:3	1.50	3.35	2.43	28.24	-	-	-	-	-	-	1	6.6	0.0
KA3552H01:1	0.65	2.10	1.38	23.38	-	-	-	-	-	-	0	0.0	0.6
KA3553B01:1	0.65	2.02	1.34	23.72	-	-	-	-	-	-	0	-1.4	4.9
KA3554G01:1	25.15	30.01	27.58	47.76	5.2	7.309	4.24E-01	4.7E-07	7.0E-07	1.1E-06	2	52.4	53.8
KA3554G01:2	22.60	24.15	23.38	43.96	5.4	5.965	3.49E-01	6.6E-07	9.0E-07	1.9E-06	2	52.2	53.6
KA3554G01:3	14.00	21.60	17.80	39.04	15	1.693	1.26E-01	3.6E-07	2.1E-06	2.8E-06	2	27.6	44.2
KA3554G01:4	5.00	13.00	9.00	31.73	17	0.987	7.61E-02	3.6E-07	3.5E-06	4.7E-06	2	24.8	42.3
KA3554G01:5	1.50	4.00	2.75	27.08	-	-	-	-	-	-	0	-15.1	8.8
KA3554G02:1	22.00	30.01	26.01	37.57	88	0.267	3.30E-02	6.6E-08	3.5E-06	2.0E-06	2	16.4	22.1
KA3554G02:2	15.90	21.00	18.45	32.27	26	0.667	5.77E-02	2.8E-07	4.4E-06	4.9E-06	2	36.4	42.9
KA3554G02:3	13.20	14.90	14.05	29.63	20	0.732	5.89E-02	4.7E-07	5.7E-06	8.0E-06	2	37.0	43.4
KA3554G02:4	10.50	12.20	11.35	28.24	25	0.532	4.54E-02	7.0E-07	1.0E-05	1.5E-05	2	20.9	27.8
KA3554G02:5	1.50	9.50	5.50	25.93	44	0.255	2.56E-02	5.4E-08	2.9E-06	2.1E-06	2	63.4	77.3
KA3557G:1	15.00	30.04	22.52	38.72	-	-	-	-	-	-	0	-0.6	2.0
KA3557G:2	1.50	14.00	7.75	27.56	-	-	-	-	-	-	0	-0.4	0.8
KA3563A01:1	0.65	2.06	1.36	19.08	-	-	-	-	-	-	0	0.0	0.5
KA3563D01:1	0.65	2.01	1.33	15.61	-	-	-	-	-	-	1	3.4	0.5
KA3563G:1	15.00	30.01	22.51	36.46	-	-	-	-	-	-	0	-0.7	2.0
KA3563G:2	10.00	13.00	11.50	27.06	-	-	-	-	-	-	0	-0.5	0.2
KA3563G:3	4.00	8.00	6.00	22.90	-	-	-	-	-	-	0	-13.0	17.4
KA3563G:4	1.50	3.00	2.25	20.44	-	-	-	-	-	-	0	-0.5	1.2
KA3563I01:1	0.65	2.15	1.40	14.98	-	-	-	-	-	-	0	-0.5	2.0
KA3566C01:1	0.65	2.1	1.38	17.02	13	0.371	2.67E-02	1.3E-06	2.0E-05	4.7E-05	2	11.1	14.3

Table 6-18 Interference test results for KG0048A01, 32.80 - 33.80 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3566G01:1	23.50	30.01	26.76	43.18	160	0.194	2.85E-02	-	-	-	1	2.2	3.4
KA3566G01:2	20.00	21.50	20.75	37.28	25	0.927	7.92E-02	7.0E-07	5.7E-06	8.8E-06	2	17.2	19.4
KA3566G01:3	12.00	18.00	15.00	31.68	30	0.558	5.02E-02	9.1E-07	1.2E-05	1.8E-05	2	13.3	15.5
KA3566G01:4	7.30	10.00	8.65	25.57	88	0.124	1.53E-02	-	-	-	2	14.0	10.8
KA3566G01:5	1.50	6.30	3.90	21.09	78	0.095	1.13E-02	9.1E-08	1.2E-05	8.0E-06	2	10.8	20.9
KA3566G02:1	19.00	30.10	24.55	31.24	51	0.319	3.35E-02	1.4E-07	5.3E-06	4.3E-06	2	25.6	30.8
KA3566G02:2	16.00	18.00	17.00	25.22	22	0.482	3.98E-02	1.0E-07	2.7E-06	2.6E-06	2	92.5	104.1
KA3566G02:3	12.00	14.00	13.00	22.41	66	0.127	1.44E-02	3.3E-08	3.5E-06	2.3E-06	2	70.0	79.6
KA3566G02:4	8.00	11.00	9.50	20.27	130	0.053	7.29E-03	-	-	-	2	58.3	69.6
KA3566G02:5	1.30	6.00	3.65	17.71	170	0.031	4.59E-03	-	-	-	1	4.2	8.9
KA3568D01:1	0.65	2.30	1.48	12.66	-	-	-	-	-	-	0	0.2	0.2
KA3572G01:1	7.30	12.03	9.67	23.87	-	-	-	-	-	-	0	-1.5	3.2
KA3572G01:2	2.70	5.30	4.00	18.84	150	0.039	5.68E-03	-	-	-	0	-2.0	3.2
KA3573A:1	26.00	40.07	33.04	46.49	46	0.783	7.97E-02	2.3E-06	1.3E-05	2.9E-05	1	5.9	7.1
KA3573A:2	21.00	24.00	22.50	36.23	17	1.287	9.91E-02	1.2E-06	6.5E-06	1.2E-05	2	15.2	16.5
KA3573A:3	14.50	19.00	16.75	30.70	24	0.655	5.53E-02	1.4E-06	1.3E-05	2.6E-05	2	16.5	18.0
KA3573A:4	10.50	12.50	11.50	25.75	4	2.763	1.51E-01	9.9E-07	2.5E-06	6.5E-06	2	54.3	55.5
KA3573A:5	1.30	8.50	4.90	19.75	5	1.300	7.47E-02	3.7E-06	9.1E-06	5.0E-05	1	9.8	12.3
KA3573C01:1	0.65	2.05	1.35	15.00	0.85	4.413	1.82E-01	3.0E-07	1.1E-06	1.6E-06	2	95.6	104.9
KA3574D01:1	0.65	2.05	1.35	10.59	-	-	-	-	-	-	0	0.0	0.5
KA3574G01:1	8.00	12.03	10.02	23.67	-	-	-	-	-	-	0	0.2	0.2
KA3574G01:2	5.10	7.00	6.05	20.04	-	-	-	-	-	-	0	-0.2	0.0
KA3574G01:3	1.80	4.10	2.95	17.31	-	-	-	-	-	-	0	0.2	0.2
KA3576G01:1	8.00	12.01	10.01	24.41	-	-	-	-	-	-	0	1.0	0.2
KA3576G01:2	4.00	6.00	5.00	20.02	-	-	-	-	-	-	0	0.2	0.0
KA3576G01:3	1.30	3.00	2.15	17.66	-	-	-	-	-	-	0	0.0	0.2
KA3578C01:1	0.65	2.09	1.37	16.99	8	0.602	3.84E-02	5.4E-06	1.9E-05	1.4E-04	1	6.2	8.6
KA3578G01:1	6.50	12.58	9.54	24.05	-	-	-	-	-	-	1	2.0	0.2
KA3578G01:2	4.30	5.50	4.90	19.98	-	-	-	-	-	-	0	0.5	0.2
KA3578H01:1	0.65	1.90	1.28	13.00	13	0.217	1.56E-02	1.4E-07	1.0E-05	9.3E-06	2	63.5	71.3
KA3579D01:1	0.65	2.00	1.33	12.18	-	-	-	-	-	-	0	-0.2	0.2
KA3579G:1	14.70	22.65	18.68	32.61	-	-	-	-	-	-	0	-0.5	1.5
KA3579G:2	12.50	13.70	13.10	27.44	-	-	-	-	-	-	0	0.0	0.7
KA3579G:3	2.30	11.50	6.90	21.92	-	-	-	-	-	-	0	0.2	0.0
KA3584G01:1	7.00	12.00	9.50	25.74	-	-	-	-	-	-	1	1.7	0.0
KA3584G01:2	1.30	5.00	3.15	20.73	-	-	-	-	-	-	0	-0.5	1.2
KA3588C01:1	0.65	2.04	1.35	22.68	8.5	1.009	6.54E-02	1.4E-06	7.8E-06	2.1E-05	2	14.7	20.9
KA3588D01:1	0.65	1.90	1.28	17.77	190	0.028	4.26E-03	-	-	-	0	0.2	2.0
KA3588I01:1	0.65	1.96	1.31	18.40	100	0.056	7.23E-03	-	-	-	1	1.5	2.5
KA3590G01:1	16.00	30.00	23.00	41.66	9	3.214	2.11E-01	5.9E-07	1.4E-06	2.8E-06	2	36.9	40.1
KA3590G01:2	7.00	15.00	11.00	31.07	8	2.011	1.28E-01	5.9E-07	2.7E-06	4.6E-06	2	36.9	40.4
KA3590G01:3	1.30	6.00	3.65	25.21	42	0.252	2.50E-02	1.1E-06	2.7E-05	4.3E-05	1	8.9	10.3
KA3590G02:1	25.50	30.01	27.76	36.68	4.2	5.339	2.96E-01	4.9E-07	8.5E-07	1.7E-06	2	104.9	116.3
KA3590G02:2	15.20	23.50	19.35	30.40	15	1.027	7.66E-02	1.1E-07	1.3E-06	1.4E-06	2	90.5	100.8
KA3590G02:3	11.90	13.20	12.55	26.21	110	0.104	1.37E-02	6.8E-08	9.5E-06	4.9E-06	2	10.3	14.0
KA3590G02:4	1.30	9.90	5.60	23.24	20	0.450	3.62E-02	2.0E-06	2.0E-05	5.6E-05	2	13.3	6.6
KA3592C01:1	0.65	2.01	1.33	25.63	-	-	-	-	-	-	0	0.0	1.0
KA3593G:1	25.20	30.02	27.61	46.42	-	-	-	-	-	-	0	-0.2	0.2
KA3593G:2	23.50	24.20	23.85	43.01	43	0.717	7.16E-02	5.9E-07	7.7E-06	8.3E-06	2	10.6	12.3
KA3593G:3	9.00	22.50	15.75	35.91	-	-	-	-	-	-	0	0.2	0.2
KA3593G:4	3.00	7.00	5.00	27.35	140	0.089	1.26E-02	7.4E-08	1.1E-05	5.9E-06	1	5.2	8.1
KA3597D01:1	0.65	2.22	1.44	25.10	-	-	-	-	-	-	0	0.0	0.7
KA3597H01:1	0.65	2.06	1.36	27.56	56	0.226	2.44E-02	3.7E-06	5.4E-05	1.5E-04	1	3.2	3.7
KA3600F:1	43.00	50.10	46.55	75.88	110	0.872	1.15E-01	5.9E-07	5.6E-06	5.1E-06	1	3.2	4.4
KA3600F:2	40.50	42.00	41.25	70.62	110	0.756	9.96E-02	1.0E-06	8.7E-06	1.0E-05	1	3.2	4.2
KA3600F:3	20.00	39.50	29.75	59.23	70	0.835	9.63E-02	1.3E-06	9.2E-06	1.3E-05	1	5.2	6.2
KA3600F:4	1.30	18.00	9.65	39.47	120	0.216	2.93E-02	7.9E-08	5.0E-06	2.7E-06	1	8.9	9.1
KG0021A01:1	42.50	48.82	45.66	27.23	6.1	2.026	1.22E-01	2.2E-07	1.2E-06	1.8E-06	2	72.4	94.5
KG0021A01:2	37.00	41.50	39.25	27.23	1.7	7.268	3.37E-01	3.7E-07	5.0E-06	1.1E-06	2	102.3	119.5
KG0021A01:3	35.00	36.00	35.50	27.92	3.2	4.059	2.13E-01	2.6E-07	7.3E-07	1.2E-06	2	100.6	113.7
KG0021A01:4	19.00	34.00	26.50	31.40	1.4	11.737	5.26E-01	3.2E-07	4.6E-07	6.1E-07	2	101.5	112.3
KG0021A01:5	5.00	18.00	11.50	41.10	14	2.011	1.47E-01	7.4E-07	2.8E-06	5.0E-06	2	37.1	42.3
KG0048A01:1	49.00	54.69	51.85	18.55	-	-	-	-	-	-	-		
KG0048A01:2	34.8	48	41.40	8.09	0.7	1.559	6.23E-02	-	-	-	2	99.6	109.5
KG0048A01:3	**32.80**	**33.80**	**33.30**	**0.00**	-	-	-	-	-	-	2	3006.9	3038.4
KG0048A01:4	13.00	31.80	22.40	10.91	0.06	33.044	9.49E-01	-	-	-	2	107.4	118.5
KG0048A01:5	5.00	12.00	8.50	24.80	0.15	68.357	2.19E+00	-	-	-	2	30.7	34.8

6.2.7 Test 5:27 – KA3573A:4

General test data for the pressure build-up test in the interval 10.50-12.50 m of borehole KA3573A are presented in Table 6-19.

Table 6-19 General test data for the pressure build-up test in section 10.50-12.50 m of borehole KA3573A

General test data			
Borehole section	KA3573A:4		
Test No	5:27		
Field crew	J. Magnusson, A. Blom (SWECO VIAK)		
Test equipment system	HMS		
General comment	Interference test		
	Nomen-clature	Unit	Value
Test section- secup	Secup	m	10.50
Test section- seclow	Seclow	m	12.50
Test section length	L_w	m	2.00
Test section diameter	$2 \cdot r_w$	mm	76
Test start (start of pressure registration)		yymmdd hh:mm	20050125 17:00:00
Packer expanded		yymmdd hh:mm:ss	-
Start of flow period		yymmdd hh:mm:ss	20050125 19:00:00
Stop of flow period		yymmdd hh:mm:ss	20050126 15:00:00
Test stop (stop of pressure registration)		yymmdd hh:mm	20050128 19:00:00
Total flow time	t_p	min	1200
Total recovery time	t_F	min	3120

Pressure data

Pressure data	Nomen-clature	Unit	Value	Comment
Absolute pressure in borehole before start of flow period	p_0	kPa	3561	
Absolute pressure in test section before stop of flow	p_p	kPa	3293	
Max absolute pressure in test section during recovery period	p_f	kPa	3588	
Maximal pressure change during flow period	dp_p	kPa	268	

Flow data

Flow data	**Nomen-clature**	**Unit**	**Value**
Flow rate from test section just before stop of flowing	Q_p	m^3/s	$3.73 \cdot 10^{-5}$
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	$3.74 \cdot 10^{-5}$
Total volume discharged during flow period	V_p	m^3	2.6973

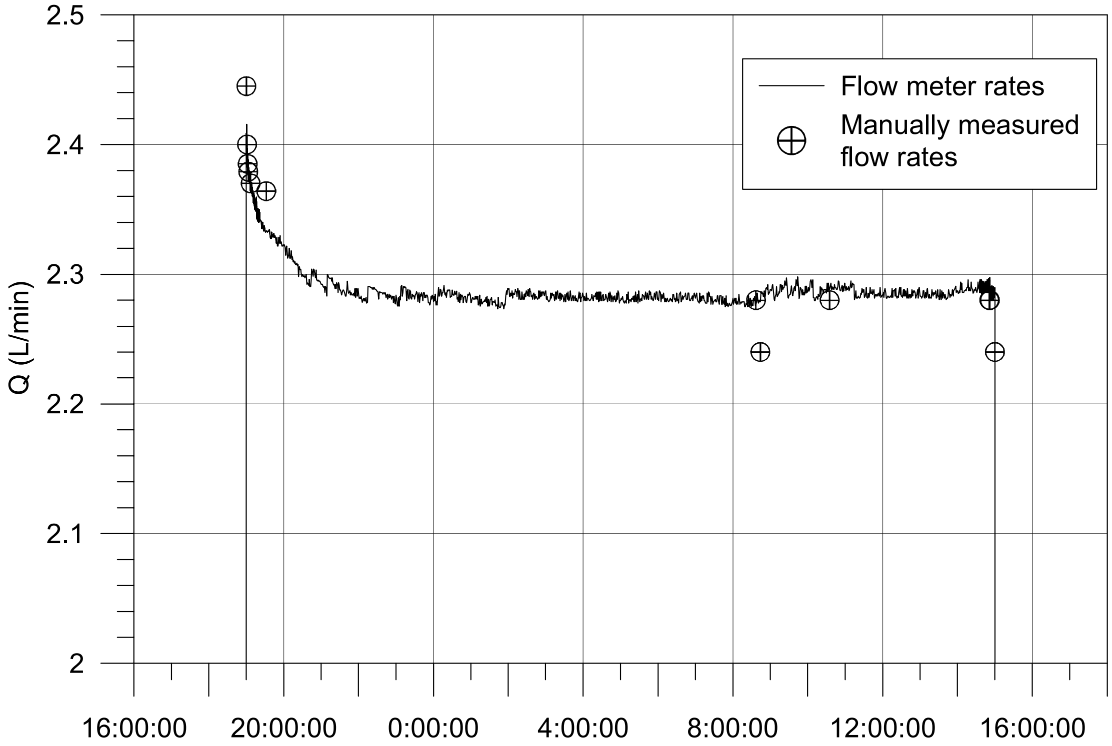


Figure 6-19 *Flow rates during draw down in KA3573A:4. Time in minutes.*

Comments to the test

The test was successful in regard to pressure responses, though the maximum response in the tests section during flow and recovery periods was approximately 170 kPa only.

Interpreted flow regimes – flowing section

0 – 0.1	minutes	Well Bore Storage (WBS)
0.1 – 0.3	minutes	Transition period
0.3 – 1.0	minutes	Radial flow period
1 – 20	minutes	Linear channel flow
20 – 200	minutes	Transition period
200 – 300	minutes	Constant pressure boundary or feature with high conductivity

Calculated parameters

Quantitative analysis was made for recovery phases in lin-log- and log-log diagrams according to the methods described in Section 5.4.1.

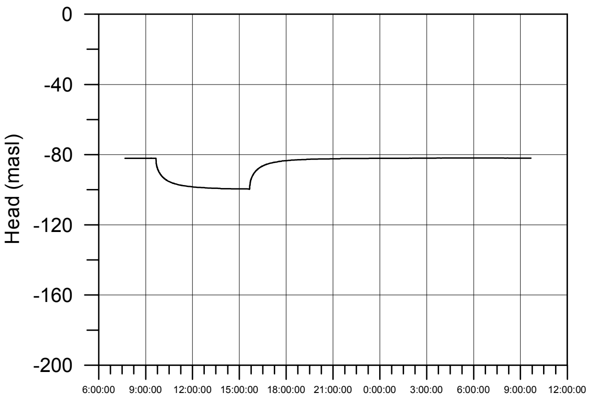
Selected representative parameters

The selected representative parameters from the test in the interval 10.50-12.50 m in KA3573A are presented in the Test Summary Sheet below. The selected parameters are derived from the recovery period.

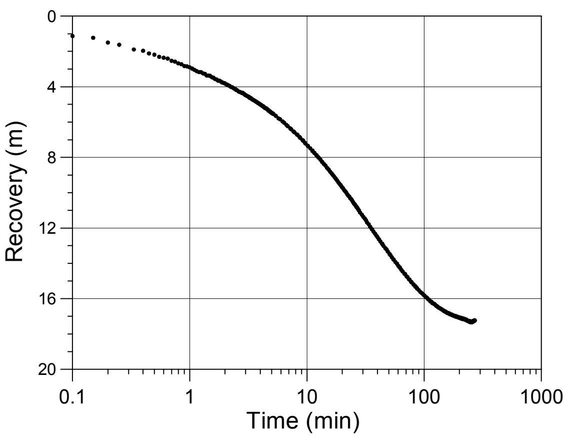
Test Summary Sheet

Project:	PROTOTYPE	Test type:	PBT
Area:	ÄSPÖ	Test no:	5:27
Borehole ID:	KA3573A	Test start:	2005-01-25 17:00
Test section (m):	10.50-12.50	Responsible for test performance:	SWECO VIAK AB J. Magnusson/A. Blom
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	SWECO VIAK AB T. Forsmark

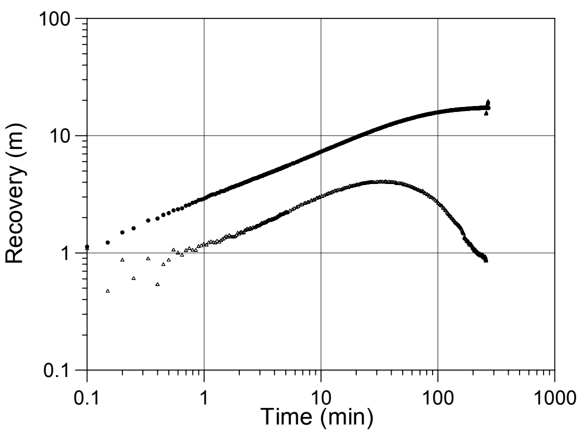
Linear plot Head



Lin-Log plot



Log-Log plot incl. derivative- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)	3561		
p_i (kPa)			
p_p(kPa)	3293	p_F (kPa)	3588
Q_p (m^3/s)	$3.73 \cdot 10^{-5}$		
tp (min)	1200	t_F (min)	3120
S*		S*	$1 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(gr C)			
Derivative fact.		Derivative fact.	0.2
Results		**Results**	
Q/s (m^2/s)	$1.4 \cdot 10^{-6}$	Flow regime:	Radial
T_{Moye}(m^2/s)	$9.7 \cdot 10^{-7}$	dt_{e1} (min)	0.3
Flow regime:		dt_{e2} (min)	1.0
dt_1 (min)		T (m^2/s)	$2.4 \cdot 10^{-6}$
dt_2 (min)		S (-)	
T (m^2/s)		K_s (m/s)	
S (-)		S_s (1/m)	
K_s (m/s)		C (m^3/Pa)	
S_s (1/m)		C_D (-)	
C (m^3/Pa)		ξ (-)	-4.8
C_D (-)			
ξ (-)			

Interpreted formation and well parameters.

Flow regime:	Radial	C (m^3/Pa)	
dt_1 (min)	0.3	C_D (-)	
dt_2 (min)	1.0	ξ (-)	-4.8
T_T (m^2/s)	$2.4 \cdot 10^{-6}$		
S (-)			
K_s (m/s)			
S_s (1/m)			

Comments: The test indicates a possible high conductivity feature during the later part of the period.

The test was carried out in KA3573A:4, section 10.50 - 12.50 metres. The flow period was for 1200 minutes with a final flow of 2.24 l/min, while the pressure build-up time was 3120 minutes. In Figure 6-20 and Figure 6-21 the r^2/t_L recordings are shown and in Table 6-20 and Table 6-21 the interference test results are presented. Diagrams of evaluated bore hole sections are presented in Appendix 7.

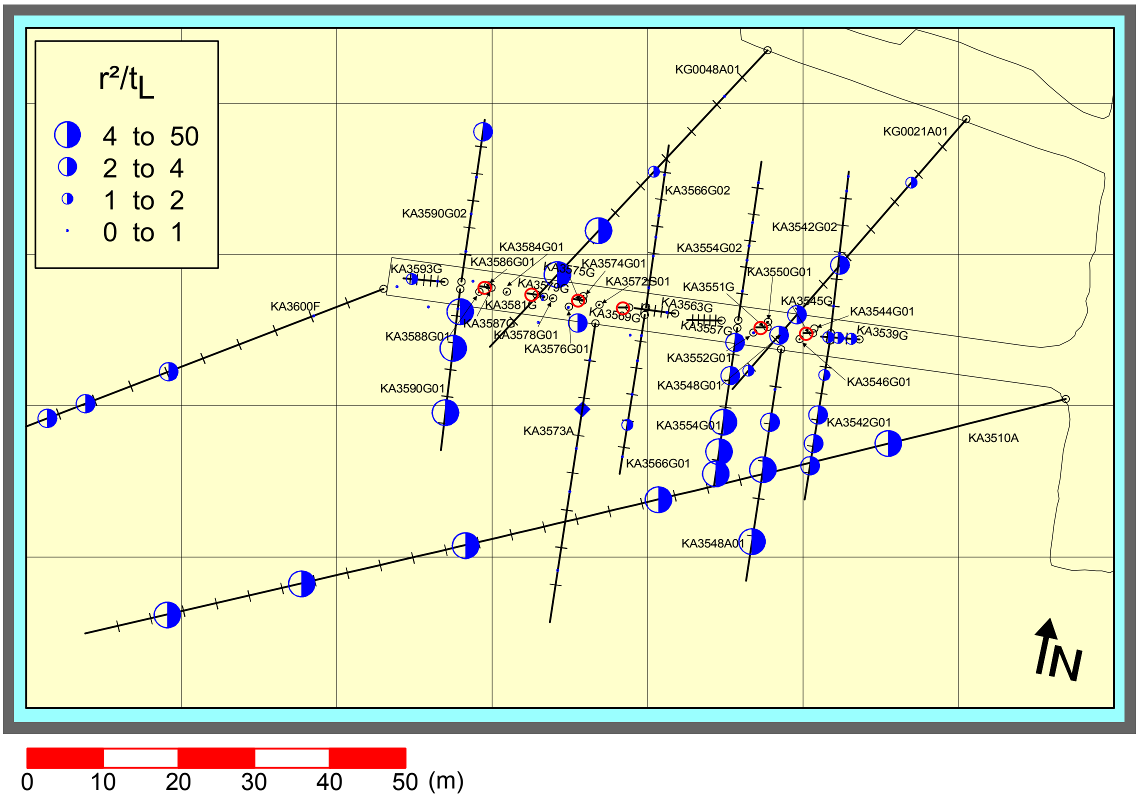


***Figure 6-20** Plot showing r^2/t_L during recovery of KA3573A:4 (Interference test 5:27) - plan view*

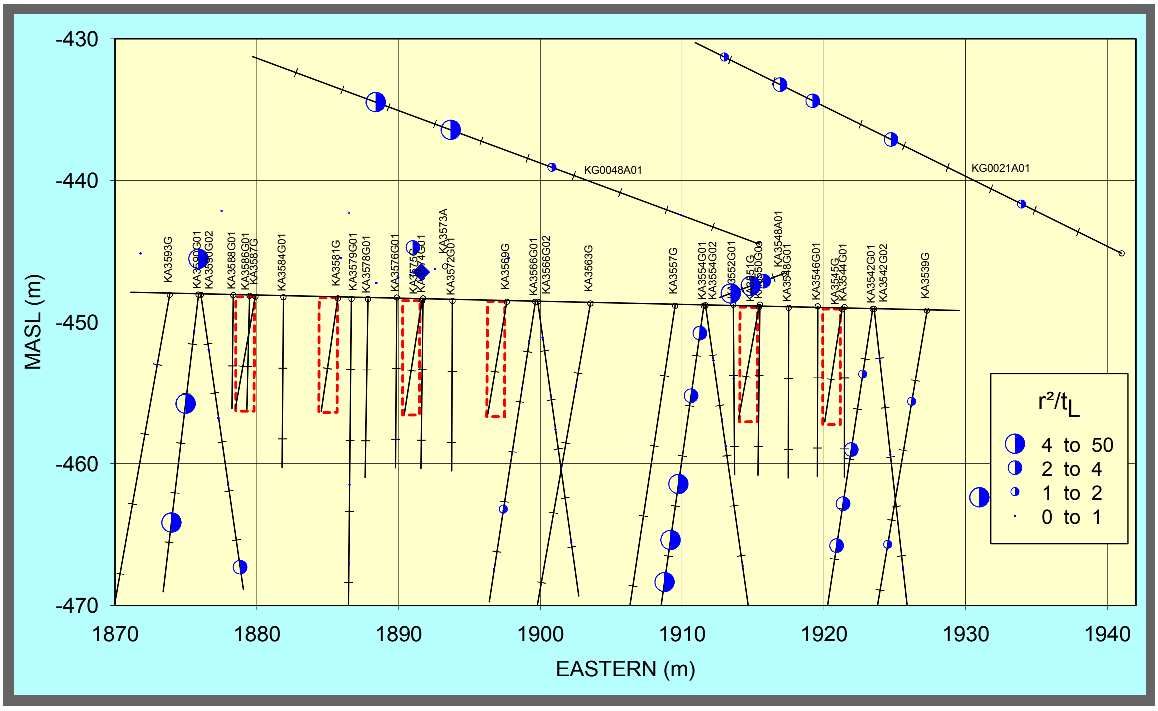


***Figure 6-21** Plot showing r^2/t_L during recovery of KA3573A:4 (Interference test 5:27) - vertical view*

This test indicates a **rather good** ($1 < r^2/t_L < 2$) hydraulic connection between the flow section and KA3593G:2, KA3566G01:2, KA3542G02:5, KA3542G01:5, KA3539G:1-2&4 KG0021A01:1 and KG0048A01:4.

A **good** ($2 < r^2/t_L < 4$) hydraulic connection is established between the flow section and KA3600F:1-3, KA3590G02:1, KA3573C01:1, KA3554G01:4&5, KA3548A01:3, KA3542 G01:2-4, KA3510A:2 & 4 and KG0021A01:2-4.

A **very good** ($4 < r^2/t_L$) hydraulic connection is apparent between the flow section and KA3590G01:1-2, KA3588C01:1, KA3554G01:1-3, KA3548A01:1-2, KA3542G01:1, KA3510A:1-5 and KG0048A01:2-3.

The transmissivity of the observation sections with $r^2/t_L > 1$, i.e. the sections mentioned above is within the range $6.9 \cdot 10^{-7} – 2.5 \cdot 10^{-5}$ m^2/s. The transmissivity of the flowing section is evaluated to be $2.4 \cdot 10^{-6}$ m^2/s with the evaluation period 0.3 – 1.0 minutes.

The flow section is located south of the repository. It has good or very good connection both westward (KA3590G01) and eastward (KA3554G01, KA3548A01 and KA3542G01). Notably only some minor hydraulic connection with the closest located borehole, KA3566G01, exists. This is in concordance with the analysis of test 5:23. The rock volume between KA3554G01 and KA3573A appears to have no hydraulic features of any magnitude.

Table 6-20 Interference test results for KA3573A, 10.50 - 12.50 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response	Po - Pp (kPa)	Pf - Pp (kPa)
KA3510A:1	125.00	150.00	137.50	92.88	4.2	34.234	1.90E+00	6.3E-06	8.2E-07	3.3E-06	2	10.4	12.7
KA3510A:2	110.00	124.00	117.00	74.35	17	5.420	4.17E-01	3.1E-06	3.5E-06	7.3E-06	2	16.4	15.3
KA3510A:3	75.00	109.00	92.00	53.71	4.2	11.448	6.34E-01	6.9E-07	8.6E-07	1.1E-06	2	91.6	94.7
KA3510A:4	51.00	74.00	62.50	36.95	2.9	7.846	4.03E-01	3.0E-06	2.2E-06	7.4E-06	2	211.0	232.3
KA3510A:5	4.50	50.00	27.25	42.70	0.75	40.516	1.64E+00	2.0E-06	3.4E-07	1.2E-06	2	225.7	251.5
KA3539G:1	18.60	30.00	24.30	42.48	29	1.037	9.24E-02	2.8E-06	1.9E-05	3.0E-05	2	50.8	60.6
KA3539G:2	15.85	17.60	16.73	39.26	20	1.284	1.03E-01	4.7E-06	2.0E-05	4.6E-05	2	51.5	60.6
KA3539G:3	10.00	14.85	12.43	37.98	26	0.924	7.99E-02	2.6E-06	1.9E-05	3.2E-05	2	46.6	54.5
KA3539G:4	4.00	9.00	6.50	36.97	22	1.035	8.55E-02	3.3E-06	2.1E-05	3.8E-05	2	48.3	55.5
KA3542G01:1	27.00	30.00	28.50	38.25	0.34	71.732	2.57E+00	2.6E-06	3.2E-07	1.0E-06	2	239.7	265.3
KA3542G01:2	21.30	26.00	23.65	35.88	6.1	3.517	2.11E-01	1.3E-06	3.3E-06	6.4E-06	2	195.4	214.8
KA3542G01:3	18.60	20.30	19.45	34.25	5.4	3.620	2.12E-01	1.6E-06	3.5E-06	7.4E-06	2	186.0	203.9
KA3542G01:4	10.50	17.60	14.05	32.82	8.2	2.190	1.41E-01	1.7E-06	5.8E-06	1.2E-05	2	187.7	206.1
KA3542G01:5	3.50	9.50	6.50	32.28	15	1.158	8.63E-02	8.5E-06	3.1E-05	9.8E-05	1	7.1	27.4
KA3542G02:1	28.20	30.01	29.11	51.43	200	0.220	3.44E-02	3.9E-07	2.1E-05	1.1E-05	2	21.3	25.3
KA3542G02:2	25.60	27.20	26.40	49.31	170	0.238	3.56E-02	4.4E-07	2.1E-05	1.2E-05	2	25.8	31.7
KA3542G02:3	21.50	24.60	23.05	46.79	-	-	-	-	-	-	0	0.0	8.6
KA3542G02:4	9.00	20.50	14.75	41.04	120	0.234	3.16E-02	6.3E-07	3.0E-05	2.0E-05	2	37.4	45.0
KA3542G02:5	2.00	8.00	5.00	35.61	22	0.961	7.93E-02	9.3E-07	1.4E-05	1.2E-05	2	45.9	54.8
KA3543A01:1	0.65	2.06	1.36	29.63	-	-	-	-	-	-	0	0.2	0.4
KA3543I01:1	0.65	2.06	1.36	31.87	-	-	-	-	-	-	0	0.2	0.4
KA3544G01:1	11.65	12.00	11.83	34.79	-	-	-	-	-	-	0	-0.2	8.8
KA3544G01:2	8.90	10.65	9.78	33.99	-	-	-	-	-	-	0	-0.2	9.1
KA3544G01:3	3.50	7.90	5.70	32.74	-	-	-	-	-	-	0	0.0	8.9
KA3546G01:1	9.30	12.00	10.65	32.20	-	-	-	-	-	-	0	-11.5	19.4
KA3546G01:2	6.75	8.30	7.53	31.08	-	-	-	-	-	-	0	0.5	14.8
KA3546G01:3	1.50	5.75	3.63	30.06	-	-	-	-	-	-	0	-5.6	6.6
KA3548A01:1	21.50	30.00	25.75	28.02	0.51	25.656	9.76E-01	4.5E-06	9.6E-07	4.6E-06	2	221.0	242.0
KA3548A01:2	11.75	20.50	16.13	24.59	0.88	11.448	4.75E-01	3.6E-06	2.7E-07	7.6E-06	2	244.4	270.0
KA3548A01:3	8.80	10.75	9.78	24.22	3	3.259	1.68E-01	2.0E-06	4.5E-06	1.2E-05	2	194.8	213.7
KA3548A01:4	3.00	7.80	5.40	24.93	12	0.863	6.08E-02	5.5E-07	7.4E-06	9.0E-06	2	158.8	177.8
KA3548D01:1	0.65	2.06	1.36	30.30	-	-	-	-	-	-	0	0.0	0.2
KA3548G01:1	6.00	12.00	9.00	30.18	-	-	-	-	-	-	0	-21.1	8.0
KA3548G01:2	2.00	5.00	3.50	28.55	-	-	-	-	-	-	0	-12.1	25.6
KA3550G01:1	8.30	12.03	10.17	29.21	-	-	-	-	-	-	0	-1.0	8.2
KA3550G01:2	5.20	7.30	6.25	27.81	-	-	-	-	-	-	0	-1.0	8.0
KA3550G01:3	1.80	4.20	3.00	27.03	-	-	-	-	-	-	0	-1.2	8.2
KA3550G05:1	1.50	3.00	2.25	30.30	-	-	-	-	-	-	0	-1.2	3.1
KA3551G05:1	1.50	3.10	2.30	25.09	-	-	-	-	-	-	0	-1.2	7.8
KA3552A01:1	0.65	2.06	1.36	21.23	-	-	-	-	-	-	0	-0.2	0.4
KA3552G01:1	7.05	12.00	9.53	27.00	-	-	-	-	-	-	0	-3.9	8.0
KA3552G01:2	4.35	6.05	5.20	25.39	125	0.086	1.18E-02	1.6E-06	1.6E-04	1.4E-04	1	3.3	17.2
KA3552G01:3	1.50	3.35	2.43	24.70	-	-	-	-	-	-	1	3.1	1.0
KA3552H01:1	0.65	2.10	1.38	23.03	-	-	-	-	-	-	0	0.2	0.6
KA3553B01:1	0.65	2.02	1.34	25.69	-	-	-	-	-	-	0	-1.6	7.6
KA3554G01:1	25.15	30.01	27.58	29.09	0.3	47.007	1.66E+00	3.0E-06	4.3E-07	1.8E-06	2	240.4	265.8
KA3554G01:2	22.60	24.15	23.38	26.42	0.49	23.745	8.98E-01	2.1E-06	6.3E-07	2.4E-06	2	240.1	265.5
KA3554G01:3	14.00	21.60	17.80	23.57	2	4.631	2.21E-01	3.0E-06	4.1E-06	1.3E-05	2	201.4	223.5
KA3554G01:4	5.00	13.00	9.00	21.40	2.1	3.636	1.75E-01	4.0E-06	6.0E-06	2.3E-05	2	194.3	218.7
KA3554G01:5	1.50	4.00	2.75	21.97	2.6	3.094	1.56E-01	1.3E-05	1.1E-05	8.7E-05	2	31.1	42.6
KA3554G02:1	22.00	30.01	26.01	42.93	88	0.349	4.31E-02	4.9E-07	1.6E-05	1.1E-05	2	43.4	50.8
KA3554G02:2	15.90	21.00	18.45	36.42	43	0.514	5.13E-02	3.5E-06	3.7E-05	6.9E-05	2	43.8	53.6
KA3554G02:3	13.20	14.90	14.05	32.84	34	0.529	4.93E-02	5.5E-06	4.4E-05	1.1E-04	2	44.2	53.6
KA3554G02:4	10.50	12.20	11.35	30.75	29	0.544	4.84E-02	2.6E-06	3.3E-05	5.4E-05	2	45.0	55.0
KA3554G02:5	1.50	9.50	5.50	26.61	60	0.197	2.17E-02	4.1E-07	2.4E-05	1.9E-05	2	56.5	59.7
KA3557G:1	15.00	30.04	22.52	30.97	-	-	-	-	-	-	0	-3.7	0.8
KA3557G:2	1.50	14.00	7.75	22.79	-	-	-	-	-	-	0	-1.6	0.6
KA3563A01:1	0.65	2.06	1.36	13.15	-	-	-	-	-	-	0	-0.2	0.3
KA3563D01:1	0.65	2.01	1.33	19.72	-	-	-	-	-	-	0	-18.0	22.4
KA3563G:1	15.00	30.01	22.51	28.88	-	-	-	-	-	-	0	-3.4	1.0
KA3563G:2	10.00	13.00	11.50	21.22	-	-	-	-	-	-	0	-0.7	0.2
KA3563G:3	4.00	8.00	6.00	18.68	40	0.145	1.42E-02	3.0E-07	2.8E-05	2.1E-05	2	77.7	89.9
KA3563G:4	1.50	3.00	2.25	17.74	-	-	-	-	-	-	0	-0.2	6.9
KA3563I01:1	0.65	2.15	1.40	16.52	-	-	-	-	-	-	0	-1.5	4.9
KA3566C01:1	0.65	2.1	1.38	11.61	17	0.132	1.02E-02	2.0E-06	1.1E-04	1.9E-04	1	1.7	20.9

Table 6-21 Interference test results for KA3573A, 10.50 - 12.50 m. (r = aprox. distance from flowing bore hole section to observation bore hole section, t_L = time lag for a pressure response of 0.1 m to be registered in an observation section, T = transmissivity, S = storage coefficient, S^* = storage coefficient from diffusivity, η.) The drawdown response is classified as 0 = no response (< 0.1 m), 1 = some response (0.1 m - 1.0 m) and 2 = good response (> 1.0 m).

Observation borehole	Secup (m)	Seclow (m)	Mid-section (m)	r (m)	t_L (recovery) (min)	r^2/t_L (m²/s)	η (m²/s)	T_{EVAL} (m²/s)	S (-)	S^* (-)	Response (0 = no, 1 = some, 2 =good response)	Po - Pp (kPa)	Pf - Pp (kPa)
KA3566G01:1	23.50	30.01	26.76	22.48	62	0.136	1.51E-02	1.6E-06	9.5E-05	1.0E-04	2	40.3	35.9
KA3566G01:2	20.00	21.50	20.75	17.82	4.2	1.261	6.98E-02	3.0E-06	1.5E-05	4.2E-05	2	87.6	95.5
KA3566G01:3	12.00	18.00	15.00	14.34	11	0.312	2.15E-02	1.1E-06	3.5E-05	5.3E-05	2	65.9	71.8
KA3566G01:4	7.30	10.00	8.65	12.60	20	0.132	1.06E-02	1.5E-06	9.6E-05	1.4E-04	2	72.2	88.0
KA3566G01:5	1.50	6.30	3.90	13.28	75	0.039	4.61E-03	4.0E-07	1.1E-04	8.6E-05	2	70.7	65.8
KA3566G02:1	19.00	30.10	24.55	37.94	70	0.343	3.95E-02	5.5E-07	1.7E-05	1.4E-05	2	40.4	52.9
KA3566G02:2	16.00	18.00	17.00	30.76	40	0.394	3.85E-02	5.5E-07	1.6E-05	1.4E-05	2	61.5	67.0
KA3566G02:3	12.00	14.00	13.00	27.04	75	0.163	1.91E-02	3.0E-07	2.3E-05	1.6E-05	2	55.1	61.2
KA3566G02:4	8.00	11.00	9.50	23.85	180	0.053	7.99E-03	1.6E-07	3.8E-05	2.0E-05	2	43.8	51.4
KA3566G02:5	1.30	6.00	3.65	18.79	330	0.018	3.15E-03	-	-	-	1	5.2	16.3
KA3568D01:1	0.65	2.30	1.48	18.08	-	-	-	-	-	-	0	0.2	0.2
KA3572G01:1	7.30	12.03	9.67	18.21	-	-	-	-	-	-	0	-0.2	2.9
KA3572G01:2	2.70	5.30	4.00	15.23	-	-	-	-	-	-	0	0.0	4.7
KA3573A:1	26.00	40.07	33.04	21.54	8	0.966	6.17E-02	6.4E-06	3.0E-05	1.0E-04	2	31.5	28.5
KA3573A:2	21.00	24.00	22.50	11.01	3	0.673	3.48E-02	4.6E-06	3.7E-05	1.3E-04	2	81.1	80.2
KA3573A:3	14.50	19.00	16.75	5.25	2.3	0.200	9.81E-03	1.9E-05	2.1E-04	1.9E-03	2	100.0	102.5
KA3573A:4	**10.50**	**12.50**	**11.50**	**0.00**	-	-	-	-	-	-	2	268.6	295.1
KA3573A:5	1.30	8.50	4.90	6.59	7	0.104	6.41E-03	3.4E-06	2.4E-04	5.3E-04	2	23.4	25.3
KA3573C01:1	0.65	2.05	1.35	11.56	0.58	3.840	1.49E-01	1.3E-05	1.1E-05	8.7E-05	2	150.6	167.5
KA3574D01:1	0.65	2.05	1.35	17.42	-	-	-	-	-	-	0	-0.7	2.0
KA3574G01:1	8.00	12.03	10.02	19.07	-	-	-	-	-	-	0	0.2	0.2
KA3574G01:2	5.10	7.00	6.05	16.90	-	-	-	-	-	-	0	0.0	0.0
KA3574G01:3	1.80	4.10	2.95	15.71	-	-	-	-	-	-	0	-2.2	2.2
KA3576G01:1	8.00	12.01	10.01	17.99	30	0.180	1.62E-02	-	-	-	1	5.7	1.7
KA3576G01:2	4.00	6.00	5.00	15.23	-	-	-	-	-	-	0	0.0	0.2
KA3576G01:3	1.30	3.00	2.15	14.22	-	-	-	-	-	-	0	0.5	0.2
KA3578C01:1	0.65	2.09	1.37	12.84	11	0.250	1.72E-02	3.9E-06	9.8E-05	2.2E-04	2	17.2	19.0
KA3578G01:1	6.50	12.58	9.54	18.99	-	-	-	-	-	-	1	6.4	0.7
KA3578G01:2	4.30	5.50	4.90	16.61	-	-	-	-	-	-	0	0.5	0.2
KA3578H01:1	0.65	1.90	1.28	15.94	11.5	0.368	2.57E-02	3.9E-06	6.0E-05	1.5E-04	2	68.6	74.3
KA3579D01:1	0.65	2.00	1.33	18.60	-	-	-	-	-	-	0	-0.5	0.2
KA3579G:1	14.70	22.65	18.68	25.97	38	0.296	2.85E-02	-	-	-	0	0.7	2.5
KA3579G:2	12.50	13.70	13.10	21.78	19	0.416	3.30E-02	-	-	-	1	1.5	2.0
KA3579G:3	2.30	11.50	6.90	18.03	-	-	-	-	-	-	1	1.2	0.2
KA3584G01:1	7.00	12.00	9.50	21.48	-	-	-	-	-	-	1	5.7	0.2
KA3584G01:2	1.30	5.00	3.15	18.97	-	-	-	-	-	-	0	-0.2	0.5
KA3588C01:1	0.65	2.04	1.35	20.36	1.4	4.936	2.21E-01	2.1E-06	3.2E-06	9.6E-06	2	63.6	73.7
KA3588D01:1	0.65	1.90	1.28	23.20	-	-	-	-	-	-	0	-0.5	2.0
KA3588I01:1	0.65	1.96	1.31	22.44	58	0.145	1.58E-02	2.3E-05	2.2E-04	1.4E-03	1	2.7	3.9
KA3590G01:1	16.00	30.00	23.00	24.96	0.95	10.934	4.59E-01	1.9E-06	1.3E-06	4.1E-06	2	189.3	211.7
KA3590G01:2	7.00	15.00	11.00	20.68	0.9	7.920	3.29E-01	2.5E-06	2.1E-06	7.5E-06	2	189.7	211.9
KA3590G01:3	1.30	6.00	3.65	21.22	10	0.750	5.05E-02	3.1E-06	2.4E-05	6.0E-05	2	46.0	50.5
KA3590G02:1	25.50	30.01	27.76	44.11	16	2.027	1.54E-01	1.5E-06	5.7E-06	9.6E-06	2	71.0	75.0
KA3590G02:2	15.20	23.50	19.35	36.80	29	0.778	6.93E-02	5.7E-07	8.1E-06	8.2E-06	2	66.4	70.1
KA3590G02:3	11.90	13.20	12.55	31.29	170	0.096	1.43E-02	4.4E-07	5.0E-05	3.0E-05	2	25.8	29.8
KA3590G02:4	1.30	9.90	5.60	26.28	72	0.160	1.86E-02	3.0E-06	1.2E-04	1.6E-04	1	9.6	3.7
KA3592C01:1	0.65	2.01	1.33	24.03	470	0.020	3.91E-03	-	-	-	0	0.5	2.0
KA3593G:1	25.20	30.02	27.61	40.46	-	-	-	-	-	-	0	0.0	0.5
KA3593G:2	23.50	24.20	23.85	37.50	17.5	1.339	1.04E-01	8.1E-07	6.4E-06	7.8E-06	2	57.0	62.4
KA3593G:3	9.00	22.50	15.75	31.71	-	-	-	-	-	-	1	2.7	0.7
KA3593G:4	3.00	7.00	5.00	26.00	110	0.102	1.35E-02	9.4E-07	8.7E-05	7.0E-05	2	25.3	29.5
KA3597D01:1	0.65	2.22	1.44	29.74	-	-	-	-	-	-	0	-0.5	1.0
KA3597H01:1	0.65	2.06	1.36	29.19	23	0.617	5.16E-02	3.2E-06	3.1E-05	6.1E-05	2	12.5	14.7
KA3600F:1	43.00	50.10	46.55	68.86	39	2.026	1.97E-01	3.4E-06	9.9E-06	1.7E-05	2	17.2	13.8
KA3600F:2	40.50	42.00	41.25	63.93	29	2.349	2.09E-01	4.2E-06	1.1E-05	2.0E-05	2	17.7	14.0
KA3600F:3	20.00	39.50	29.75	53.46	13	3.664	2.63E-01	4.8E-06	6.6E-06	1.8E-05	2	27.1	23.9
KA3600F:4	1.30	18.00	9.65	36.70	46	0.488	4.97E-02	3.6E-07	9.7E-06	7.3E-06	2	74.7	78.4
KG0021A01:1	42.50	48.82	45.66	26.71	7	1.699	1.05E-01	3.6E-06	1.3E-05	3.4E-05	2	119.1	129.9
KG0021A01:2	37.00	41.50	39.25	30.19	4.3	3.532	1.97E-01	3.5E-06	7.4E-06	1.8E-05	2	106.2	116.1
KG0021A01:3	35.00	36.00	35.50	32.63	8	2.219	1.42E-01	3.0E-06	1.0E-05	2.1E-05	2	76.3	80.5
KG0021A01:4	19.00	34.00	26.50	39.36	7.7	3.354	2.12E-01	3.5E-06	7.0E-06	1.6E-05	2	67.6	70.8
KG0021A01:5	5.00	18.00	11.50	52.11	26	1.741	1.50E-01	3.9E-06	1.3E-05	2.6E-05	2	31.0	32.2
KG0048A01:1	49.00	54.69	51.85	20.45	-	-	-	-	-	-	-		
KG0048A01:2	34.8	48	41.40	21.72	0.54	14.563	5.59E-01	2.5E-05	2.6E-06	4.4E-05	2	156.8	172.3
KG0048A01:3	32.80	33.80	33.30	25.75	1.7	6.500	3.02E-01	4.0E-06	3.3E-06	1.3E-05	2	134.8	146.3
KG0048A01:4	13.00	31.80	22.40	33.59	10.3	1.825	1.24E-01	2.6E-06	9.7E-06	2.1E-05	2	72.0	75.9
KG0048A01:5	5.00	12.00	8.50	45.44	66	0.522	5.91E-02	7.4E-07	1.6E-05	1.3E-05	2	32.6	33.6

6.3 Hydraulic diffusivity

The diffusivity, η, versus the distance, r, and the time lag versus the distance, r, are shown in Figure 6-22 below. Data are from all 7 interference tests performed during this test campaign.

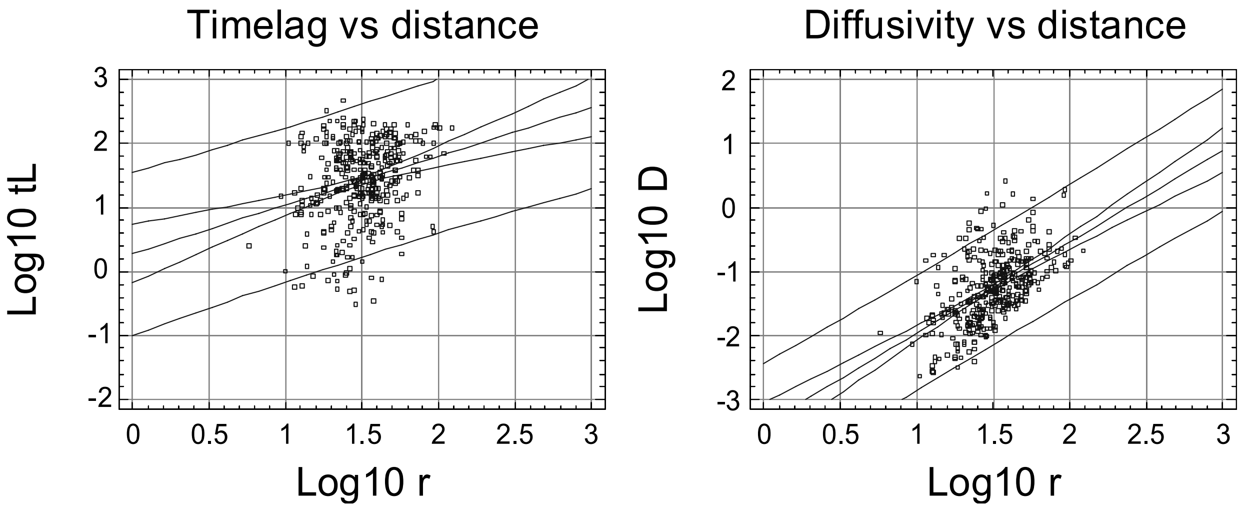


Figure 6-22 *Linear regression plots of time lag and diffusivity versus distance. Distance r in meters and t_L in minutes.*

The equations of the regression lines in *Figure 6-22* are

$$\text{Log}_{10}\, t_L = 0.763 * \text{Log}_{10}\, r + 0.279$$

$$\text{Log}_{10}\, \eta = 1.428 * \text{Log}_{10}\, r - 3.392$$

The apparent increase of diffusivity by distance in Figure 6-22 is probably not entirely relevant. As part of the flow is more spherical than radial the time lag should increase by distance. It is however probable that some feature with high transmissivity is involved at larger distances from the source that can partly justify a linear trend. Possibly the most relevant estimates of diffusivity is for short distances, which may be up to around 10 metres. According to this the range for the diffusivity should be 0.001 – 0.1 m^2/s. However, from earlier experiences it is known that the diffusivity may become closer to 1 m^2/s for increasing transmissivities (*Rhén et al, 1997*).

6.4 Storativity

The storativity is not always received from a hydraulic test. In order to estimate an approximate value of the parameter a relationship between the evaluated transmissivity T_{EVAL} and the evaluated storativity S is established from the seven evaluated interference tests 5:21-5:27. The results are shown in Figure 6-23. The evaluated relations between T and S should be seen as indications or possible ranges for S.

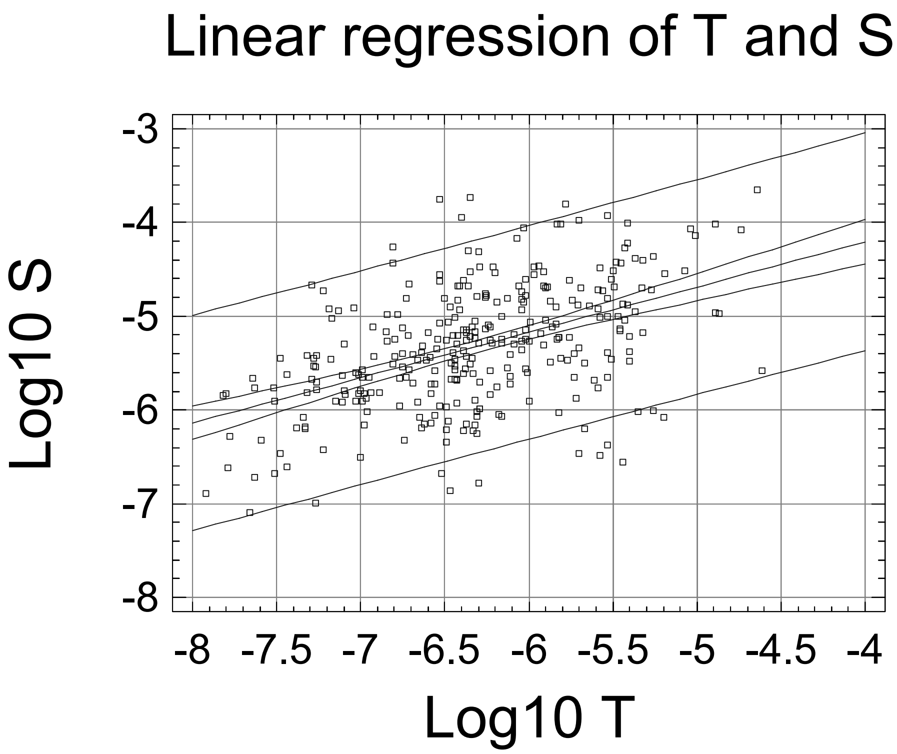


Figure 6-23 *Linear regression of T_{EVAL} and S. Transmissivity in m^2/s.*

The equation of the regression line in Figure 6-23 is

$$Log_{10}\ S = 0.483 * Log_{10}\ T_{EVAL} - 2.272$$

The relationship between T_{EVAL} and the storativity estimated from the diffusivity, η, is shown in Figure 6-24. Results from all seven tests 5:21 to 5:27 are included.

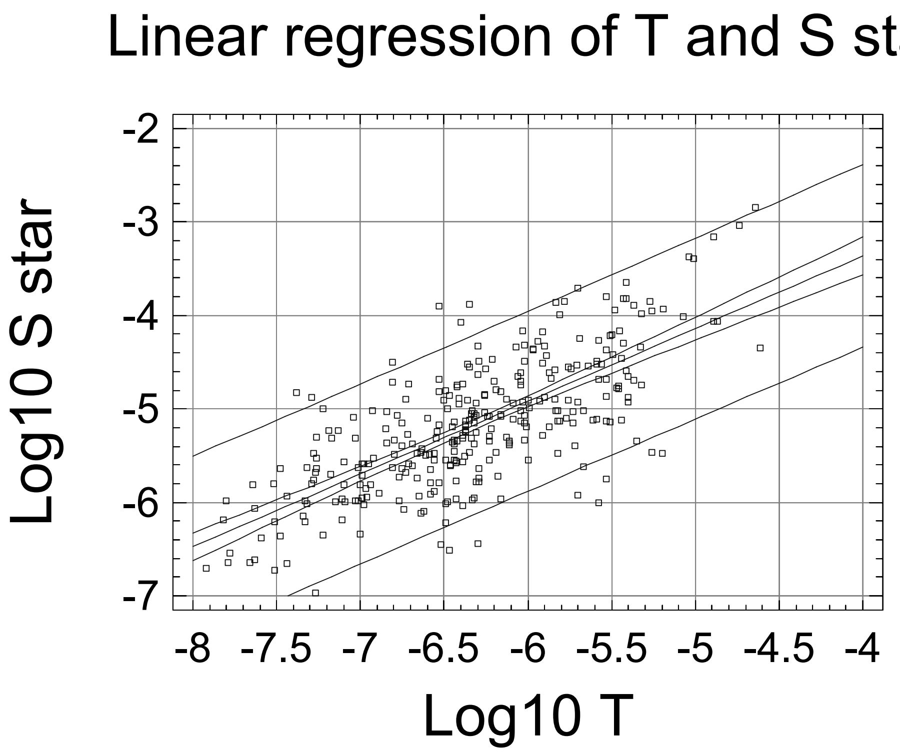


Figure 6-24 *Linear regression of* T_{EVAL} *and S*. Transmissivity in* m^2/s.

The equation of the regression line in Figure 6-24 is

$$\mathrm{Log}_{10}\, S^* = 0.778 * \mathrm{Log}_{10}\, T - 0.250$$

6.5 Deformation measurements

Deformation measurements started 2003-05-06. Results of these will be presented in a separate report.

References

Alm P, Forsmark T, Rhen I, 2005. Äspö HRL – Prototype repository – Installations for measurements of flow into tunnels, water pressure in rock and hydro mechanical responses in boreholes during operation phase. SKB IPR-05-04.

Forsmark T, Rhén I, 1999. Äspö HRL - Prototype repository Hydrogeology – Interference test campaign 1 after drill campaign 3. SKB IPR-00-07.

Forsmark T, Rhén I, 2000. Äspö HRL - Prototype repository Hydrogeology – Interference test campaign 2 after drill campaign 3. SKB IPR-00-21.

Forsmark T, Forsman I, Rhén I, 2004. Äspö HRL - Prototype repository – Hydraulic tests and displacement measurements during operation phase. Test campaign 1 – Interference tests. SKB IPR-04-16.

Forsmark T, Rhén I, 2004a. Äspö HRL - Prototype repository – Hydraulic tests and displacement measurements during operation phase. Test campaign 1 – Single hole tests. SKB IPR-04-17.

Forsmark T, Rhén I, 2004b. Äspö HRL - Prototype repository – Hydraulic tests and displacement measurements during operation phase. Test campaign 2 – Single hole tests. SKB IPR-04-18.

Forsmark T, Rhén I, 2004c. Äspö HRL - Prototype repository – Hydraulic tests and displacement measurements during operation phase. Test campaign 3 – Single hole tests. SKB IPR-04-19.

Forsmark T, Rhén I, 2005a. Äspö HRL - Prototype repository – Hydraulic tests and displacement measurements during operation phase. Test campaign 4 – Single hole tests. SKB IPR-05-02.

Forsmark T, Rhén I, 2005b. Äspö HRL - Prototype repository – Hydraulic tests and displacement measurements during operation phase. Test campaign 5 – Single hole tests. SKB IPR-05-17.

Rhén I, Gustafsson G, Stanfors R, Wikberg P, 1997. Äspö HRL – Geoscientific evaluation 1997/5. Models based on site characterization 1986 – 1995. SKB TR-97-06.

Spane F A, Wurstner S K, 1993. DERIV: A computer program for calculating pressure derivatives for use in hydraulic tests. Groundwater Vol 31, No. 5, pp 814 – 822.

Streltsova T D, 1988. Well testing in heterogeneous formations. Exxon Monograph Series.

APPENDIX 1

Interference test 5:21 in borehole KA3539G, section 15.85 m – 17.60 m

Date: 2005-01-20
Field Crew: A. Blom / J. Magnusson
Borehole length: 30.01 m
Borehole diameter: 76 mm

Flowing borehole: KA3539G, section #2: 15.85 – 17.60 m

Valve opened: 20050120 15:30.00 Valve closed: 20050120 21:30.00

End of Test: 20050121 15:30

Total flowing time : 360 min Tot. Pr. Build-up time: 1080 min.

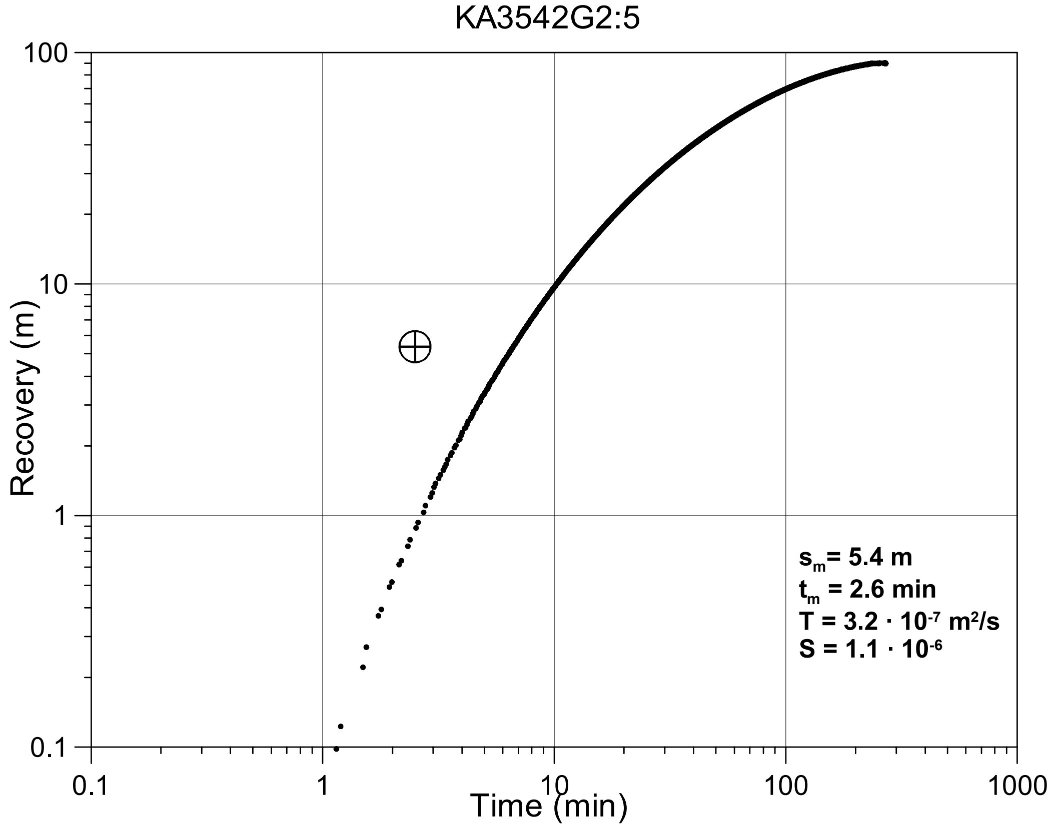
The test was performed as an Interference test. Pressure responses were monitored in 132 borehole sections including the flow section.

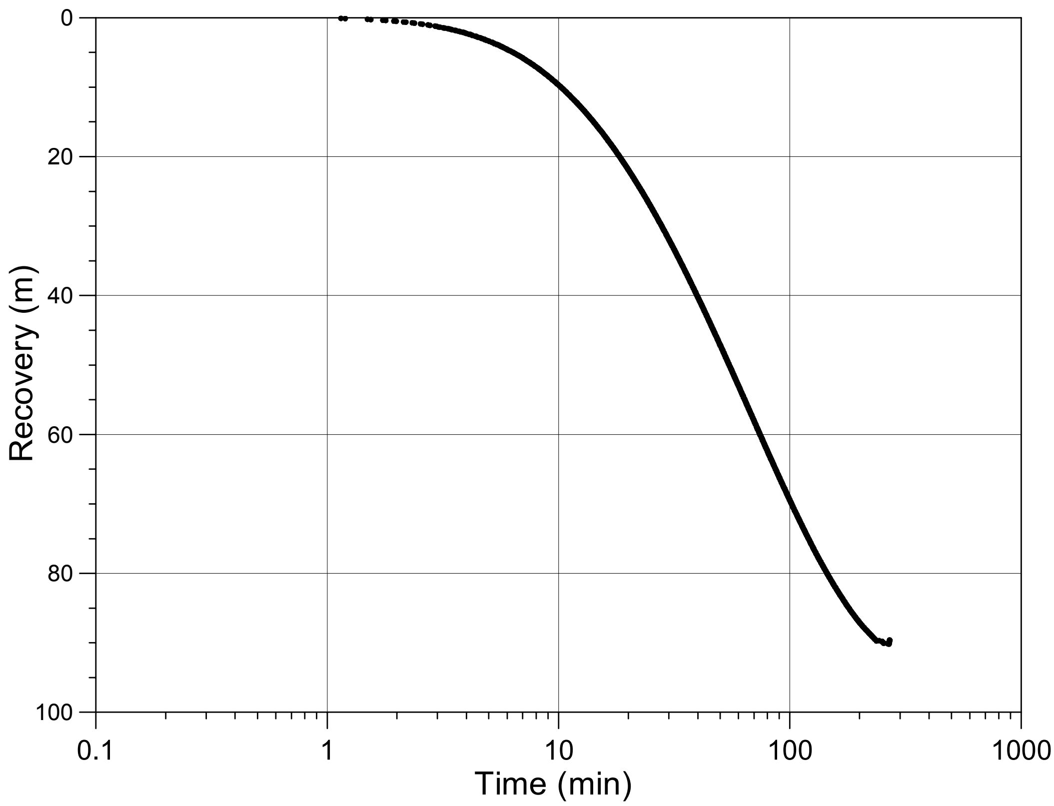
Flow data
Manually measured flow rates of KA3539G, section 15.85 m – 17.60 m are presented in the table below:

Table Manually measured flow rates, Interference test in KA3539G, section 15.85 m – 17.60 m. Prototype Repository, January 20 2005

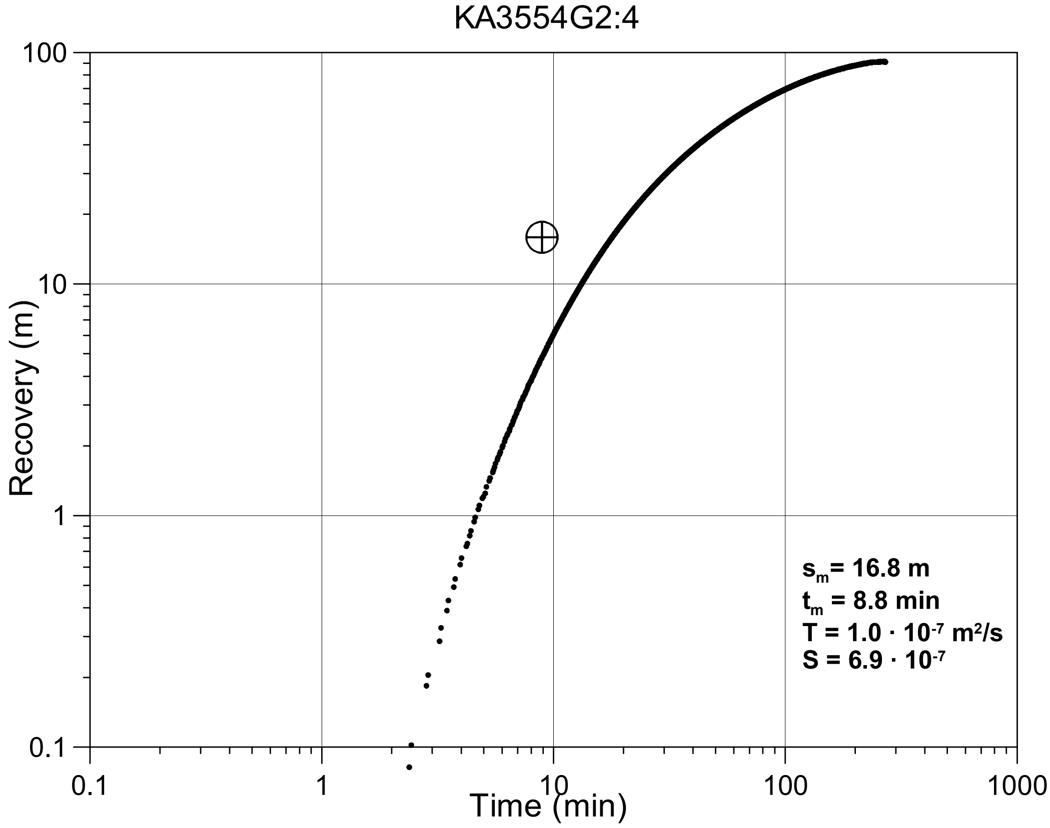
Time	Flow rate (l/min)
15:30:10	
15:31:10	2.49
15:32:10	2.43
15:43:00	2.4
15:44:15	2.112
15:45:30	2.064
16:00:40	2.04
16:02:00	1.81
16:03:20	1.8
18:31:00	1.78
18:32:30	1.35
21:14:50	1.37
21:16:30	1.32
21:18:20	1.32
21:30:00	1.32

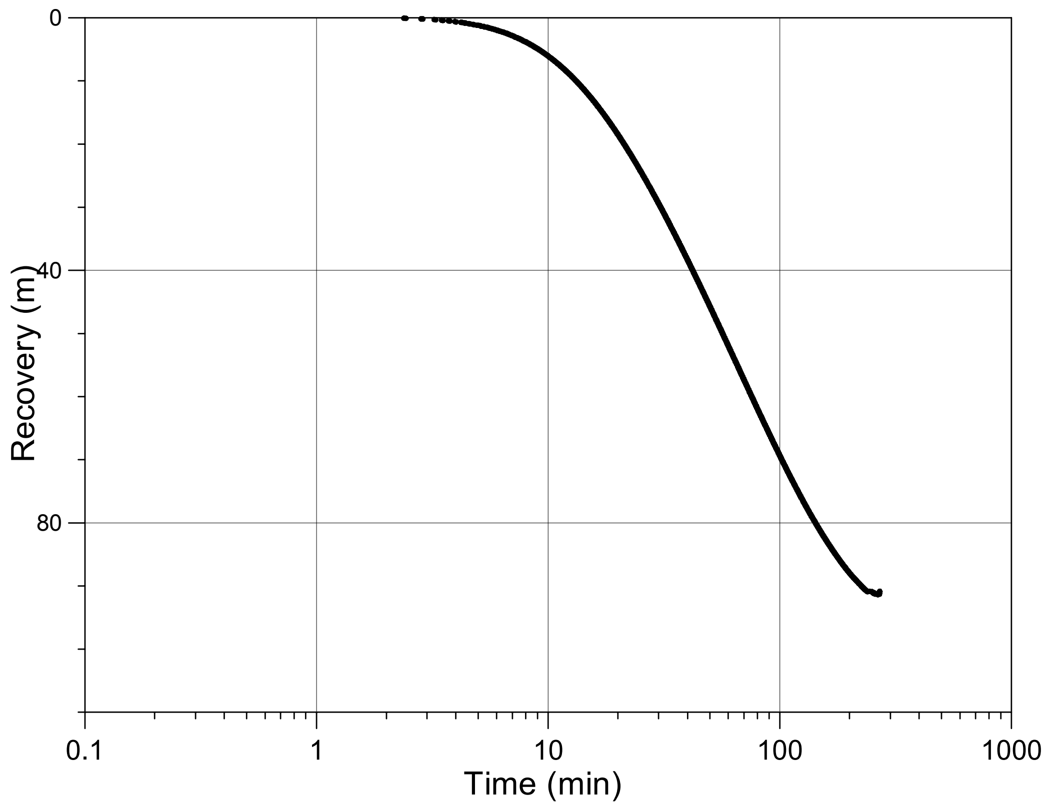
In all cases the matchpoint used is consistent with $p_D = 1$ and $t_D = 1$.





21_KA3542G2_5.GRF 2005-06-09





21_KA3554G2_4.GRF 2005-06-09

APPENDIX 2

Interference test 5:22 in borehole KA3542G02, section 2.00 m – 8.00 m

Date: 2005-01-24 Field Crew: A. Blom / J. Magnusson
Borehole length: 30.01 m Borehole diameter: 76 mm

Flowing borehole: KA3542G02, section 5: 2.00 – 8.00 m

Valve opened: 20050124 15:00.00 Valve closed: 20050124 21:00.00

End of Test: 20050125 15:00

Total flowing time : 360 min Tot. Pr. Build-up time: 1080 min.

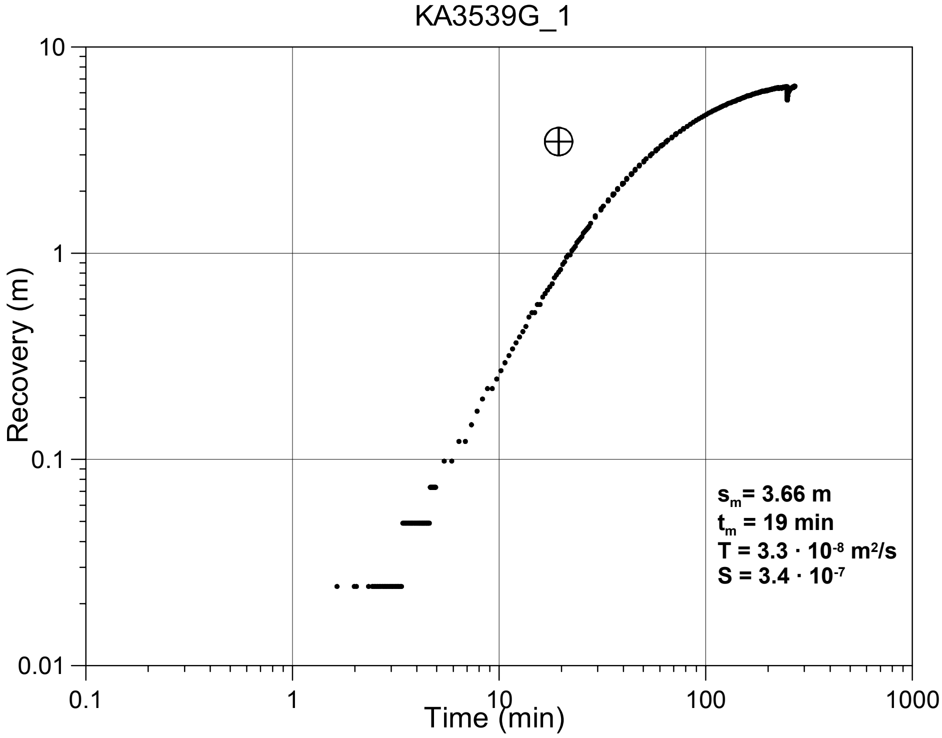
The test was performed as an Interference test. Pressure responses were monitored in 132 borehole sections including the flow section.

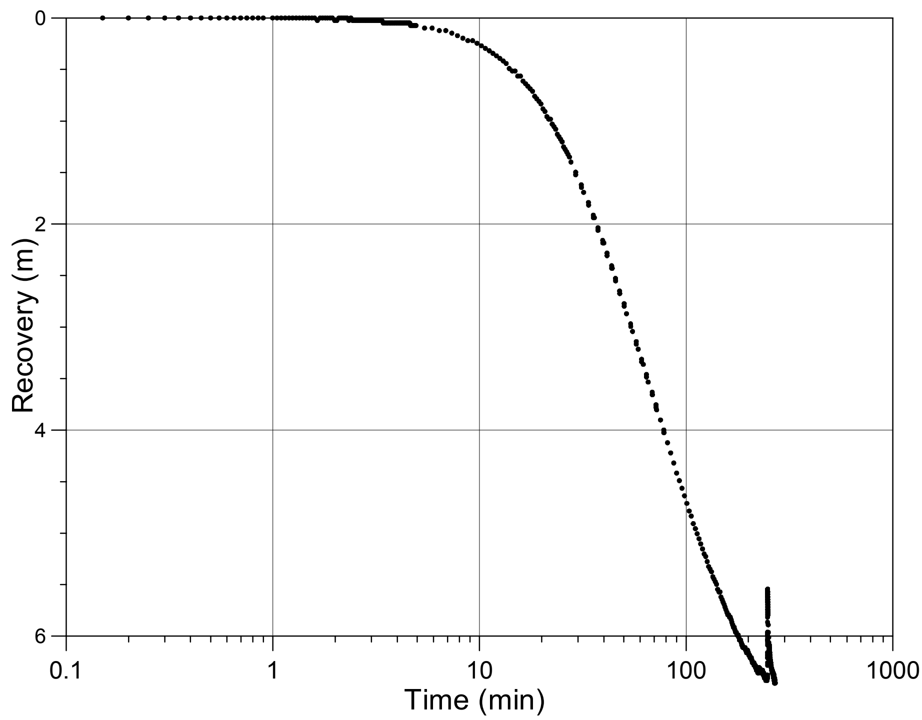
Flow data
Manually measured flow rates of KA3542G02, section 2.00 m – 8.00 m are presented in the table below:

Table Manually measured flow rates, Interference test in KA3542G02, section 2.00 m – 8.00 m. Prototype Repository, January 24 2005

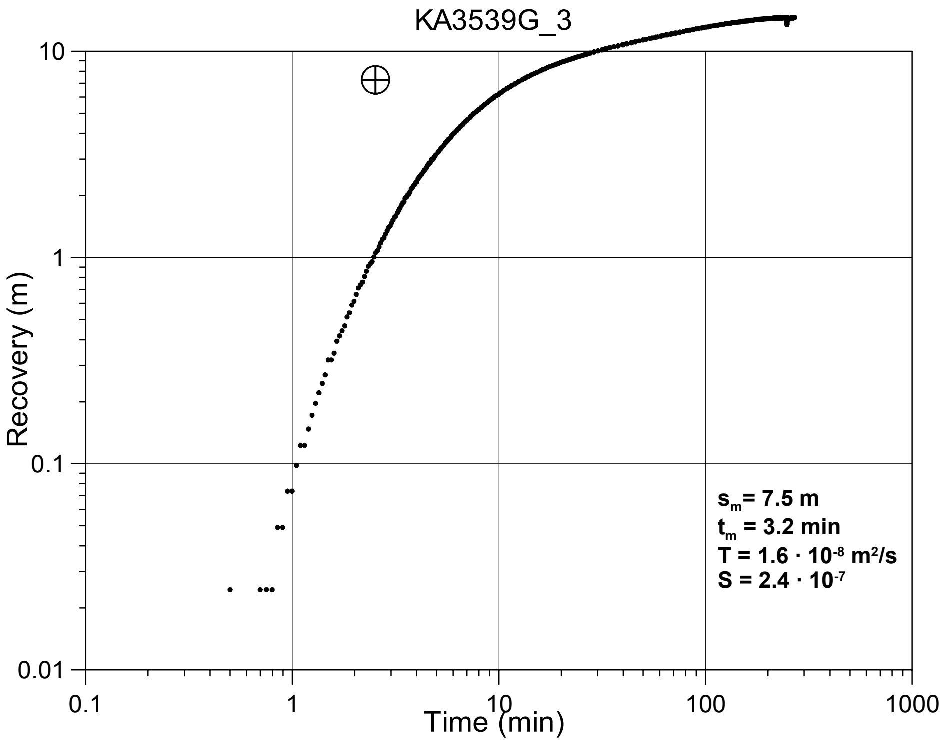
Time	Flow rate (l/min)
15:00:10	1.43E-01
15:01:30	1.22E-01
15:02:30	1.12E-01
15:08:00	9.80E-02
15:35:00	9.30E-02
19:28:00	9.10E-02
20:50:00	9.10E-02
20:52:00	9.10E-02

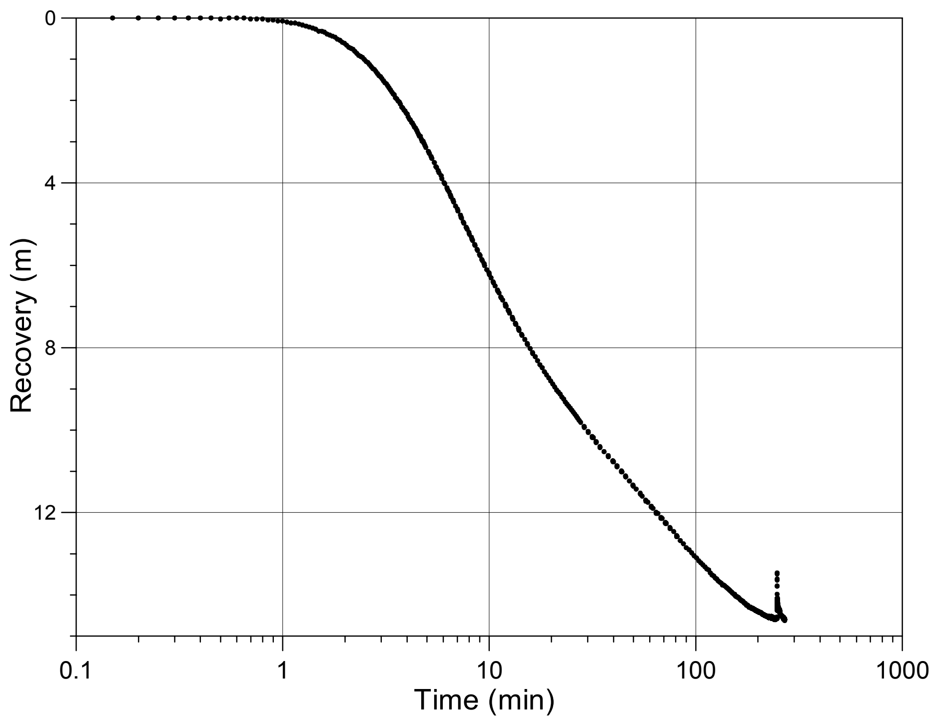
In all cases the matchpoint used is consistent with $p_D = 1$ and $t_D = 1$.



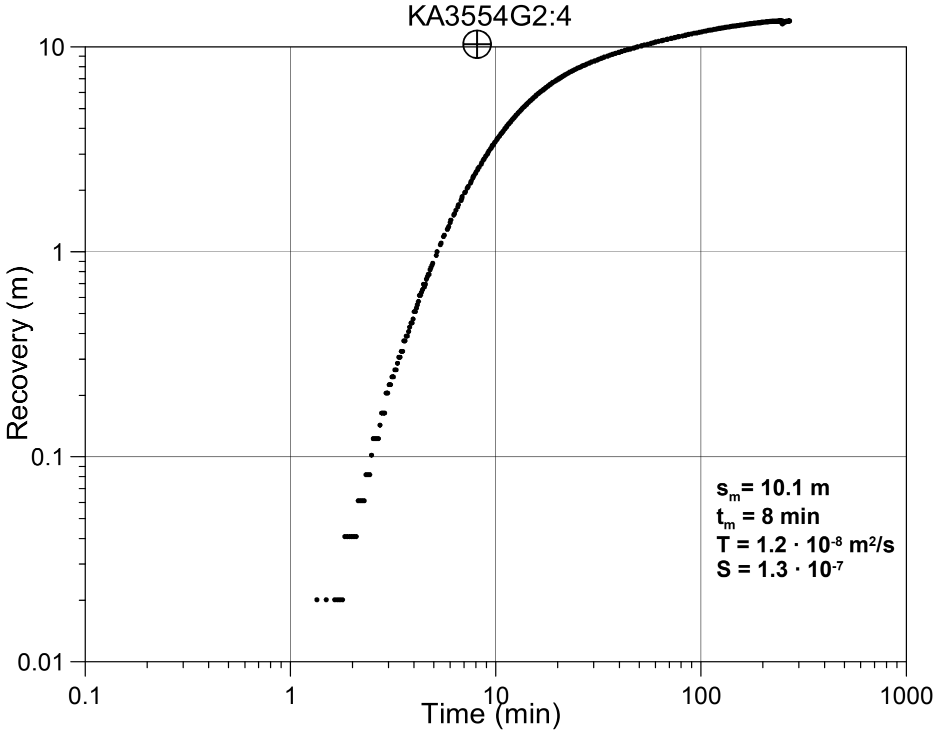


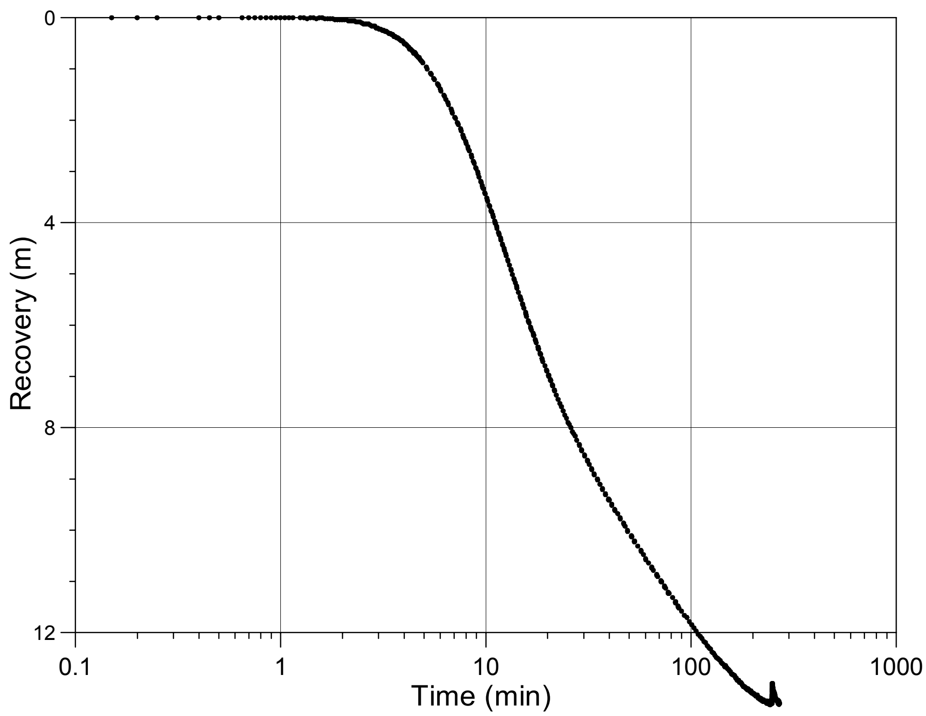
22_KA3539G_1.GRF 2005-06-10





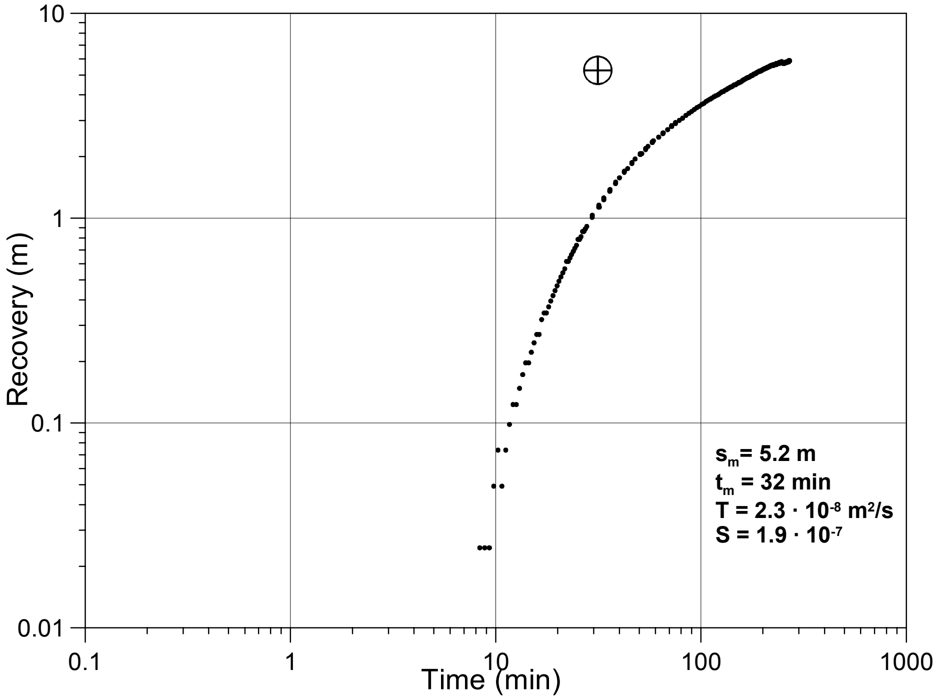
22_KA3539G_3.GRF 2005-06-10

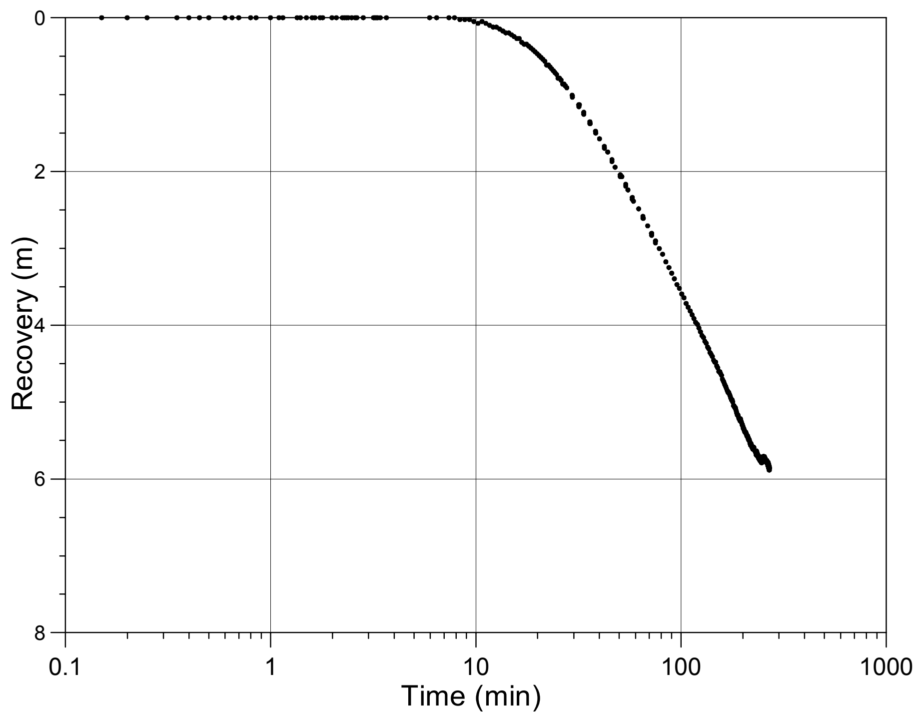




22_KA3554G2_4.GRF 2005-06-10

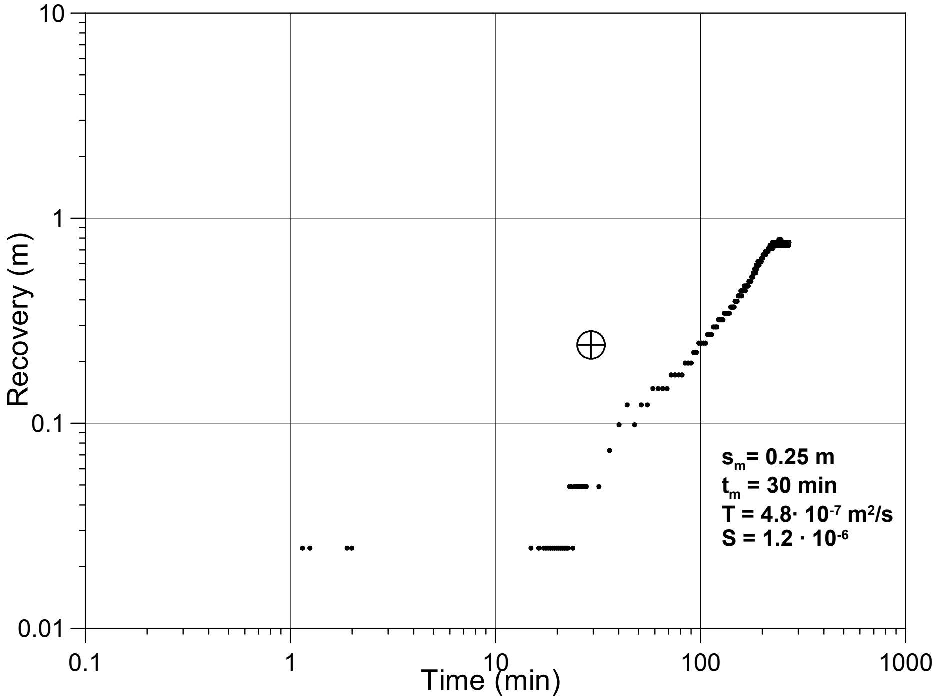
KA3566G2:1

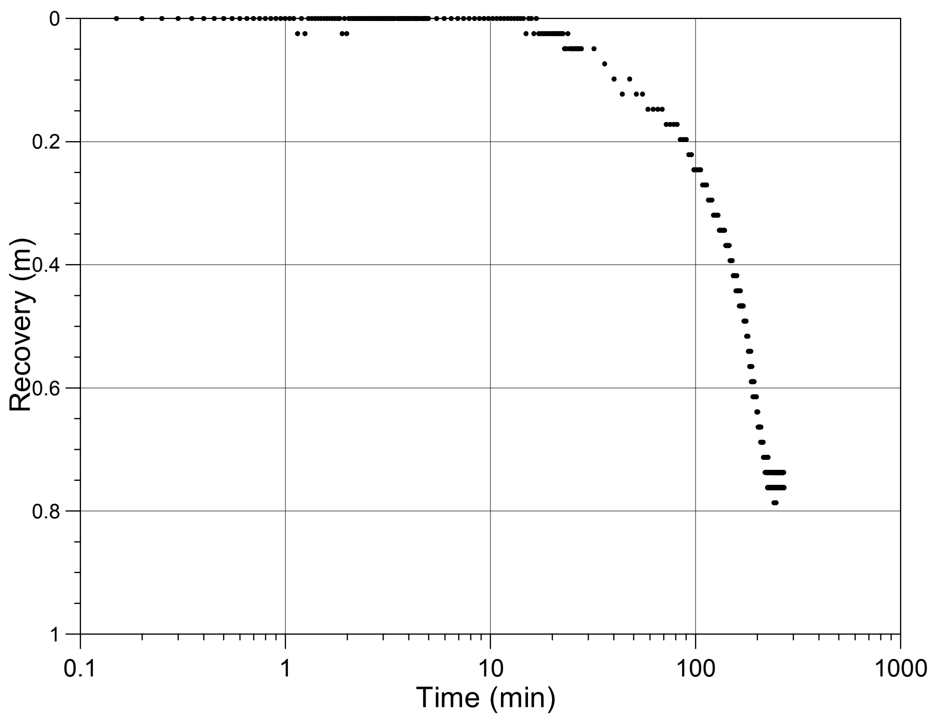




22_KA3566G2_1.GRF 2005-06-10

KA3590G2:1





22_KA3590G2_1.GRF 2005-06-10

APPENDIX 3

Interference test 5:23 in borehole KA3554G01, section 22.60 m – 24.15 m

Date: 2005-01-22
Field Crew: A. Blom / J. Magnusson
Borehole length: 30.01 m
Borehole diameter: 76 mm

Flowing borehole: KA3554G01, section 2: 22.60 – 24.15 m

Valve opened: 20050122 15:00.00
Valve closed: 20050122 21:00.00

End of Test: 20050123 15:00

Total flowing time : 360 min
Tot. Pr. Build-up time: 1080 min.

The test was performed as an Interference test. Pressure responses were monitored in 132 borehole sections including the flow section.

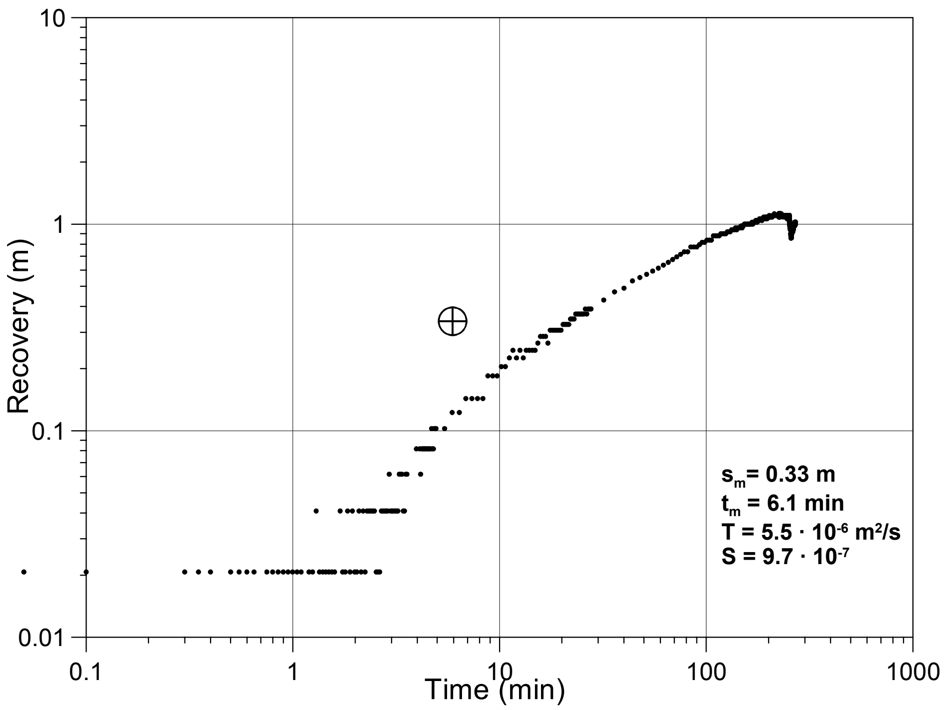
Flow data
Manually measured flow rates of KA3554G01, section 22.60 m – 24.15 m are presented in the table below:

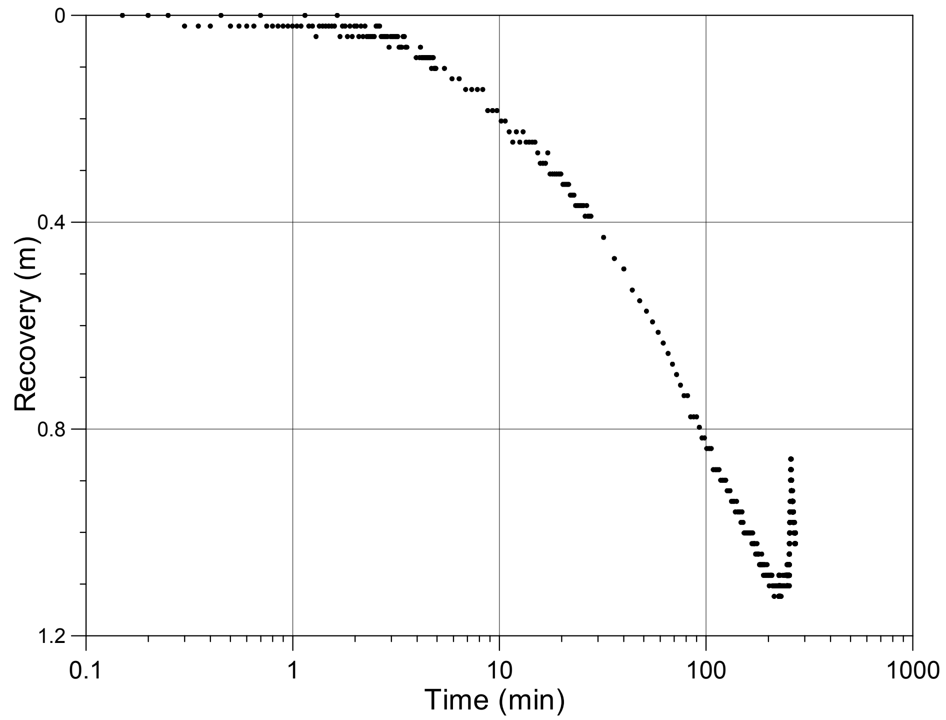
Table Manually measured flow rates, Interference test in KA3554G01, section 22.60 m – 24.15 m. Prototype Repository, January 22 2003

Time	Flow rate (l/min)
15:00:10	2.64E+00
15:01:00	1.71E+00
15:02:00	1.61E+00
15:07:00	1.53E+00
15:22:00	1.47E+00
20:48:00	1.36E+00
20:49:00	1.36E+00

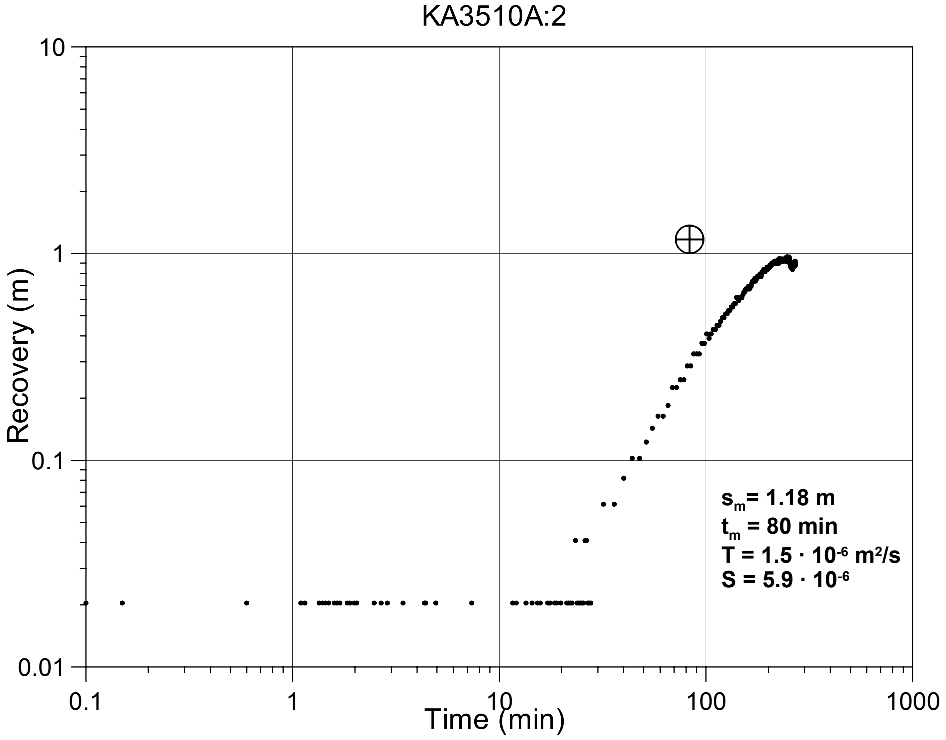
In all cases the matchpoint used is consistent with $p_D = 1$ and $t_D = 1$.

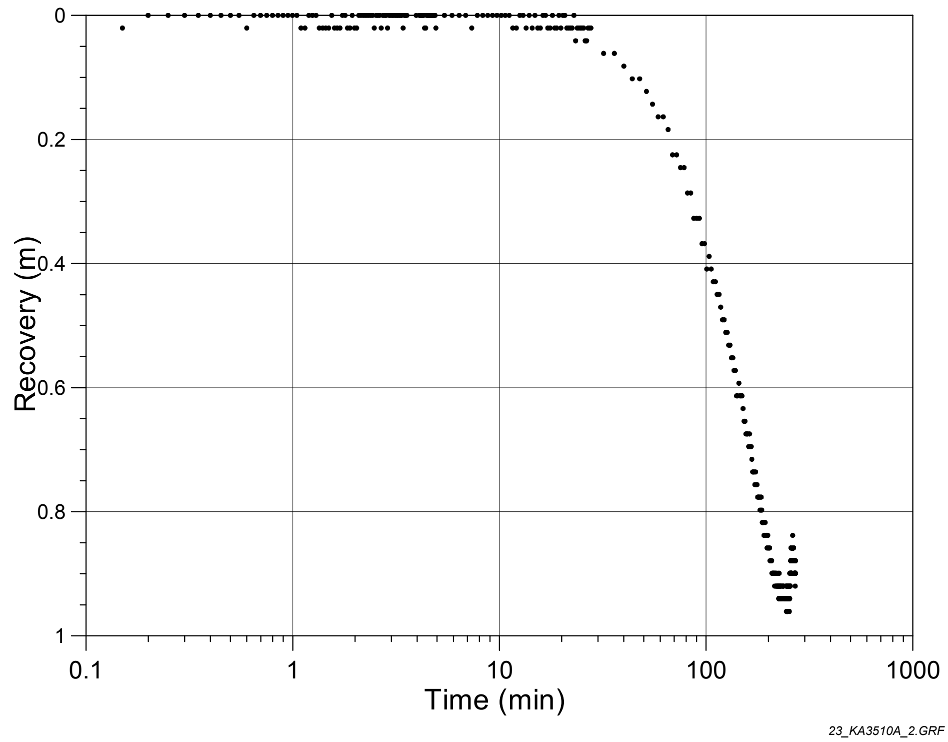
KA3510A:1



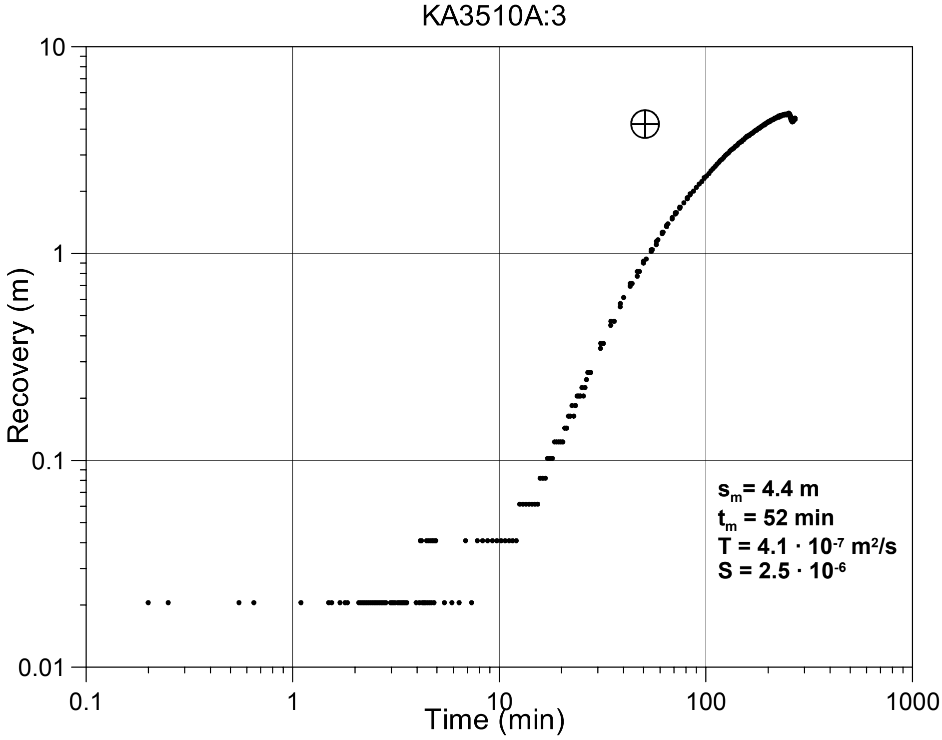


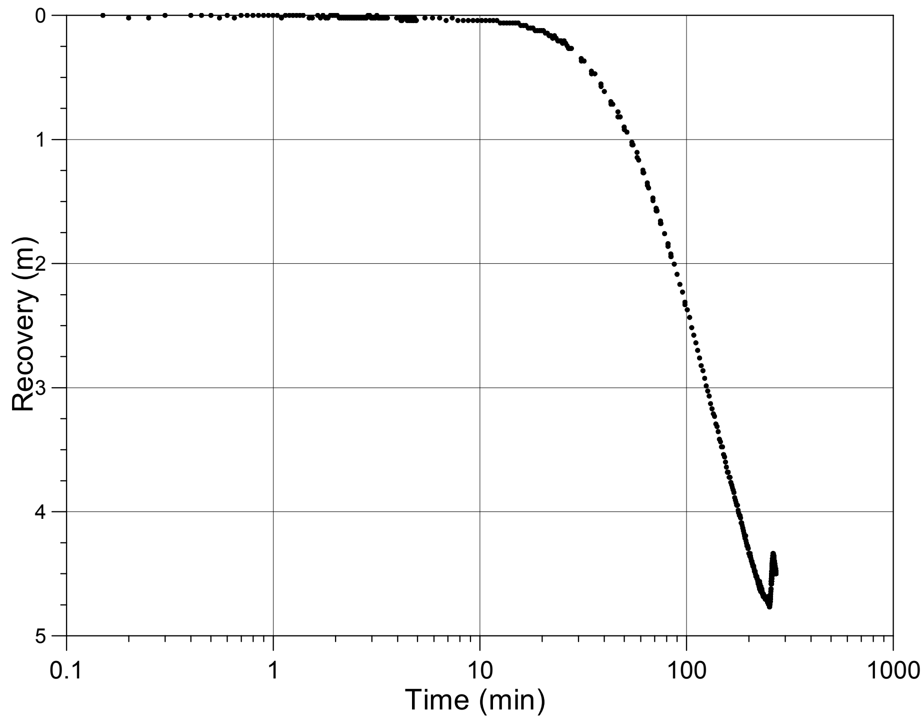
23_KA3510A_1.GRF 2005-06-10



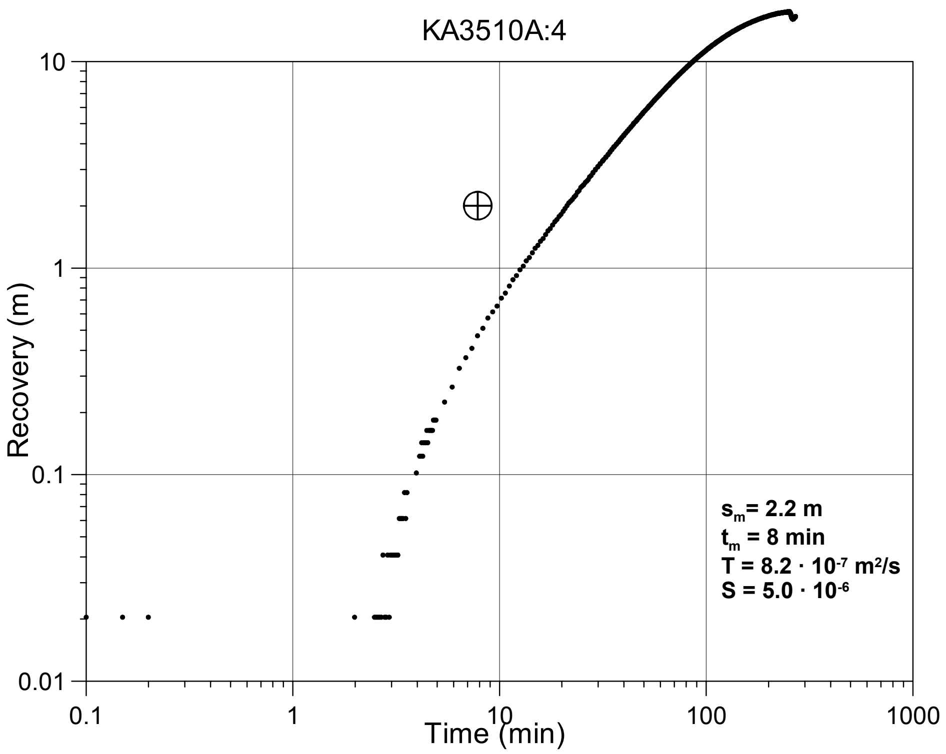


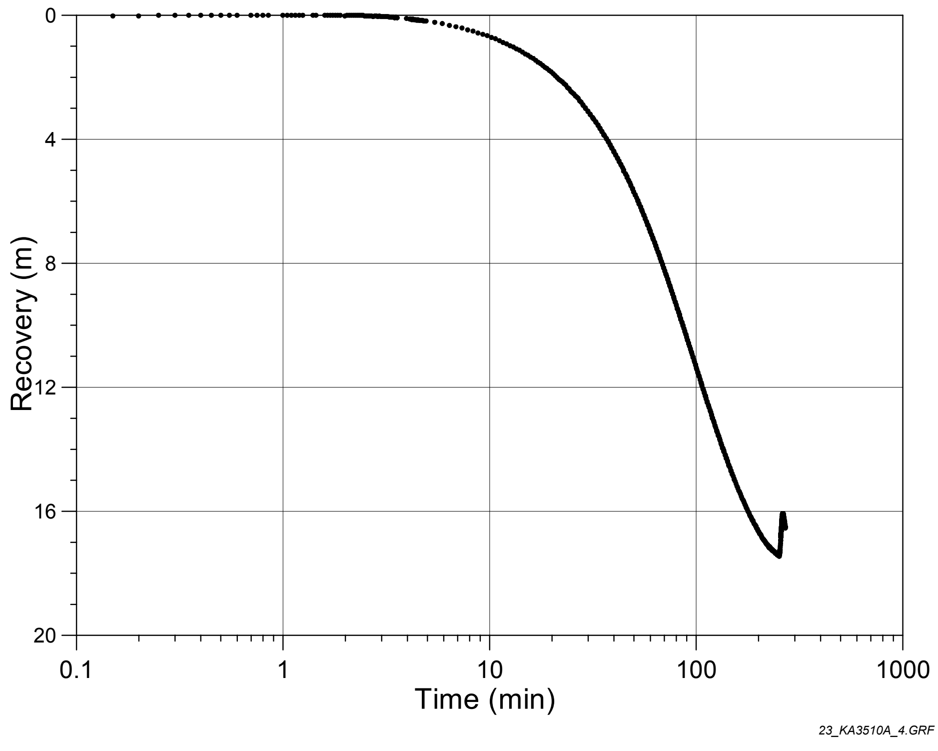
23_KA3510A_2.GRF 2005-06-10





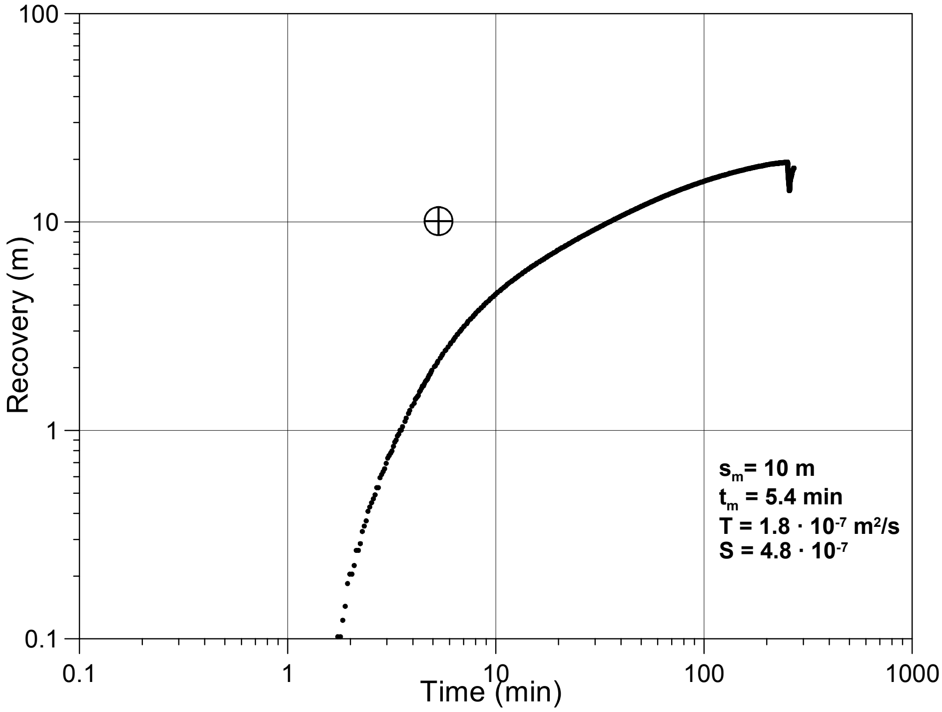
23_KA3510A_3.GRF 2005-06-10

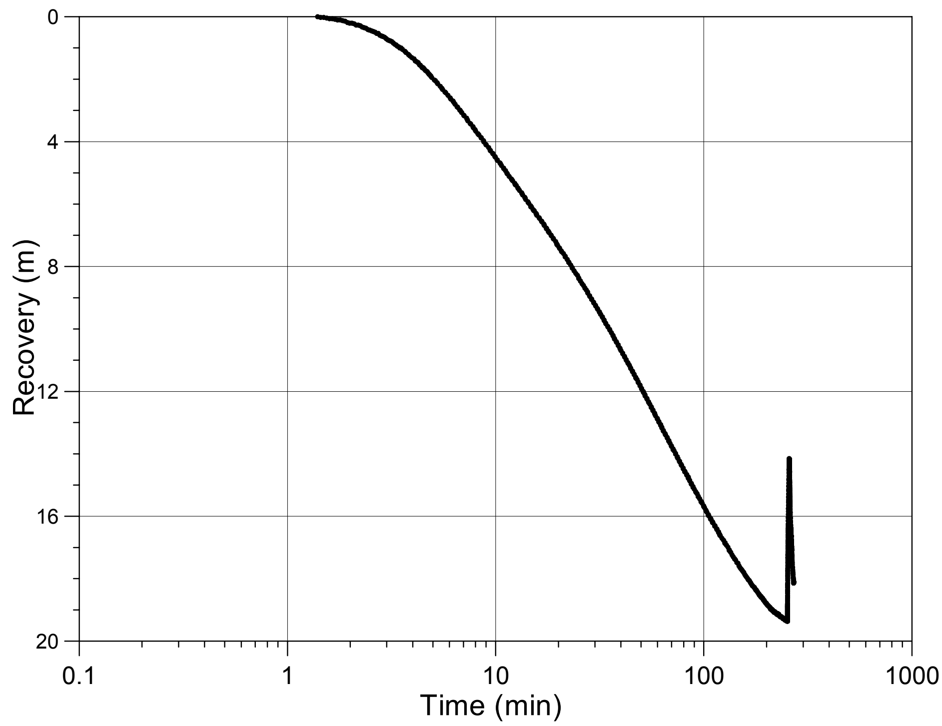




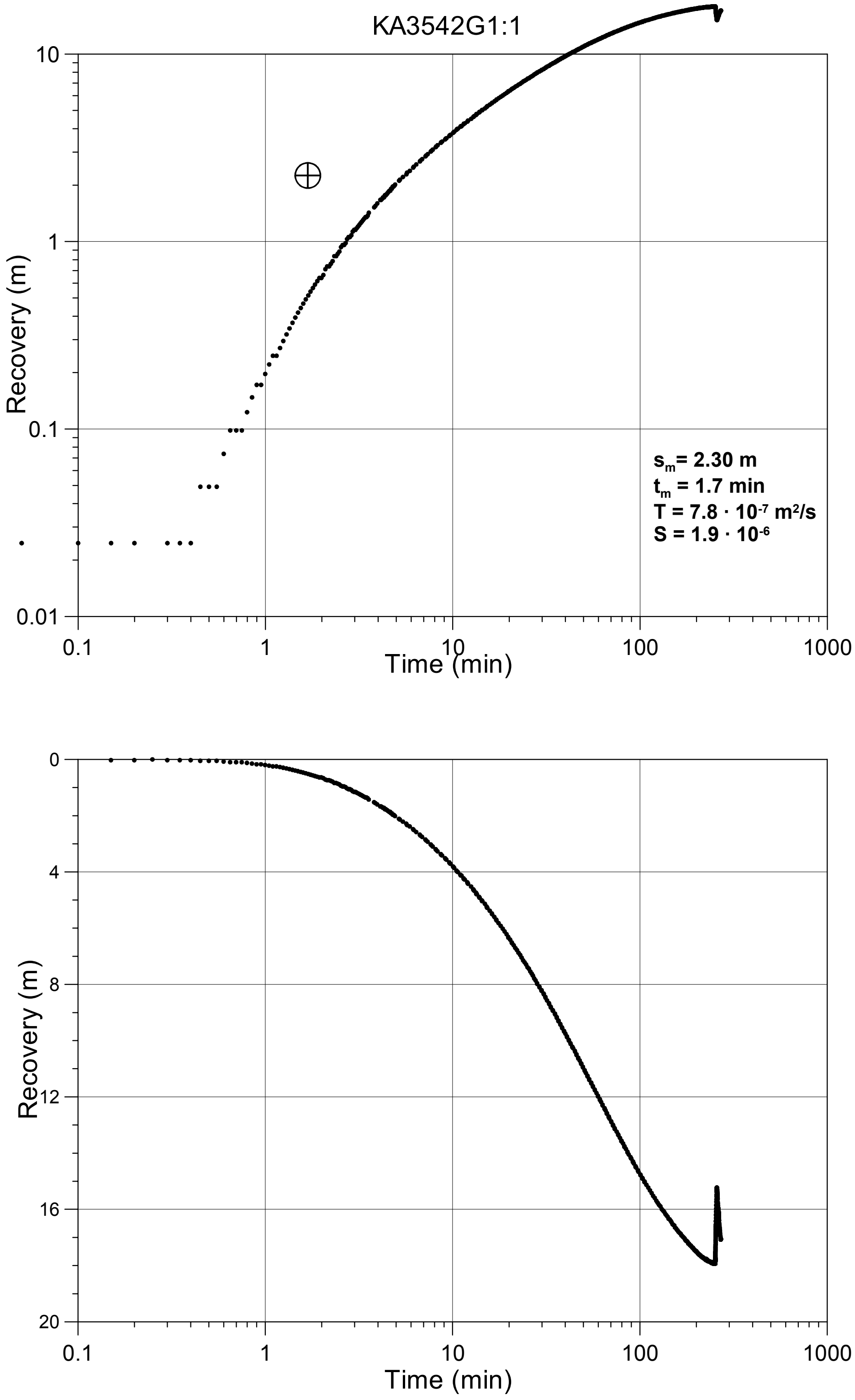
23_KA3510A_4.GRF 2005-06-10

KA3510A:5

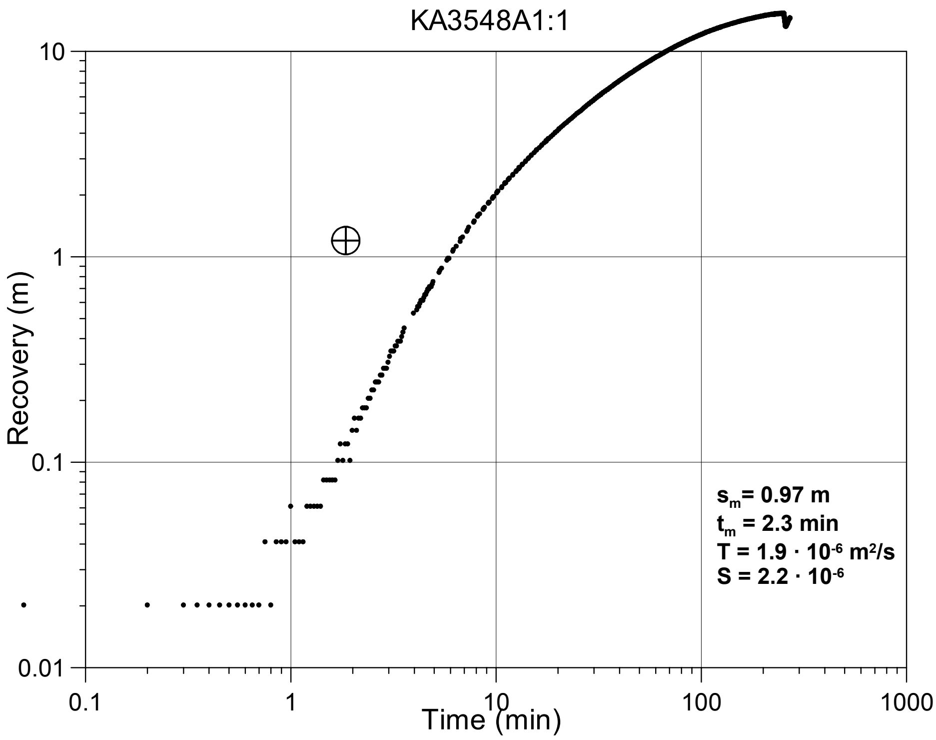


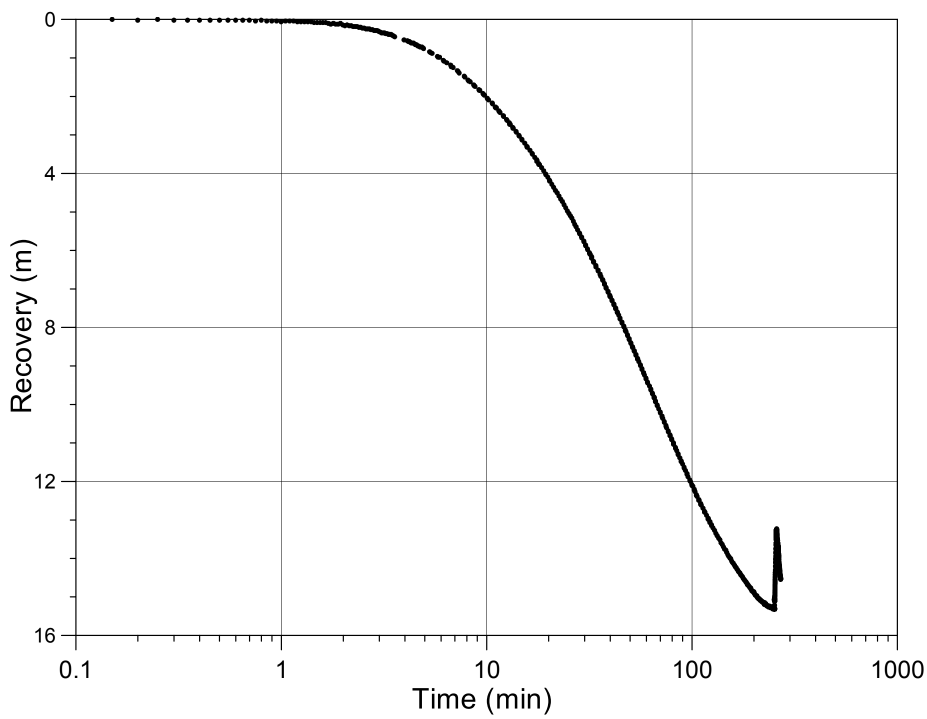


23_KA3510A_5.GRF 2005-06-10

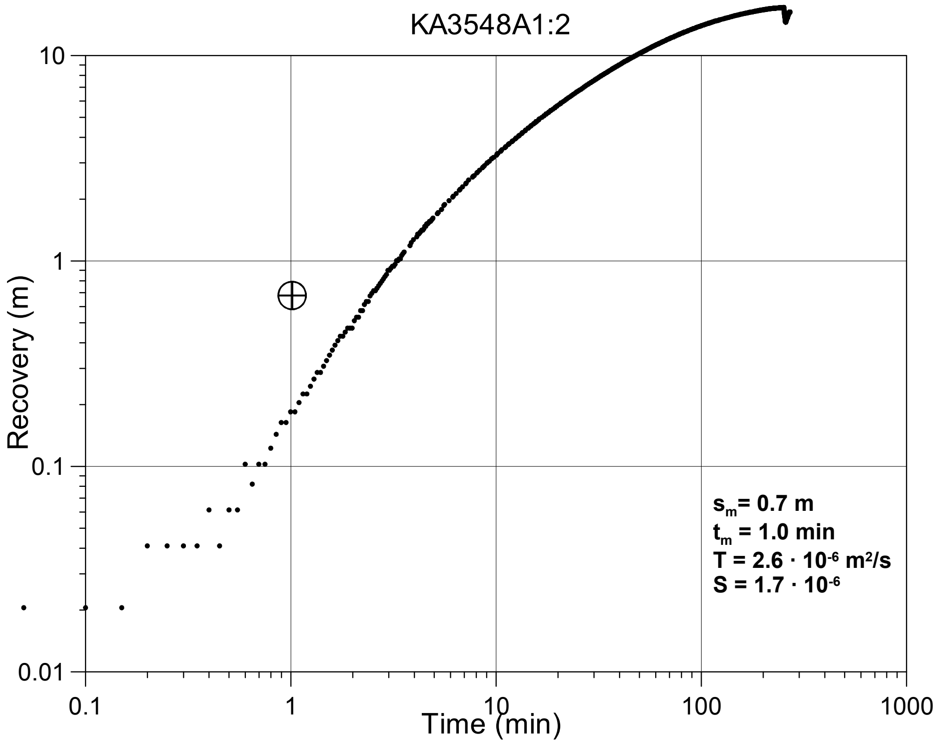


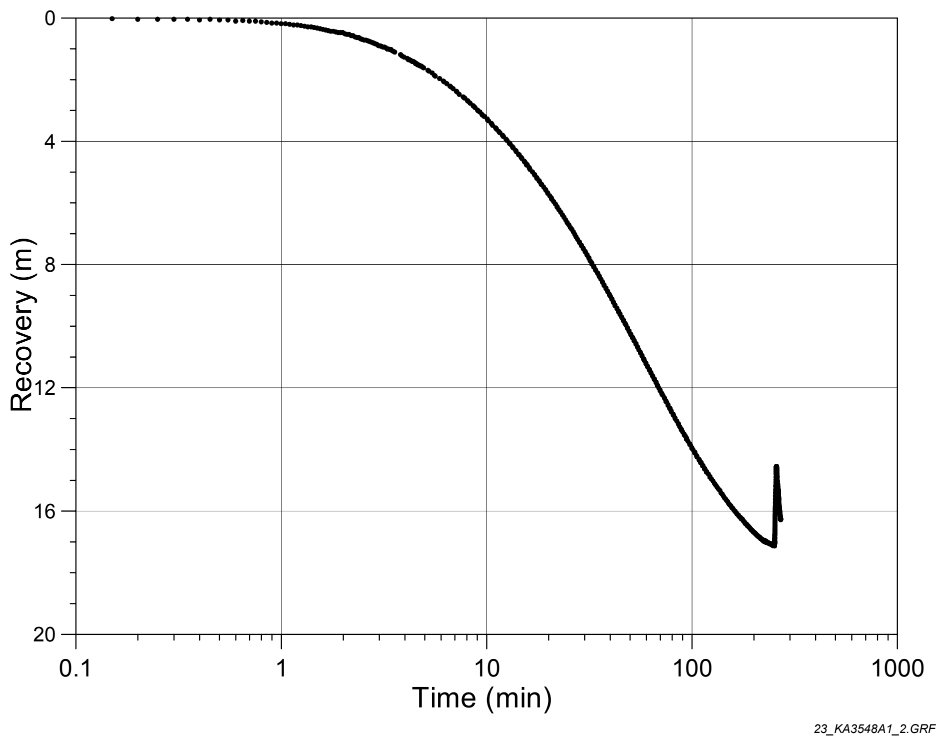
23_KA3542G1_1.GRF 2005-06-13



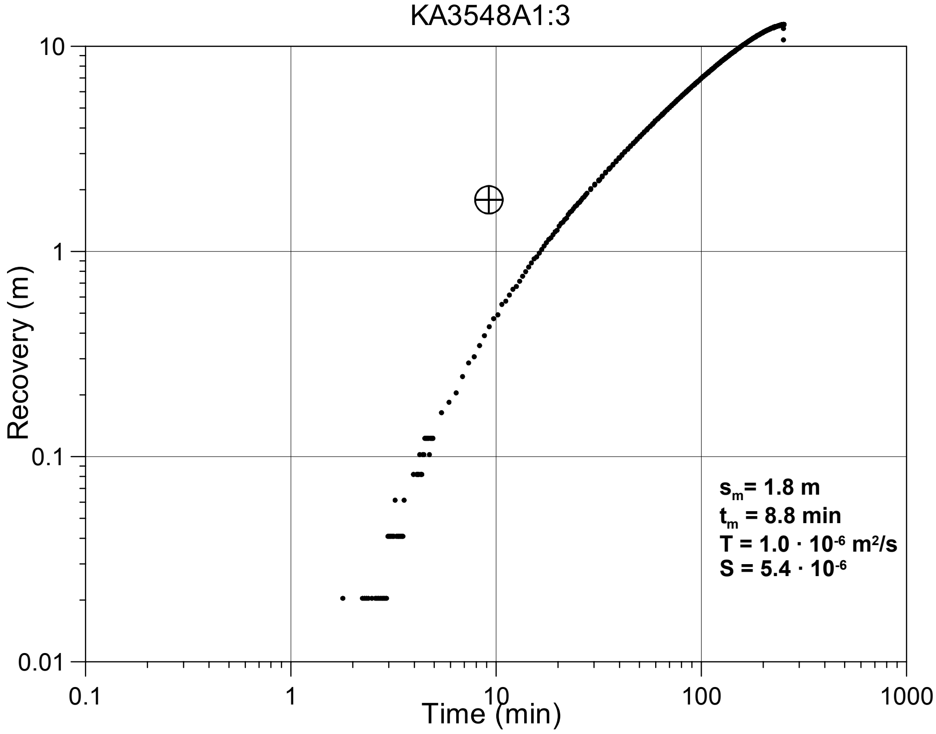


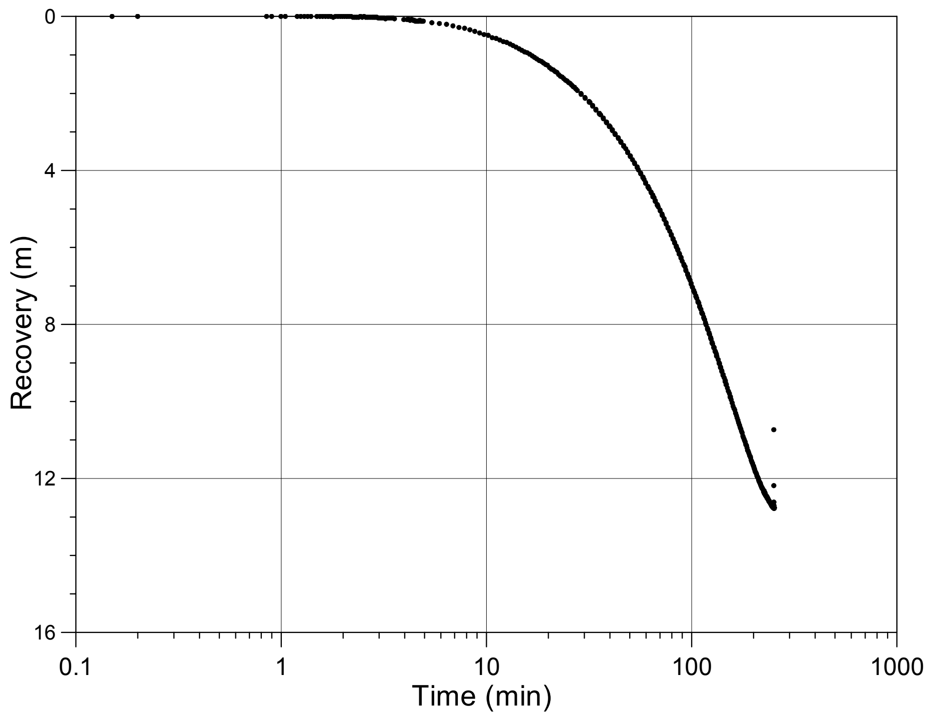
23_KA3548A1_1.GRF 2005-06-13



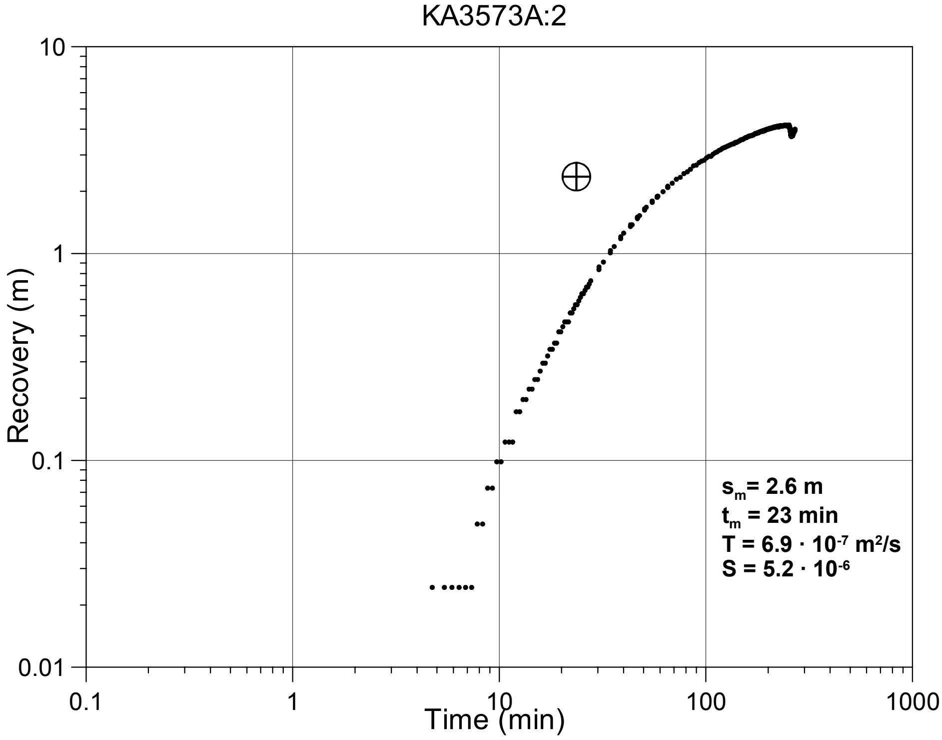


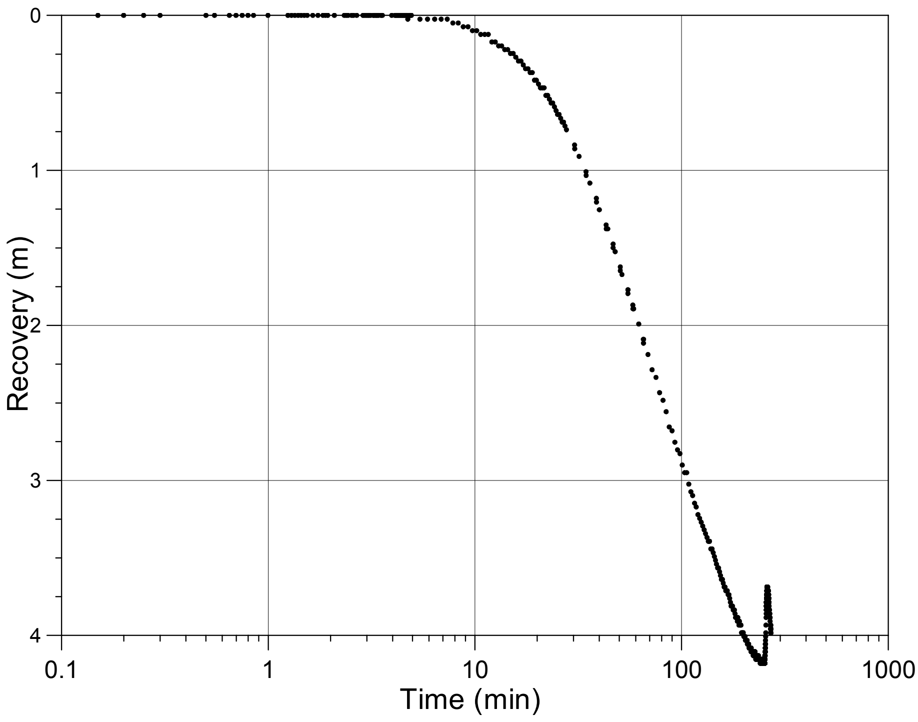
23_KA3548A1_2.GRF 2005-06-13



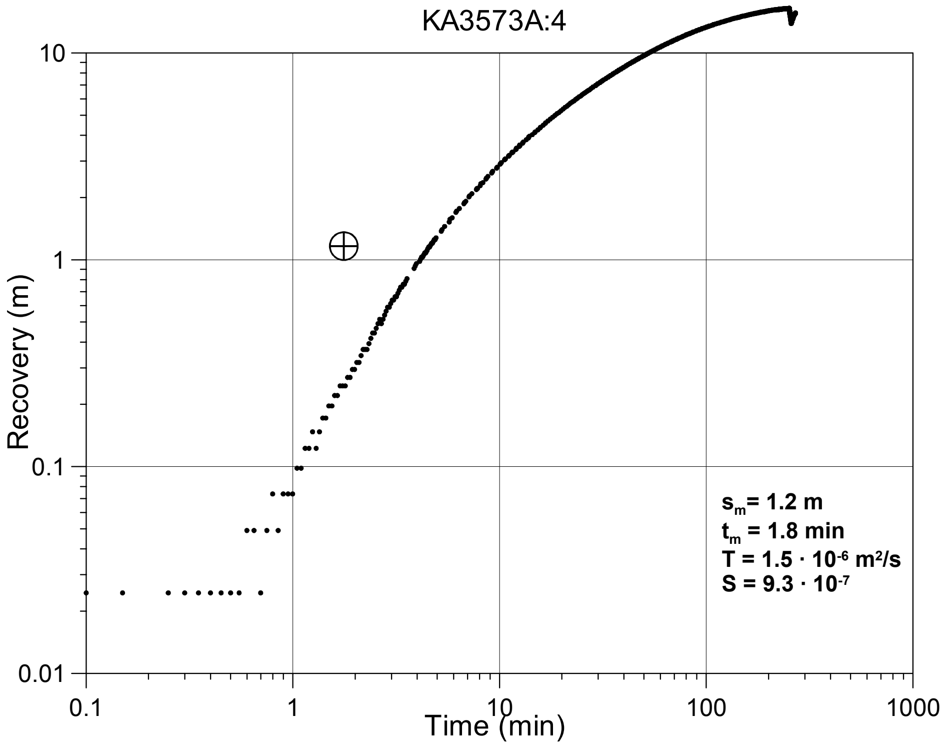


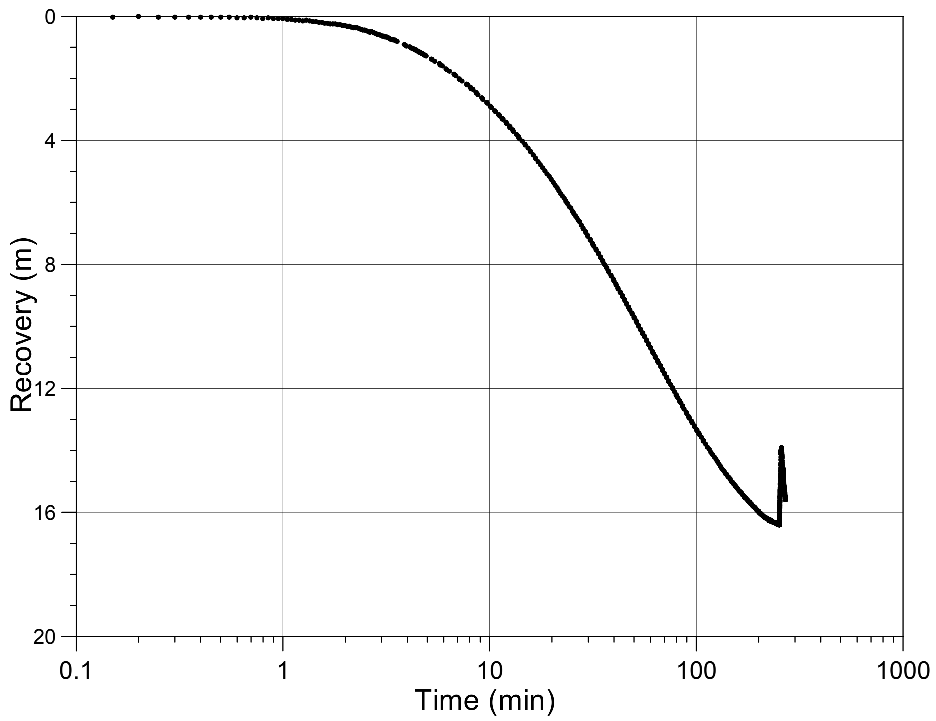
23_KA3548A1_3.GRF 2005-06-13



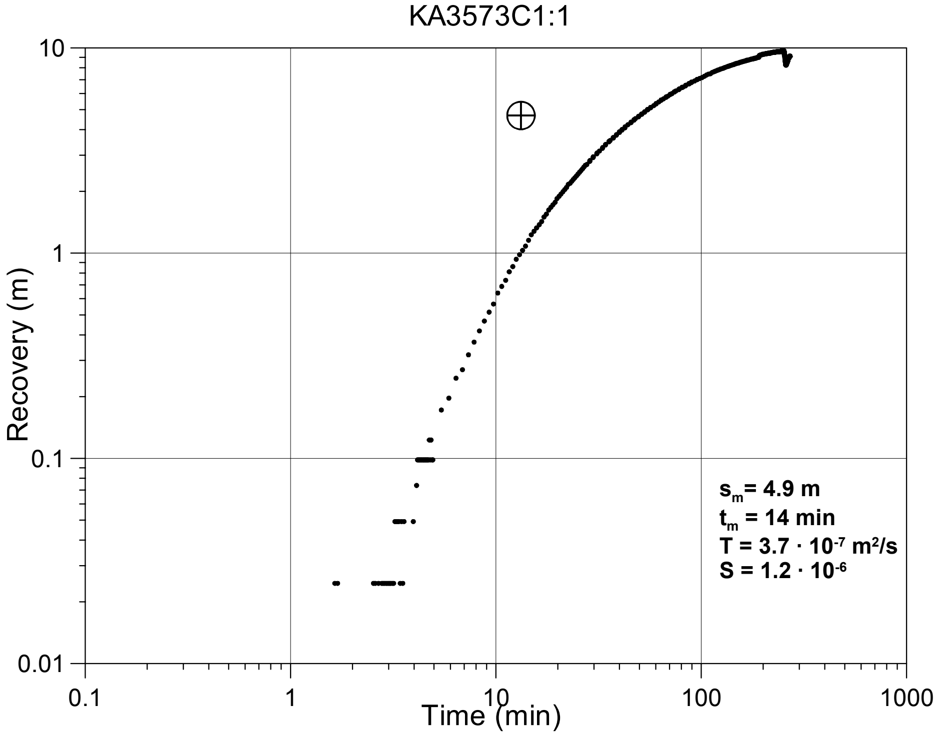


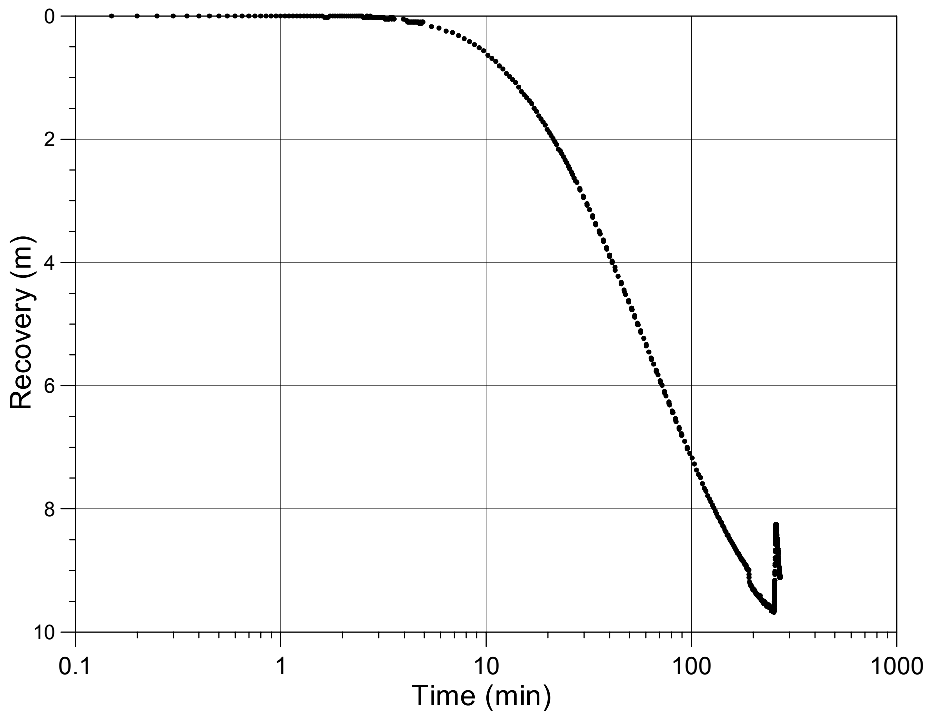
23_KA3573A_2.GRF 2005-06-13



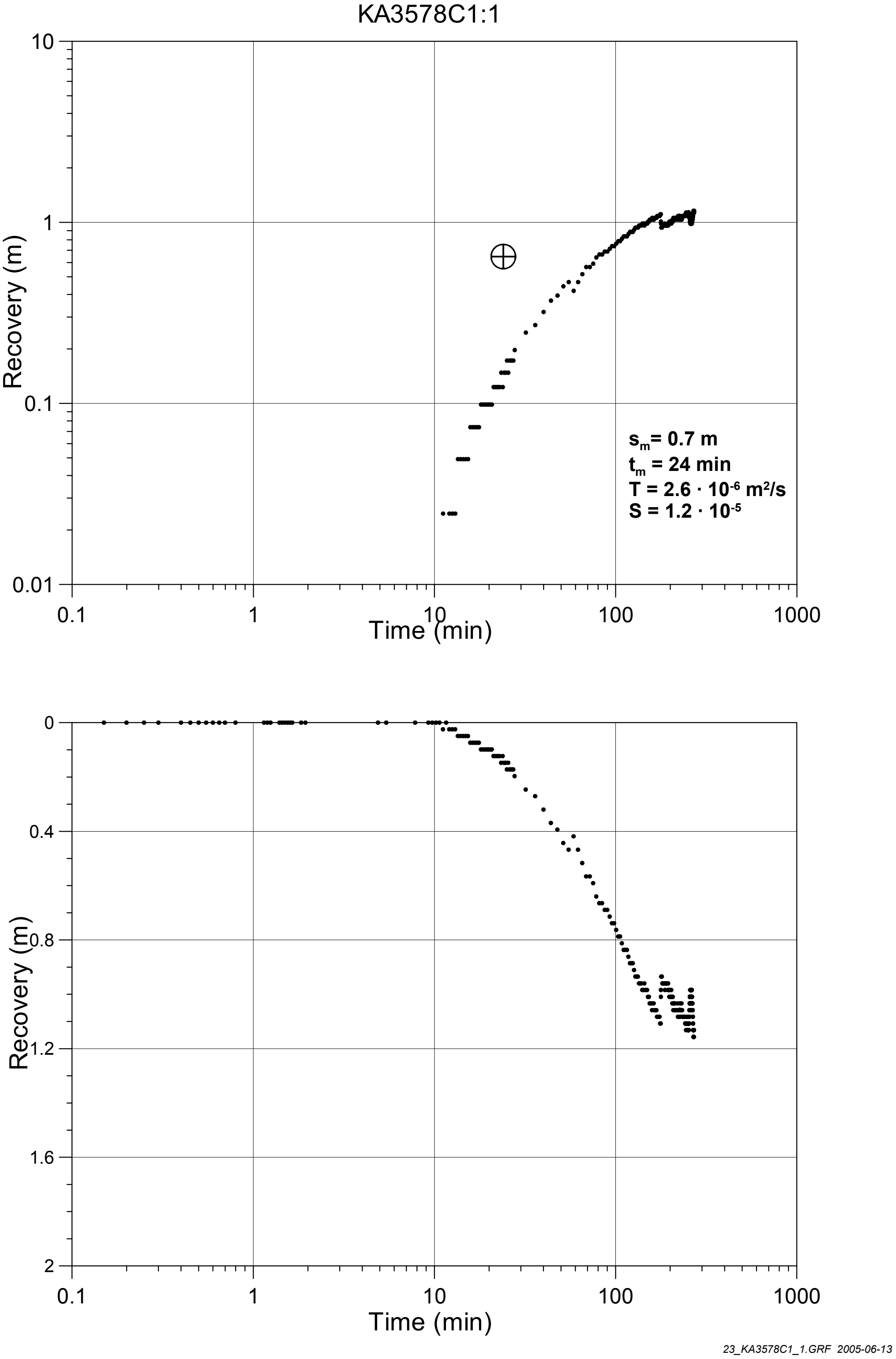


23_KA3573A_4.GRF 2005-06-13

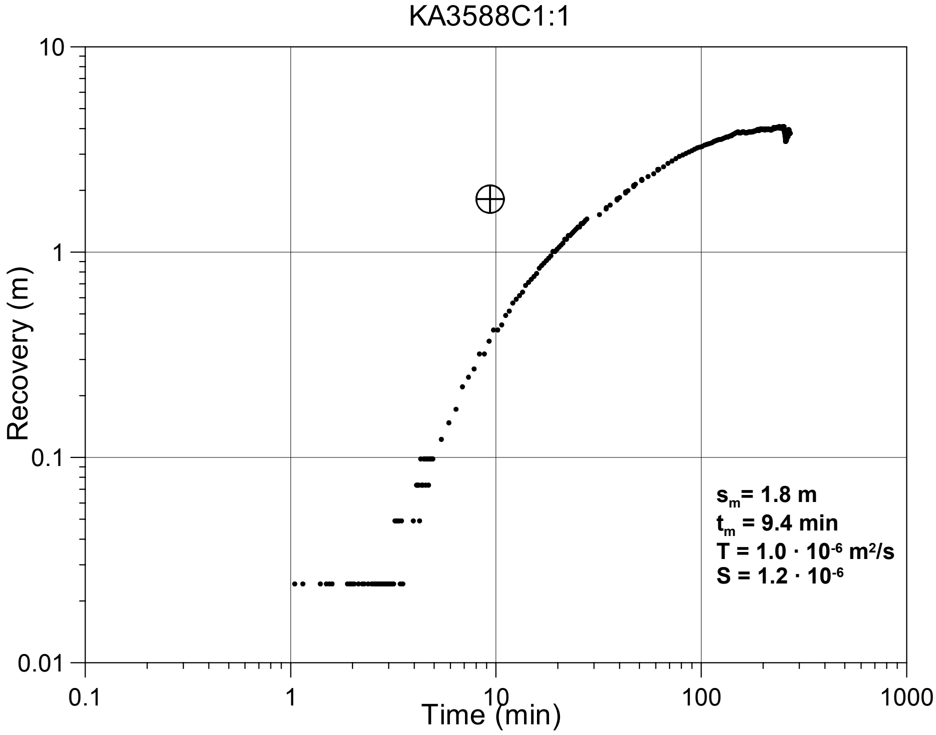


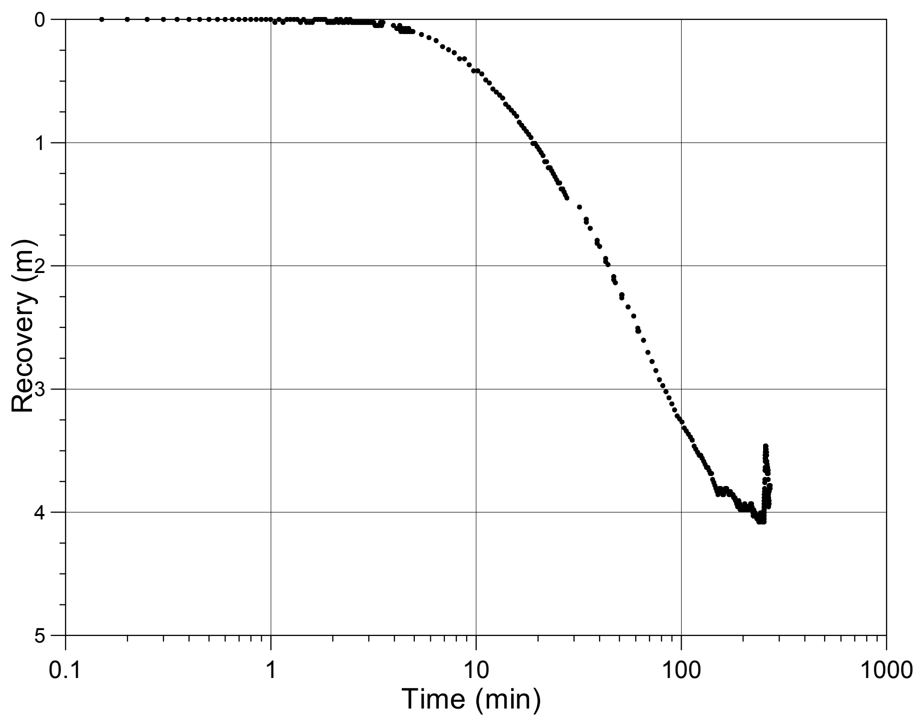


23_KA3573C1_1.GRF 2005-06-13

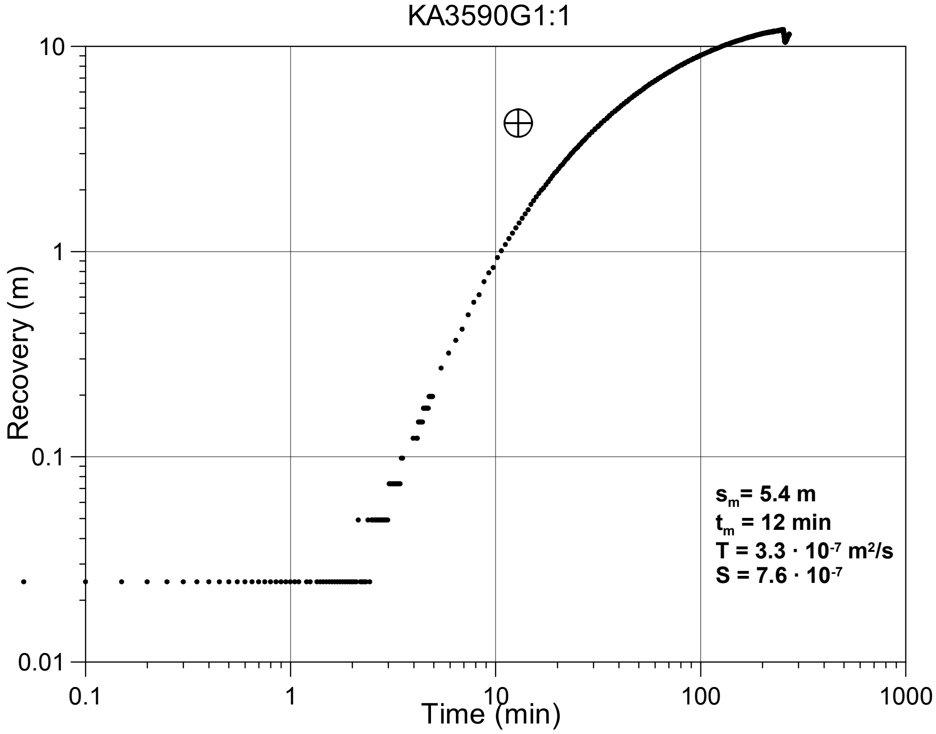


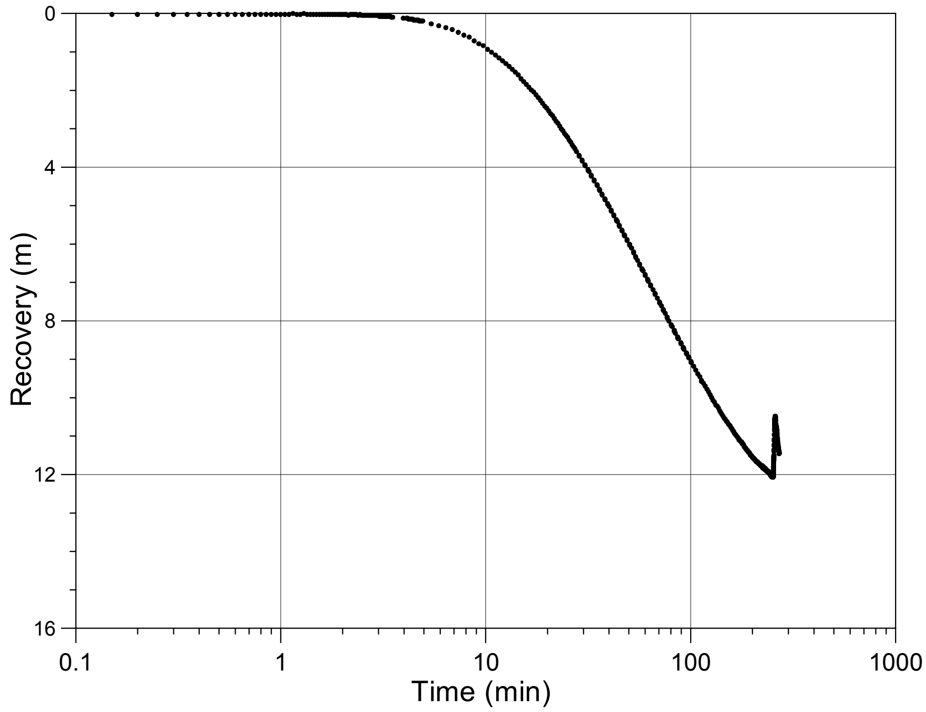
KA3578C1:1
Recovery (m)
Time (min)
s_m= 0.7 m
t_m = 24 min
T = 2.6 · 10^{-6} m^2/s
S = 1.2 · 10^{-5}
Recovery (m)
Time (min)
23_KA3578C1_1.GRF 2005-06-13



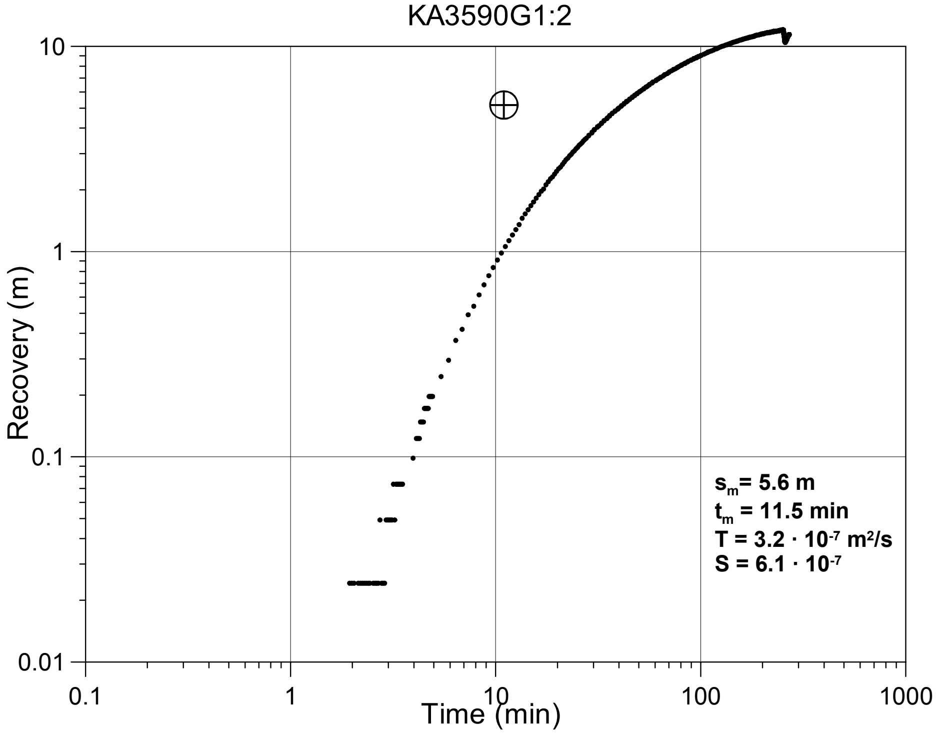


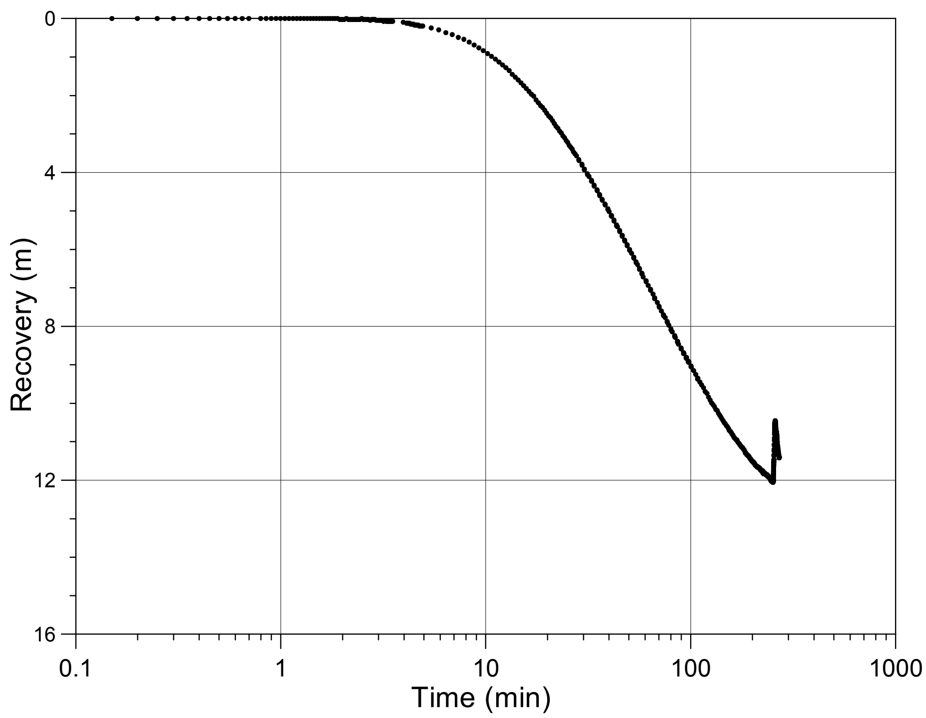
23_KA3588C1_1.GRF 2005-06-13





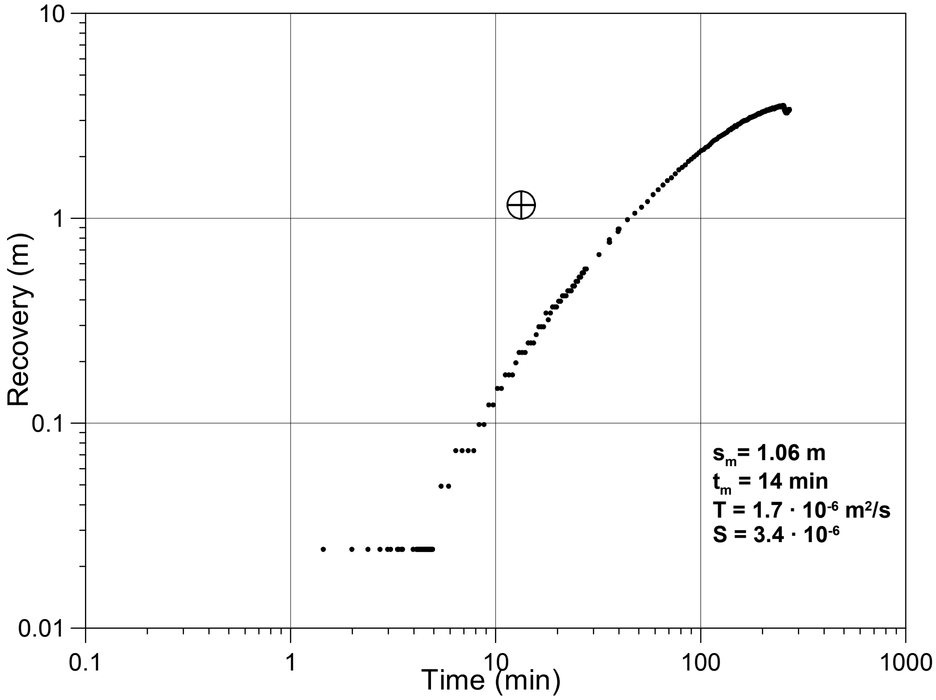
23_KA3590G1_1.GRF 2005-06-13

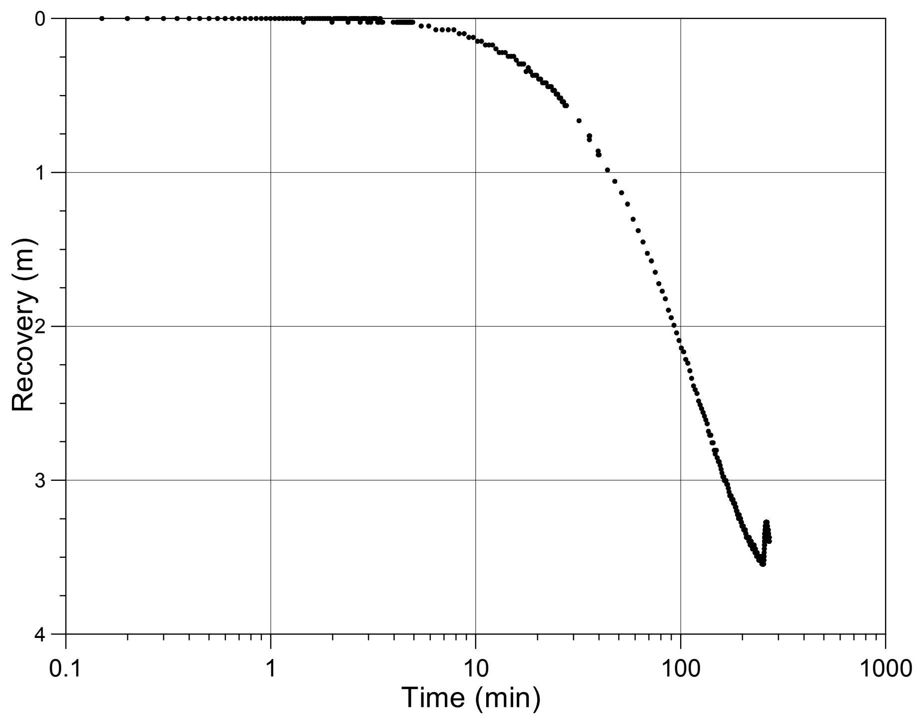




23_KA3590G1_2.GRF 2005-06-13

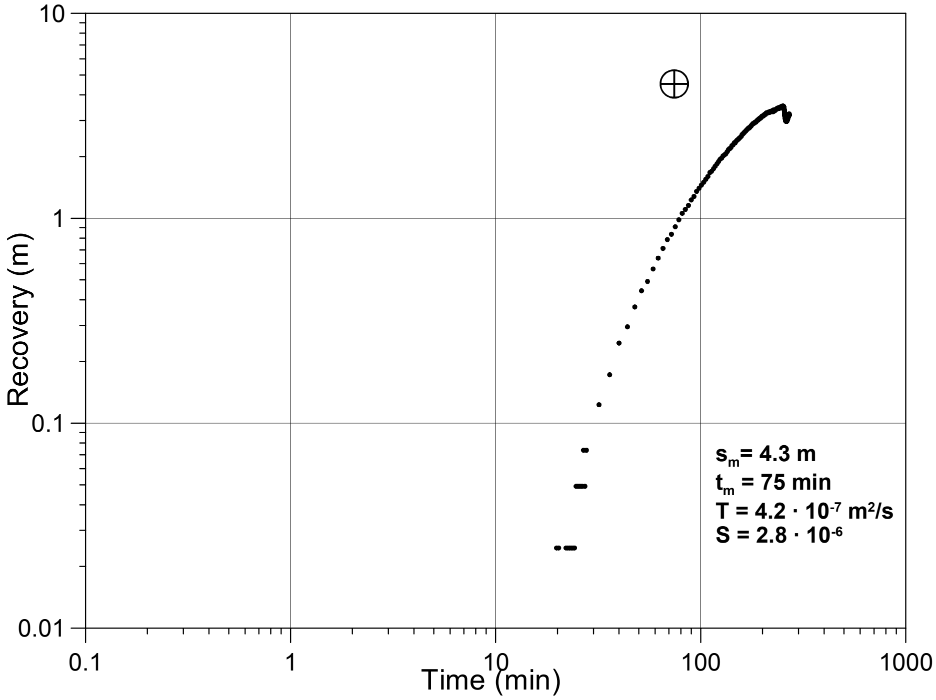
KA3590G1:3

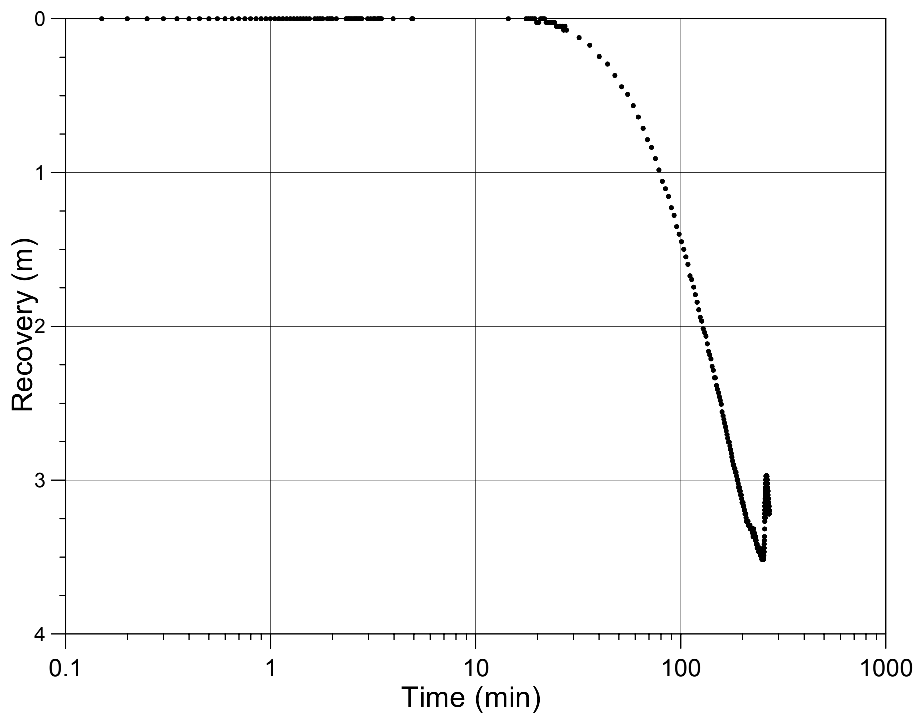




23_KA3590G1_3.GRF 2005-06-13

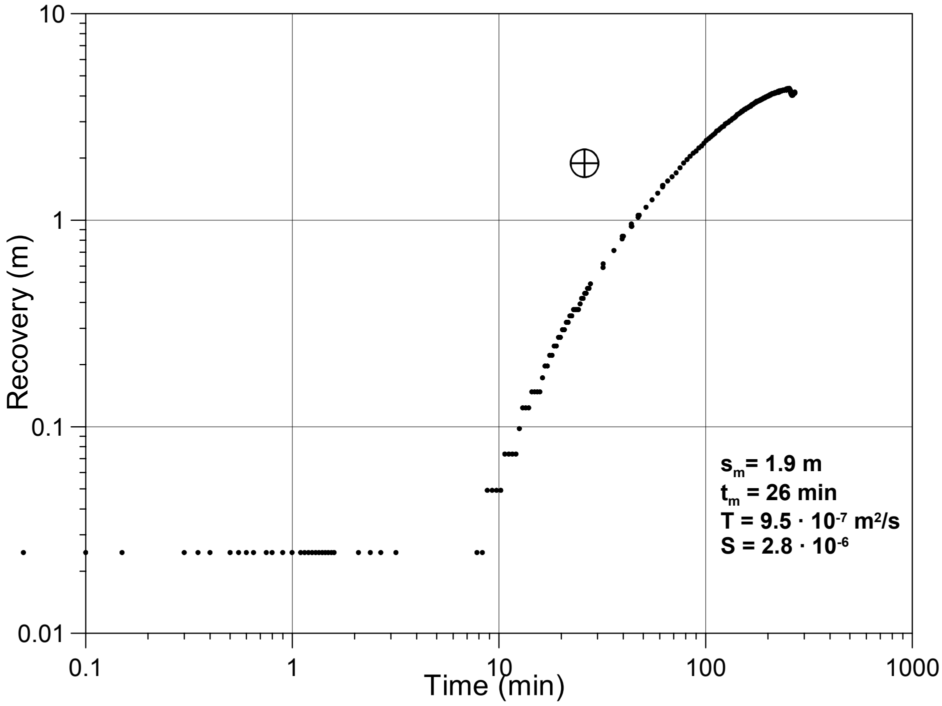
KA3590G2:1

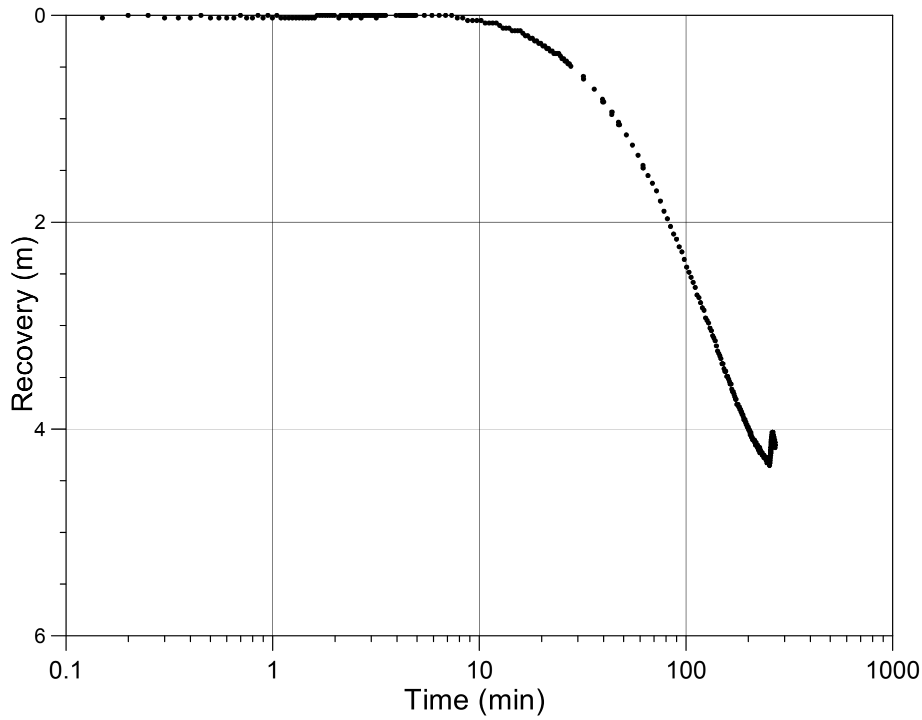




23_KA3590G2_1.GRF 2005-06-13

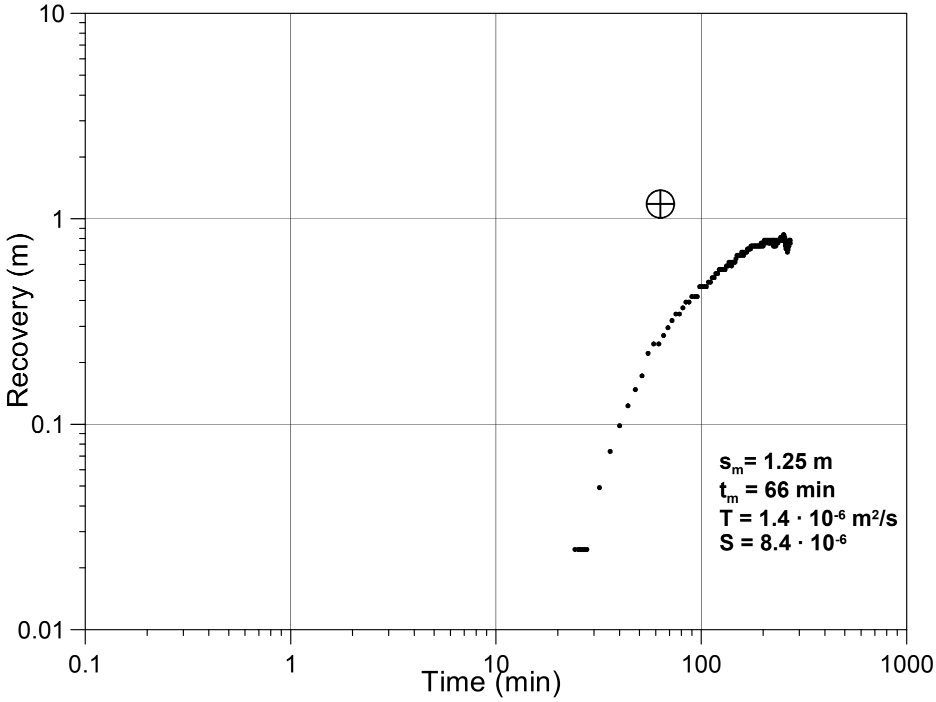
KA3593G:2

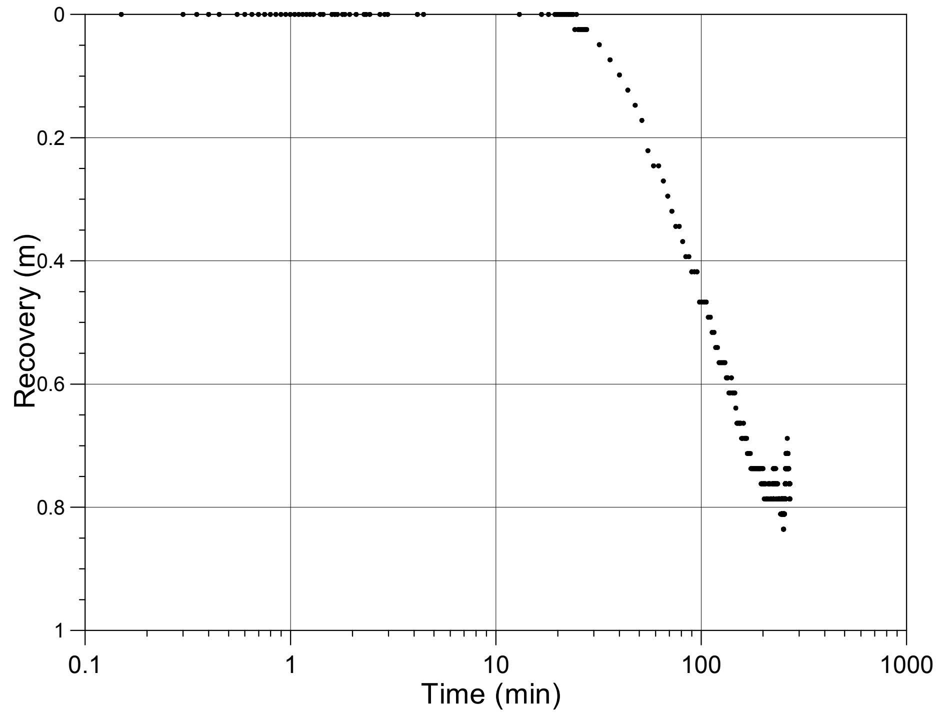




23_KA3593G_2.GRF 2005-06-13

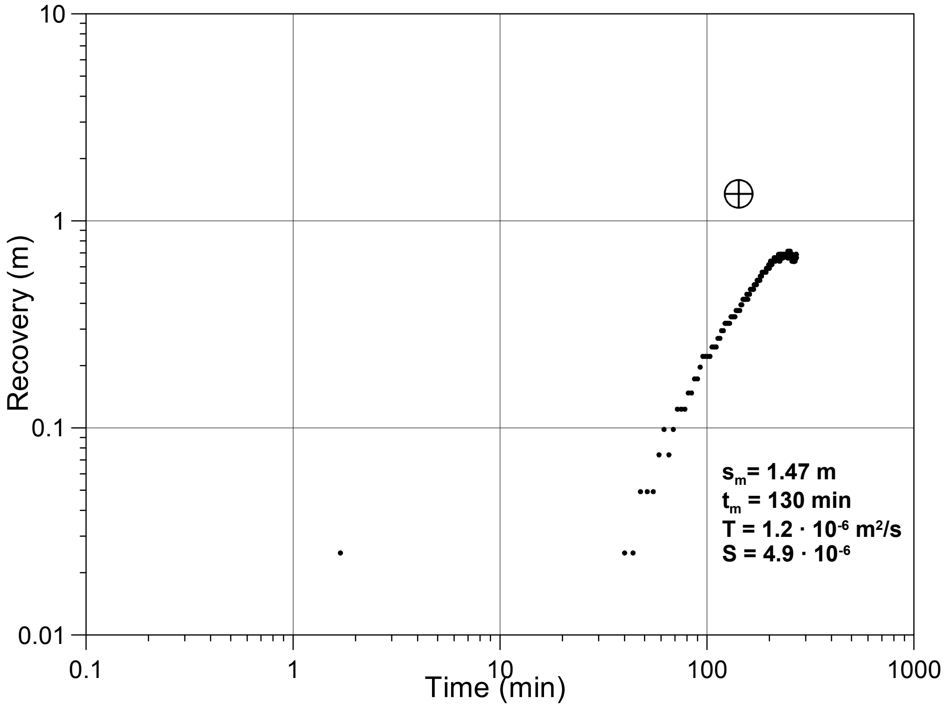
KA3597H1:1

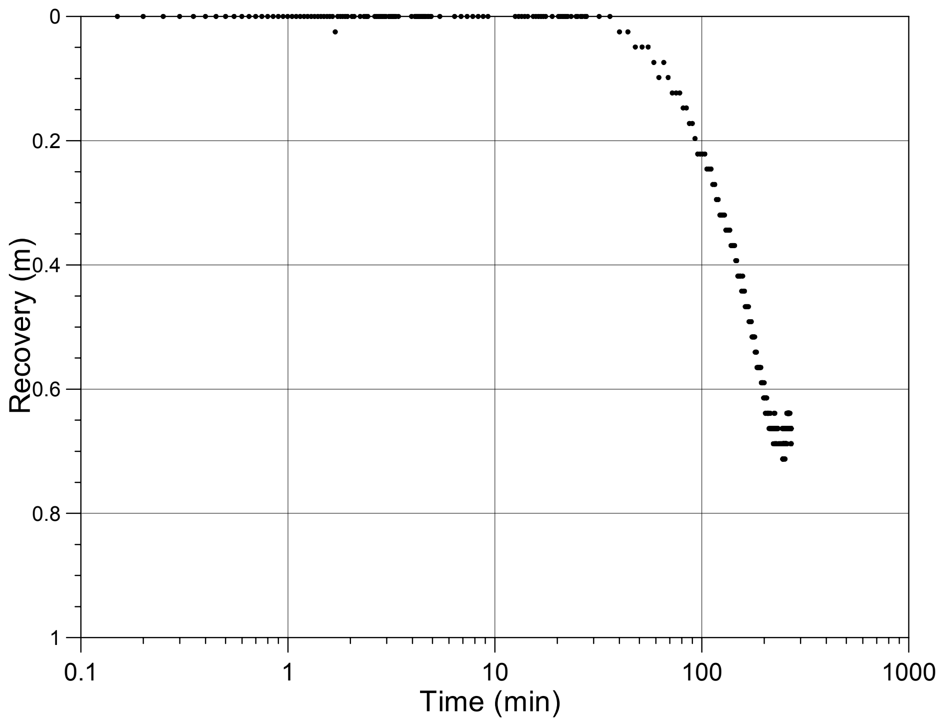




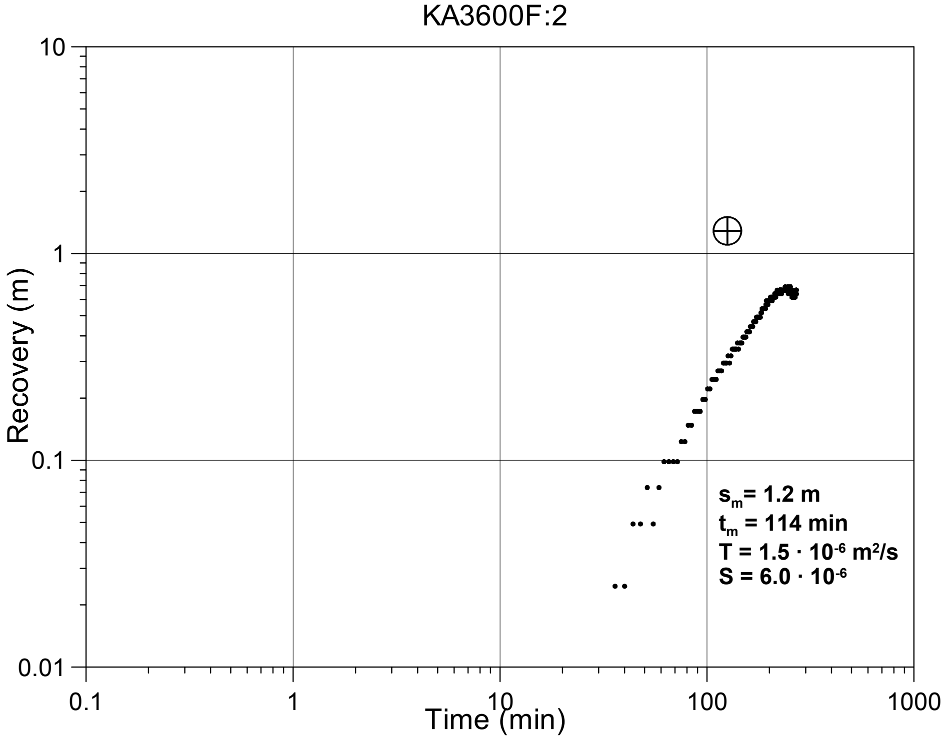
23_KA3597H1_1.GRF 2005-06-13

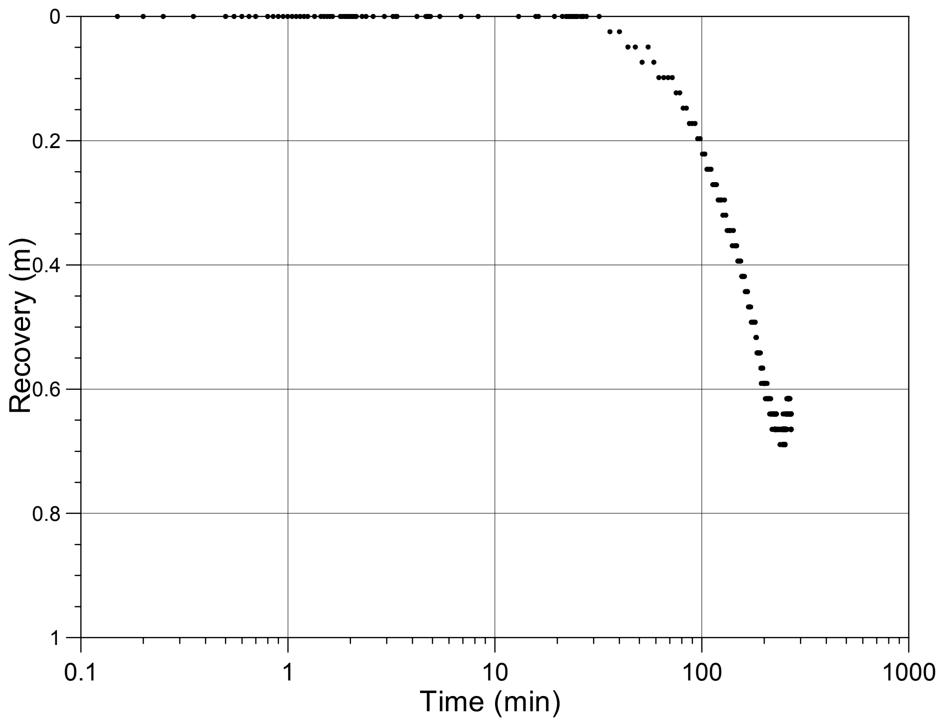
KA3600F:1





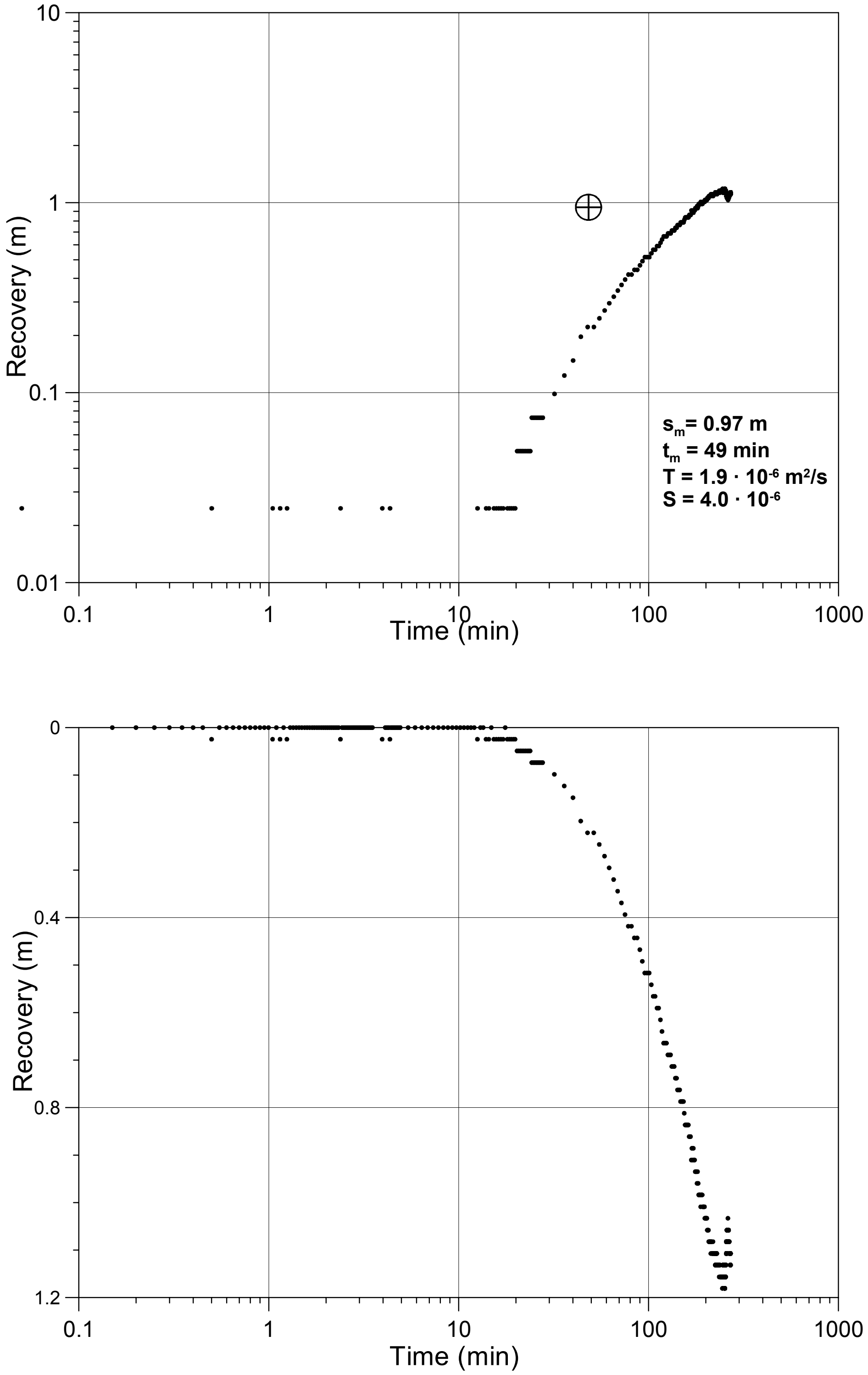
23_KA3600F_1.GRF 2005-06-13



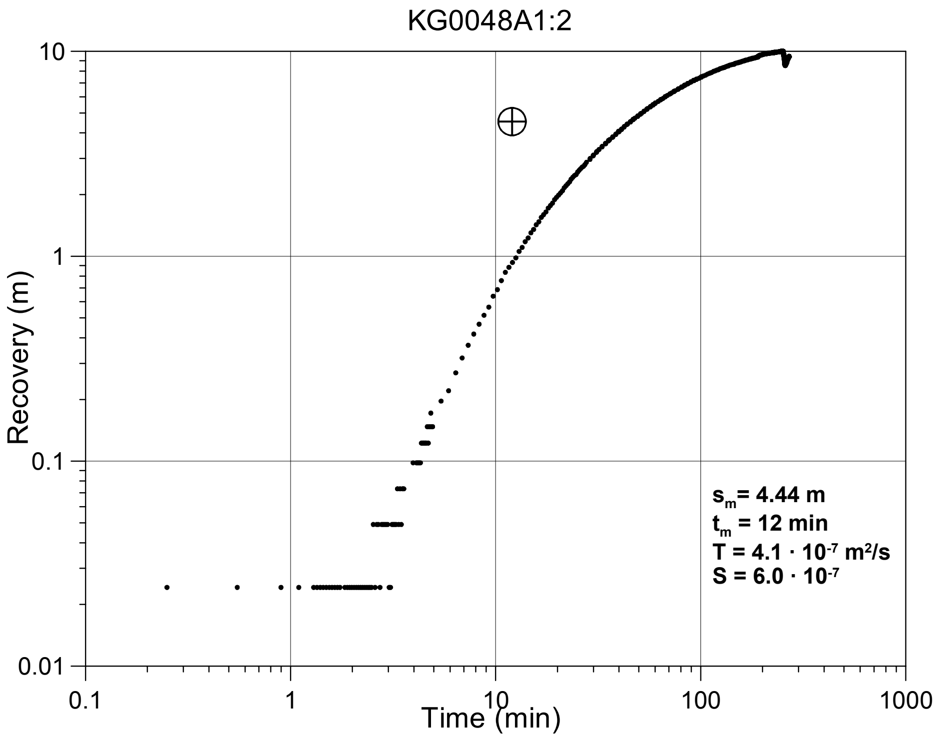


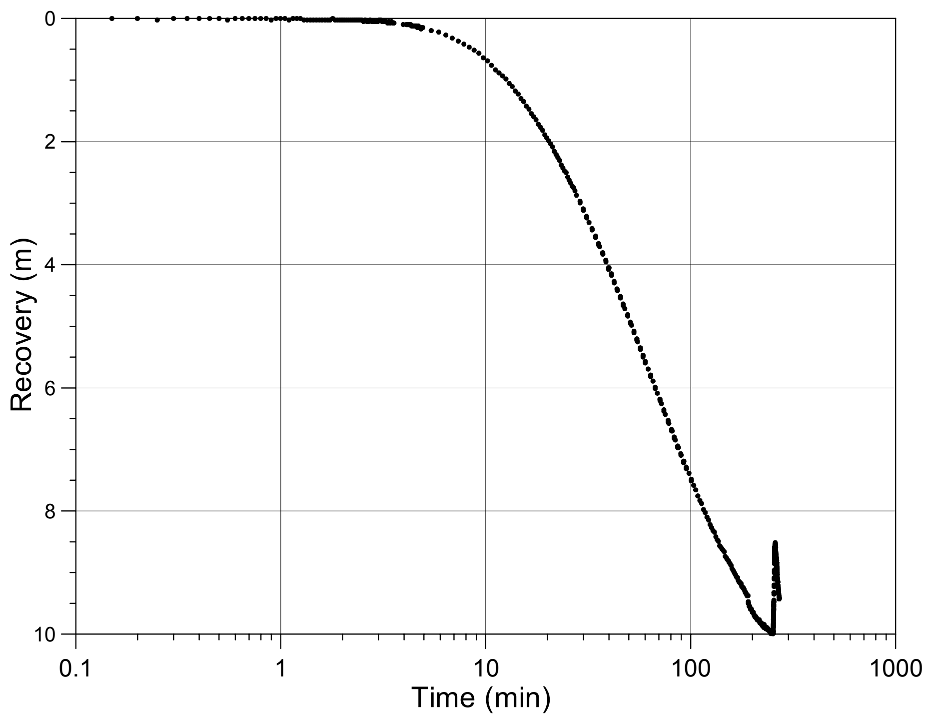
23_KA3600F_2.GRF 2005-06-13

KA3600F:3

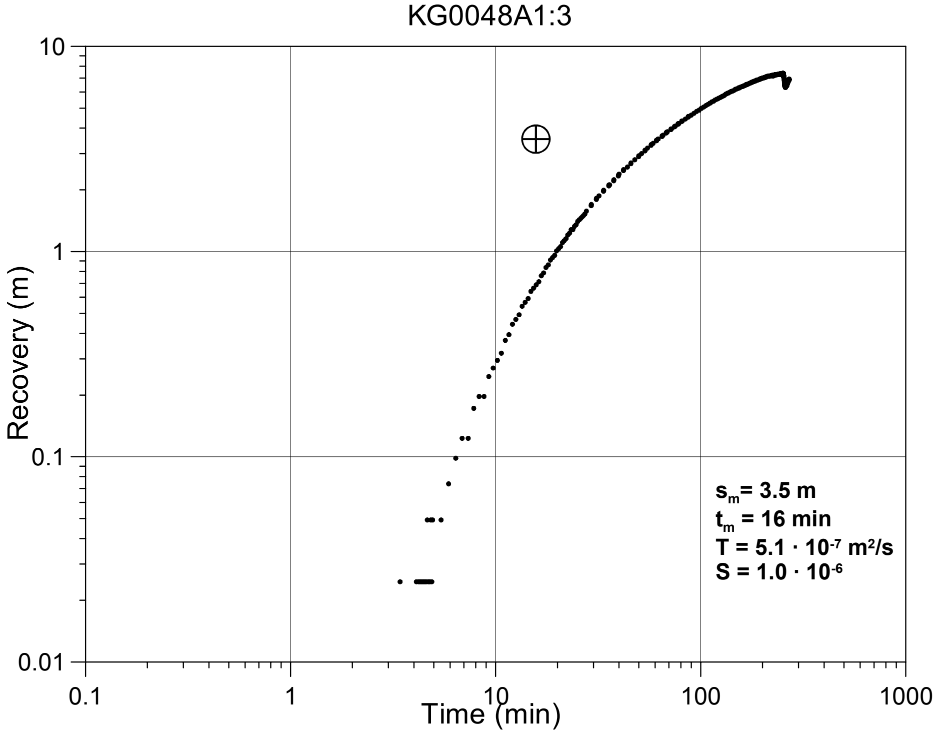


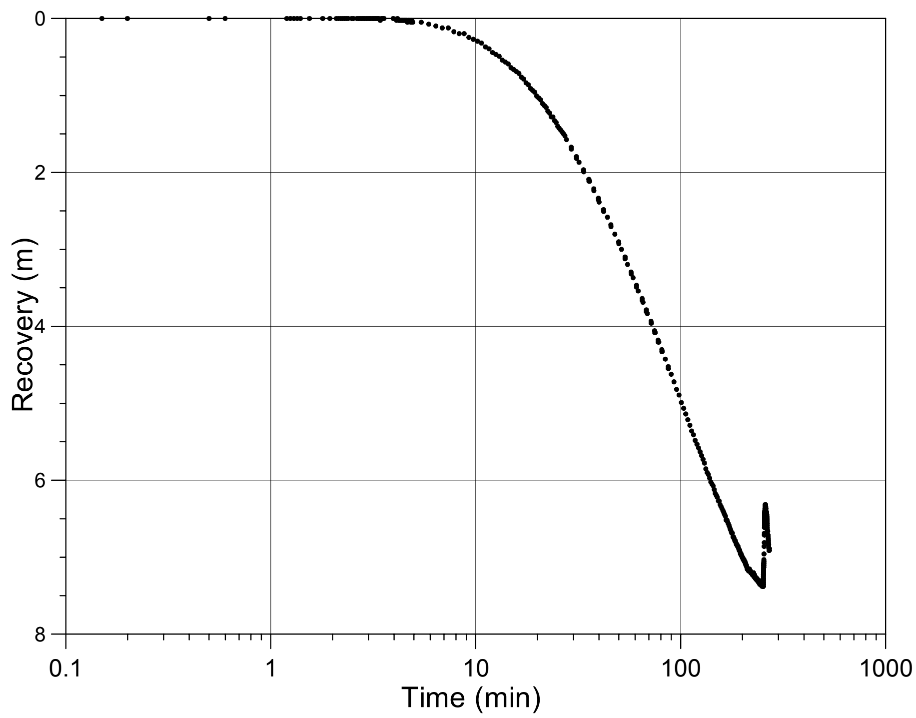
23_KA3600F_3.GRF 2005-06-13





23_KG0048A1_2.GRF 2005-06-13





23_KG0048A1_3.GRF 2005-06-13

APPENDIX 4

Interference test 5:24 in borehole KA3590G02, section 25.50 m – 30.01 m

Date: 2005-01-21
Field Crew: A. Blom / J. Magnusson
Borehole length: 30.01 m
Borehole diameter: 76 mm

Flowing borehole: KA3590G02, section 1: 25.50 – 30.01 m

Valve opened: 20050121 15:00.00
Valve closed: 20050121 21:00.00

End of Test: 20050122 15:00

Total flowing time : 360 min
Tot. Pr. Build-up time: 1080 min.

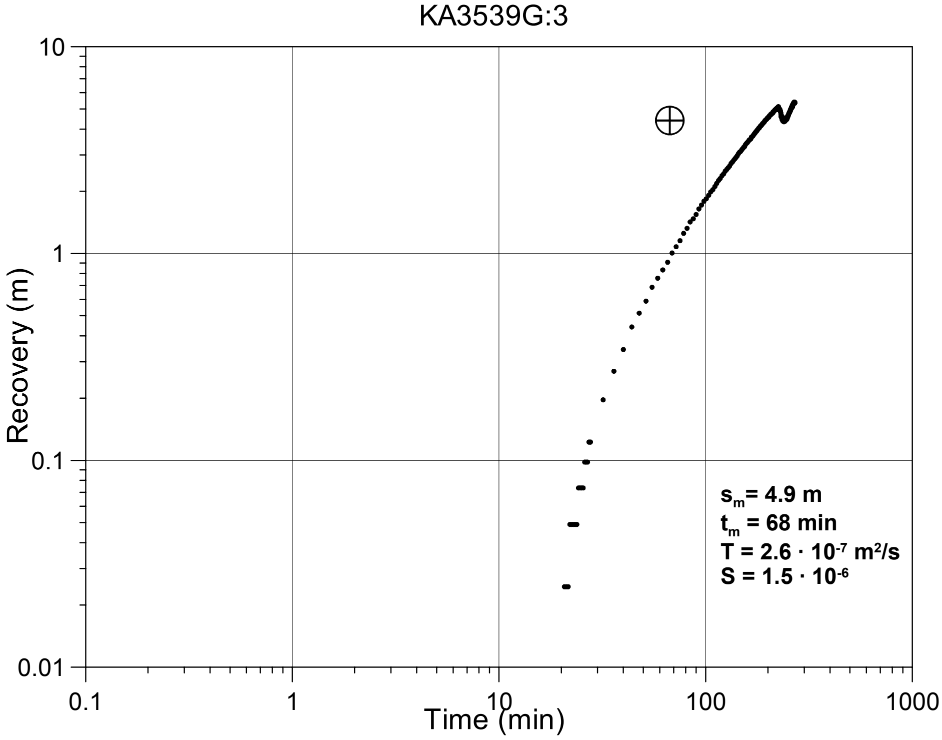
The test was performed as an Interference test. Pressure responses were monitored in 132 borehole sections including the flow section.

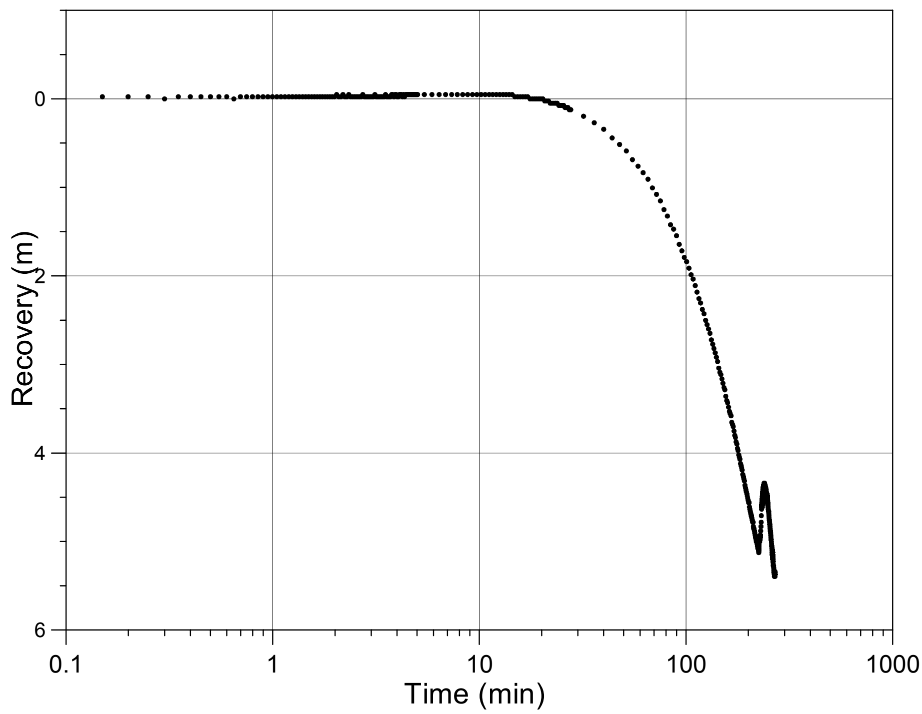
Flow data
Manually measured flow rates of KA3590G02, section 25.50 m – 30.01 m are presented in the table below:

Table Manually measured flow rates, Interference test in KA3590G02, section 25.50 m – 30.01 m. Prototype Repository, January 21 2005

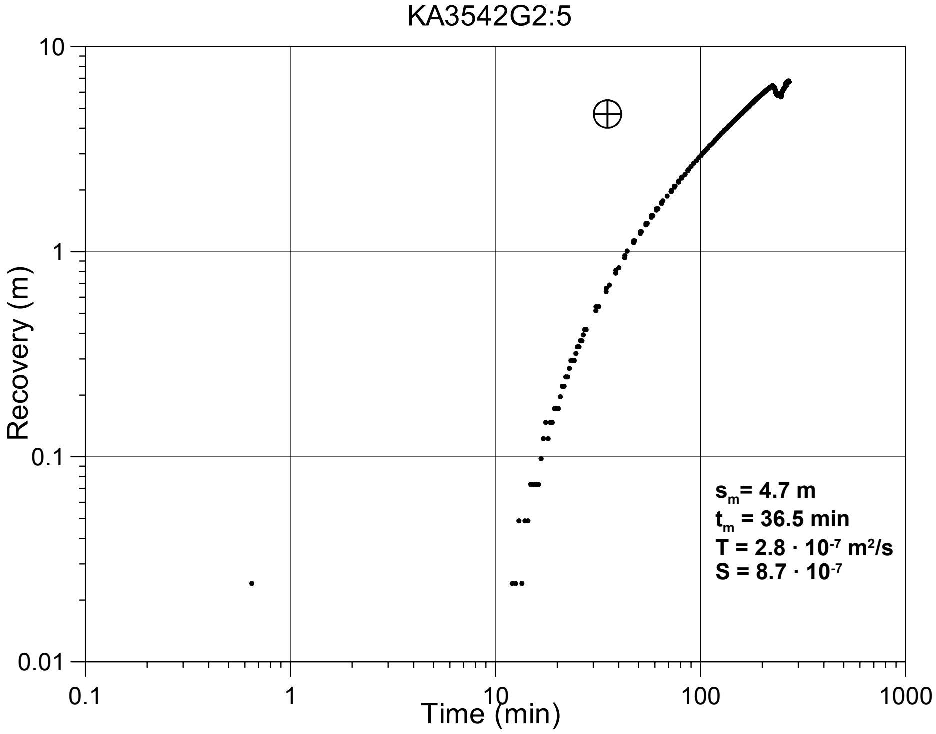
Time	Flow rate (l/min)
15:00:10	1.38E+00
15:01:10	1.32E+00
15:02:10	1.28E+00
15:37:30	1.07E+00
15:38:30	1.06E+00
15:39:30	1.06E+00
20:49:00	9.68E-01
20:50:00	9.75E-01
20:51:00	9.75E-01

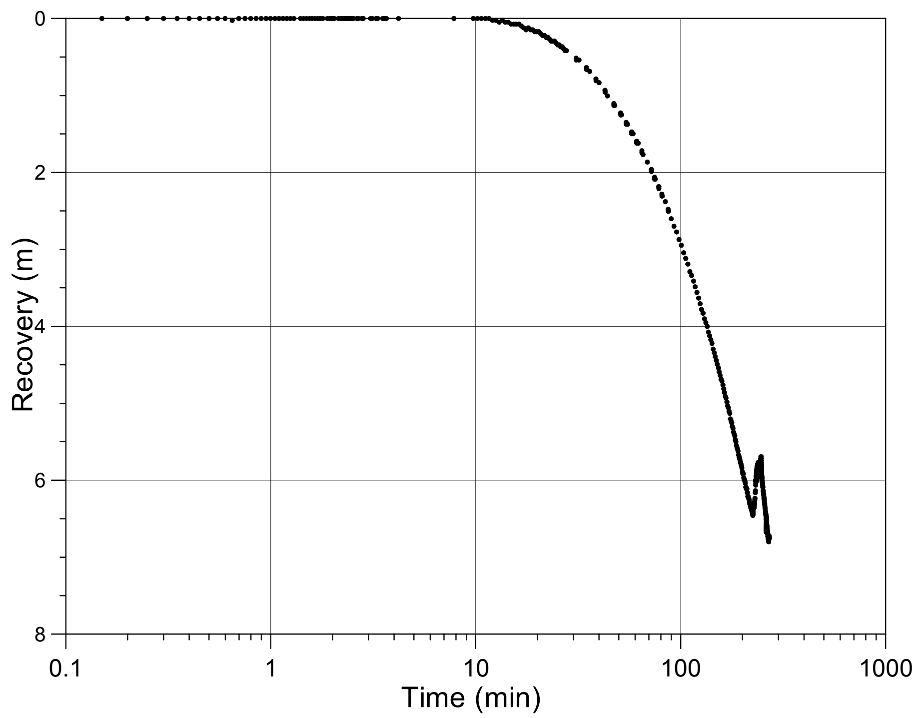
In all cases the matchpoint used is consistent with $p_D = 1$ and $t_D = 1$.



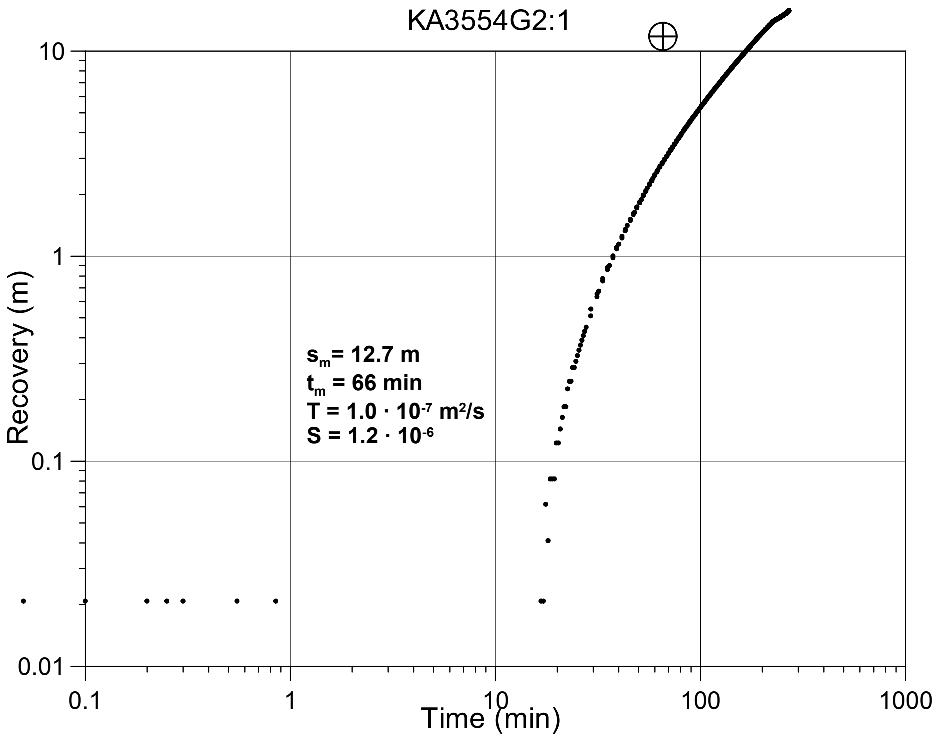


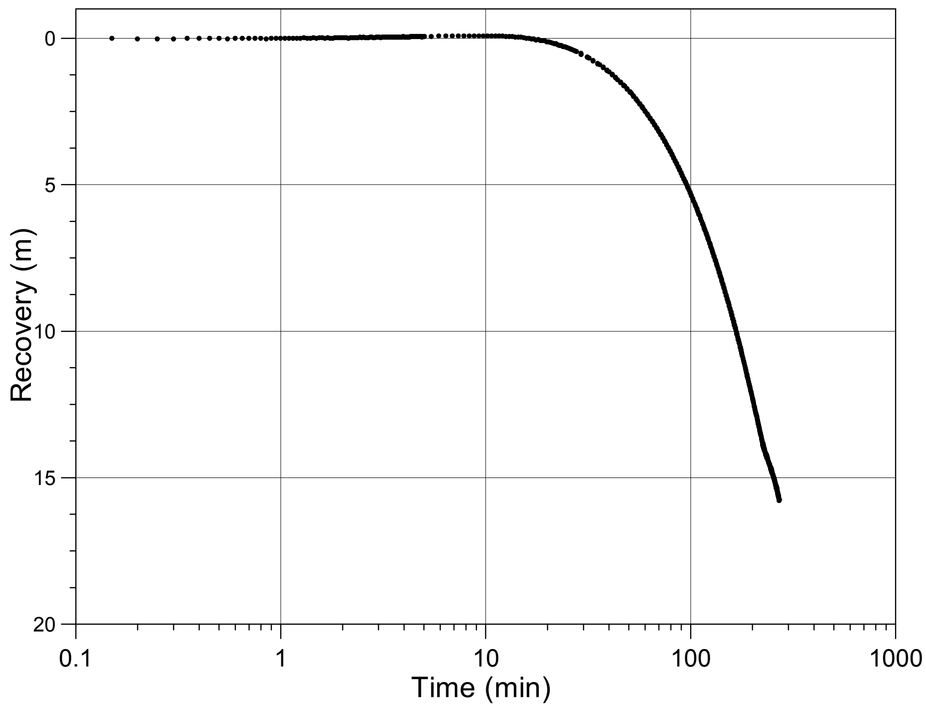
24_KA3539G_3.GRF 2005-06-14



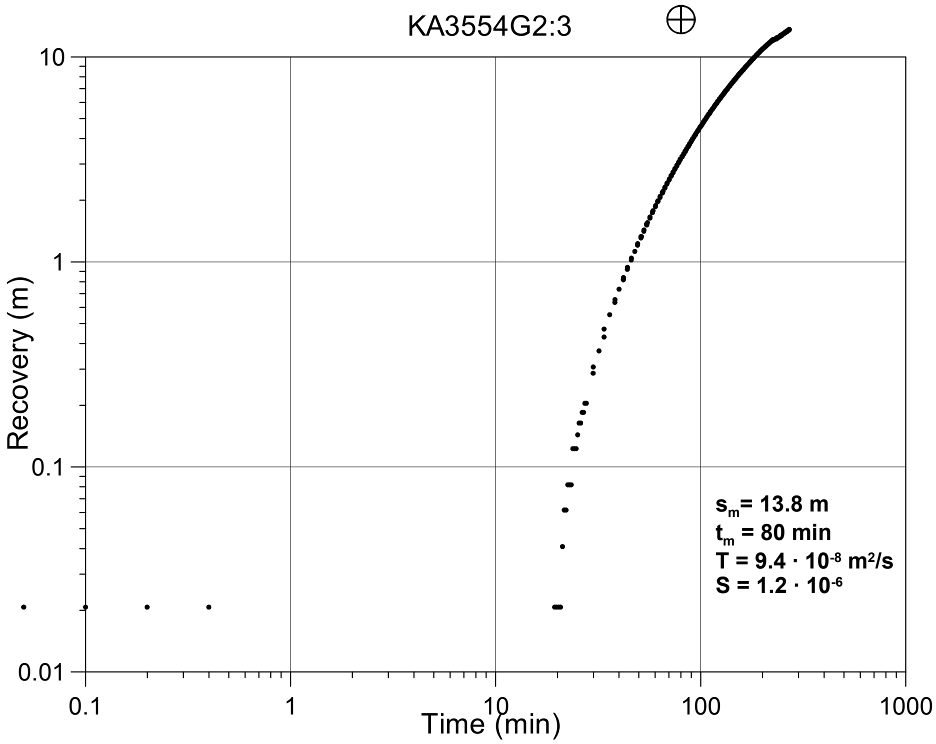


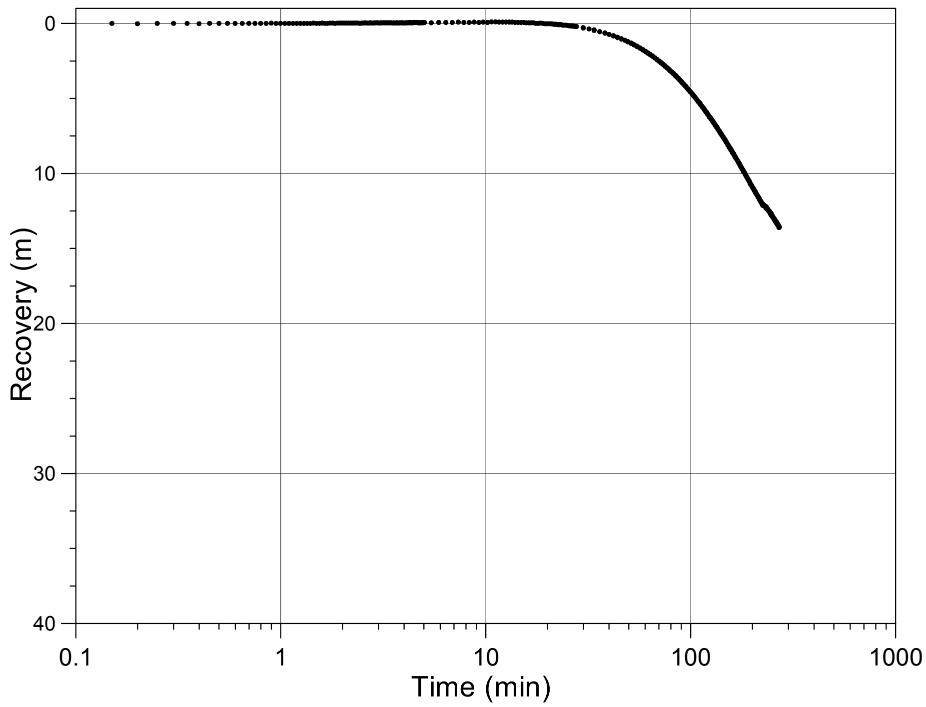
24_KA3542G2_5.GRF 2005-06-14



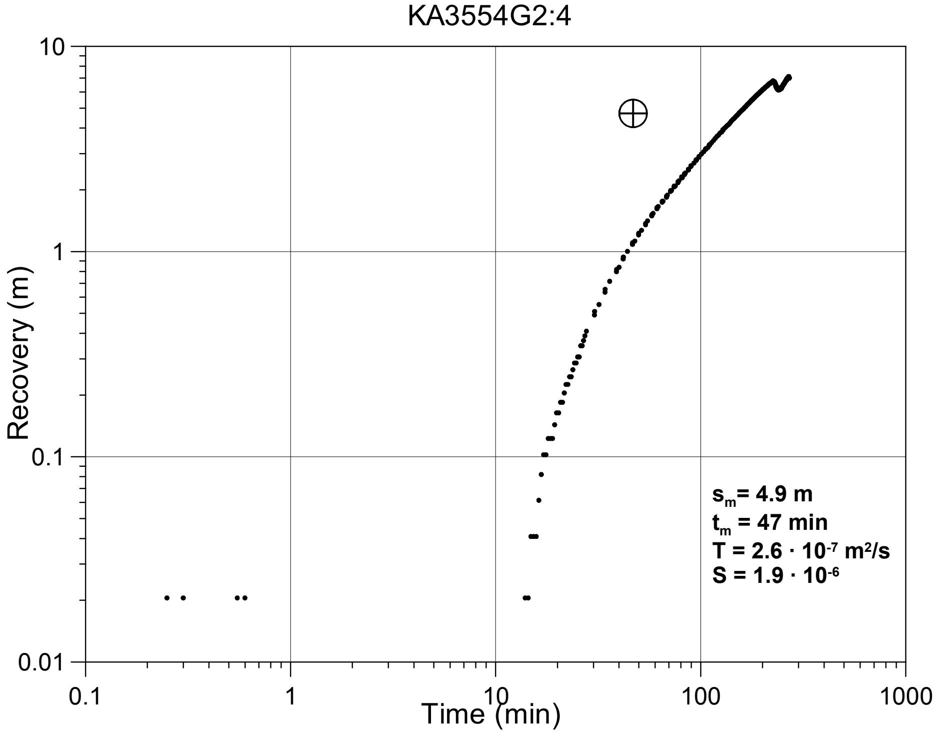


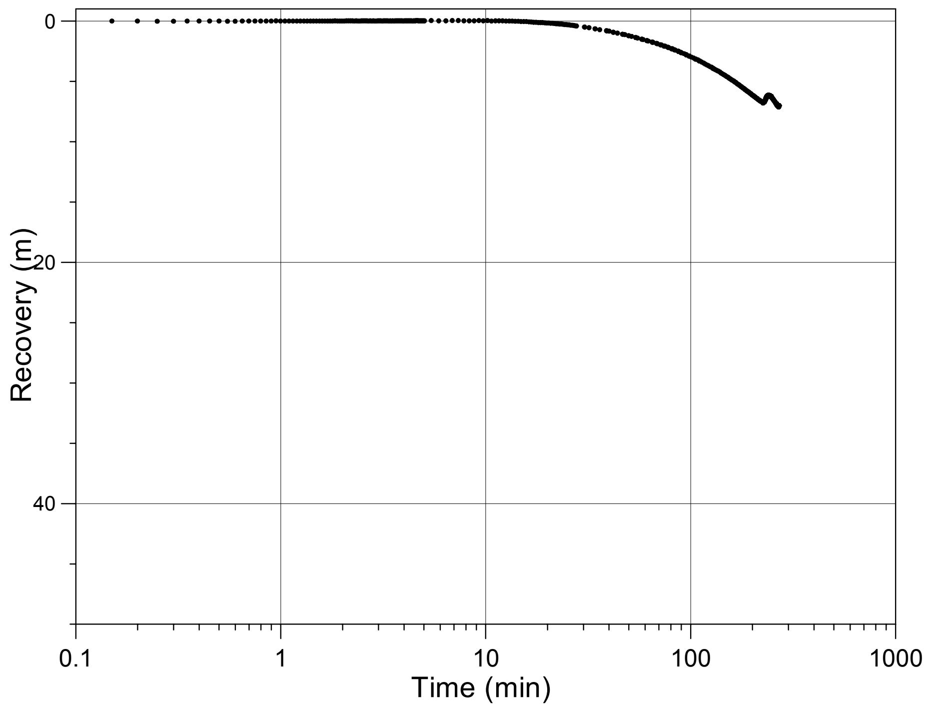
24_KA3554G2_1.GRF 2005-06-14



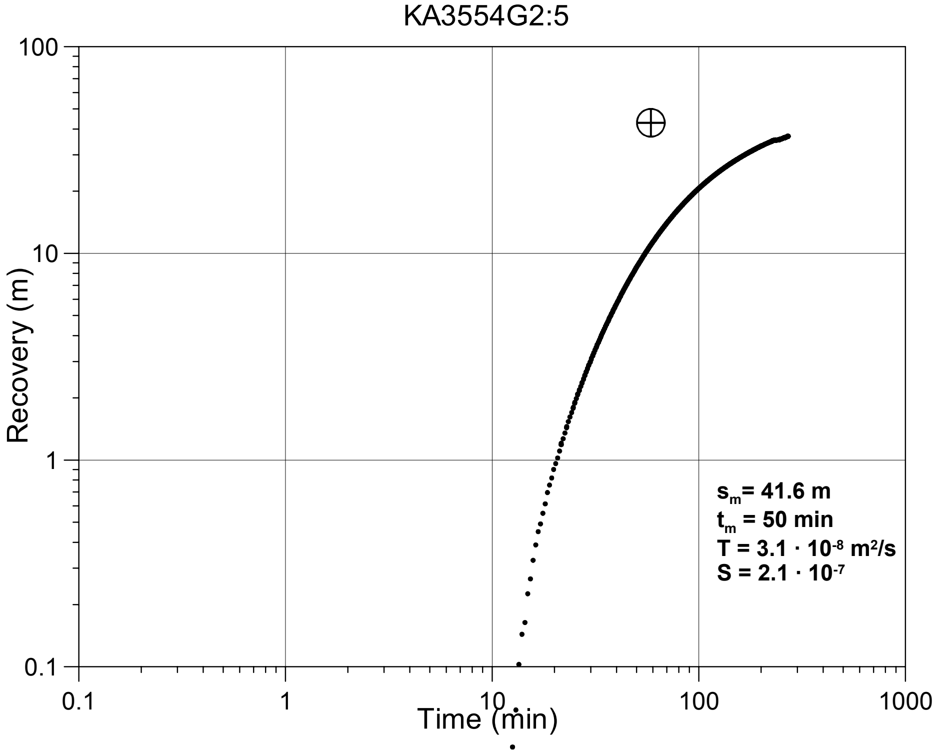


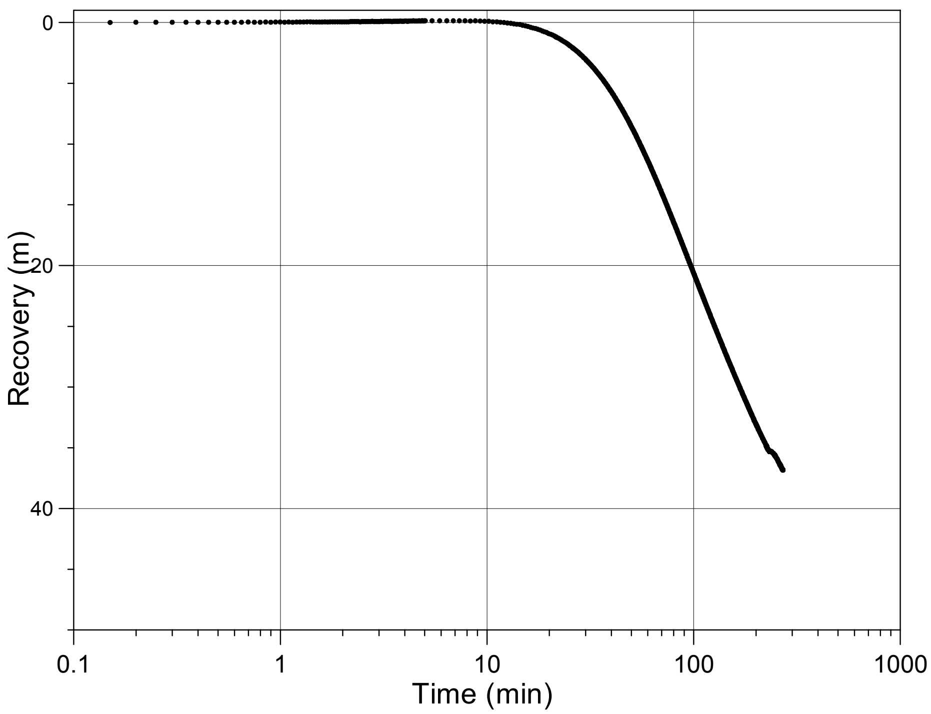
24_KA3554G2_3.GRF 2005-06-14



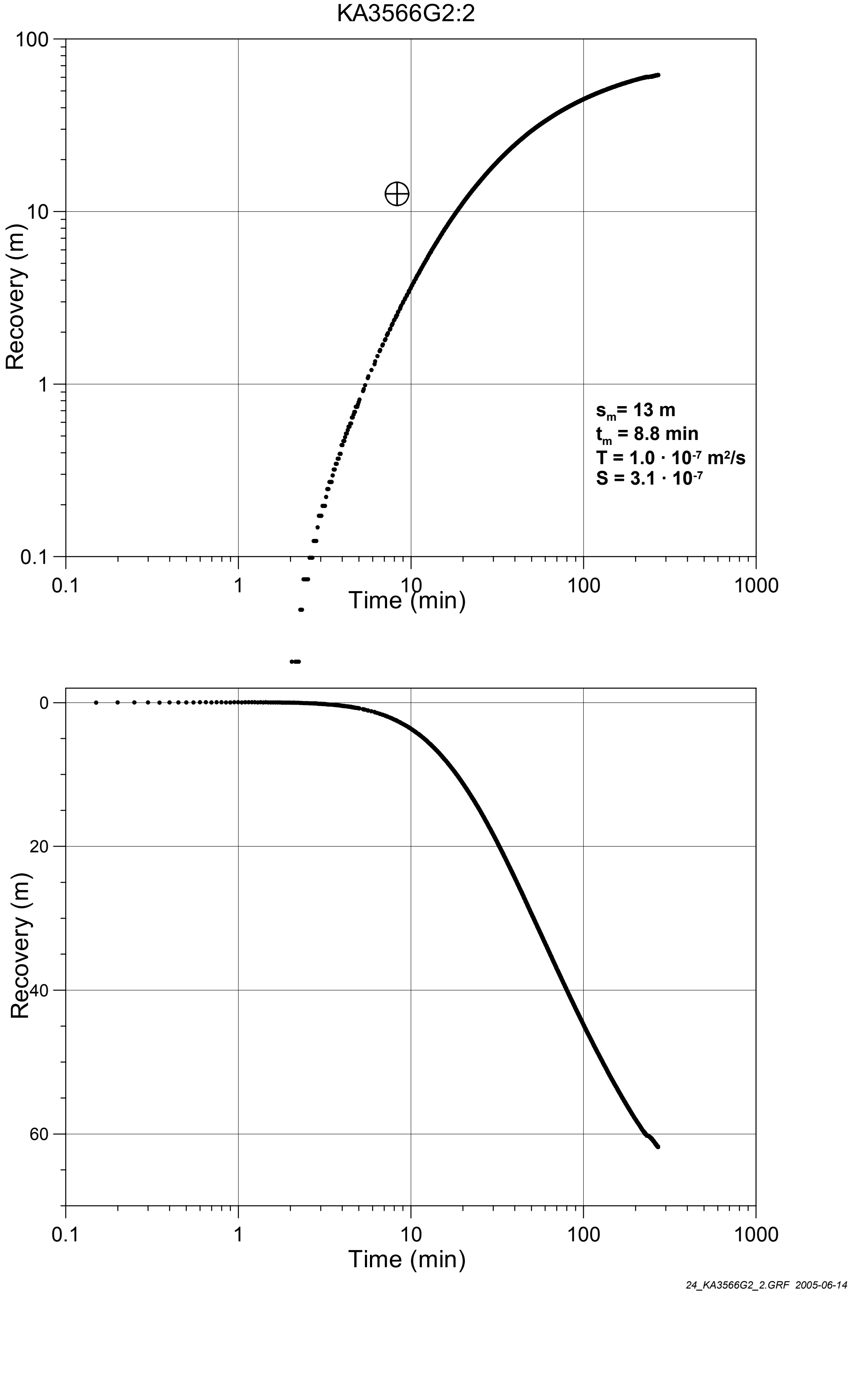


24_KA3554G2_4.GRF 2005-06-14



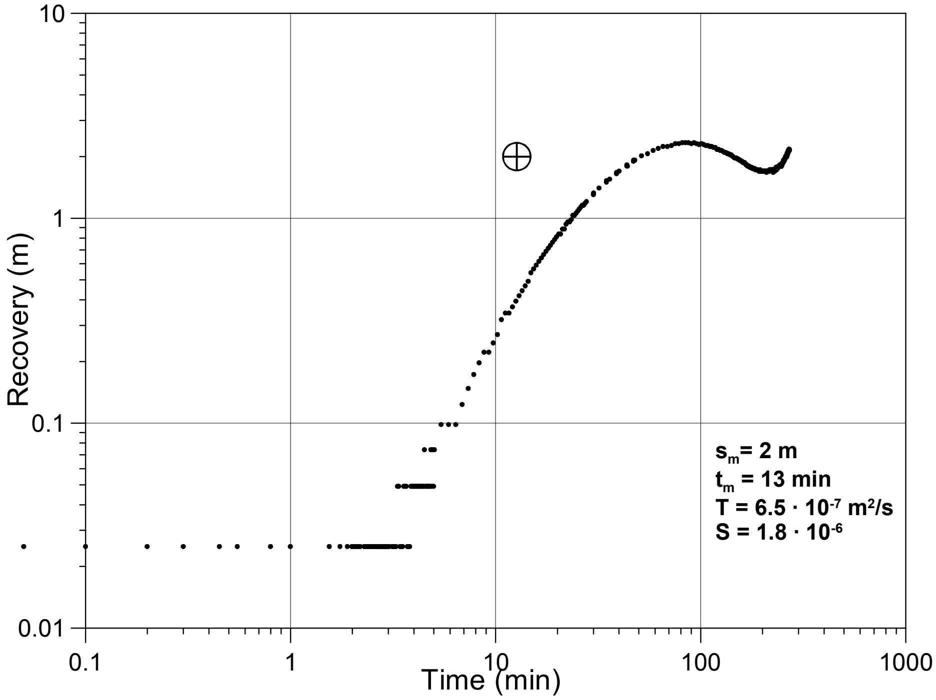


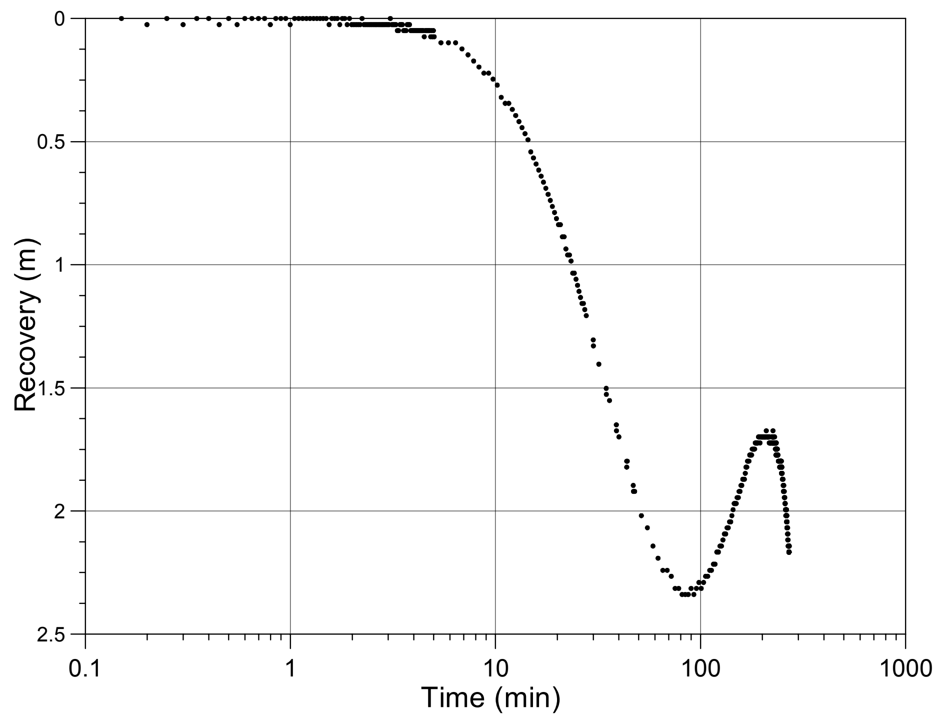
24_KA3554G2_5.GRF 2005-06-14



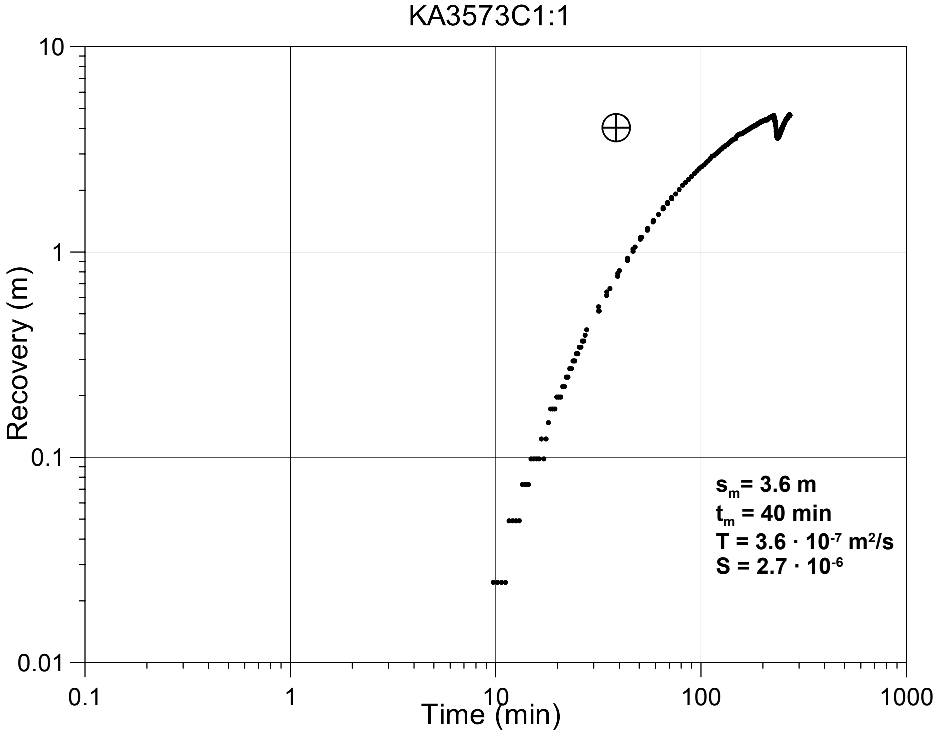
KA3566G2:2
Recovery (m)
Time (min)
s_m = 13 m
t_m = 8.8 min
T = 1.0 · 10^-7 m²/s
S = 3.1 · 10^-7
100
10
1
0.1
0.1
1
10
100
1000
0
20
40
60
Recovery (m)
Time (min)
24_KA3566G2_2.GRF 2005-06-14

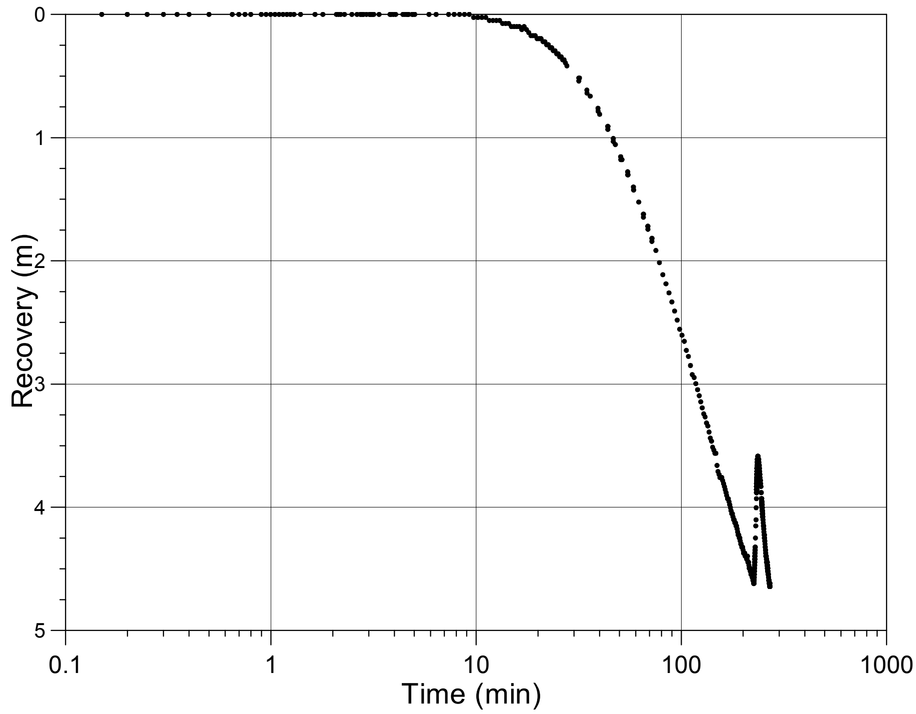
KA3566G2:5



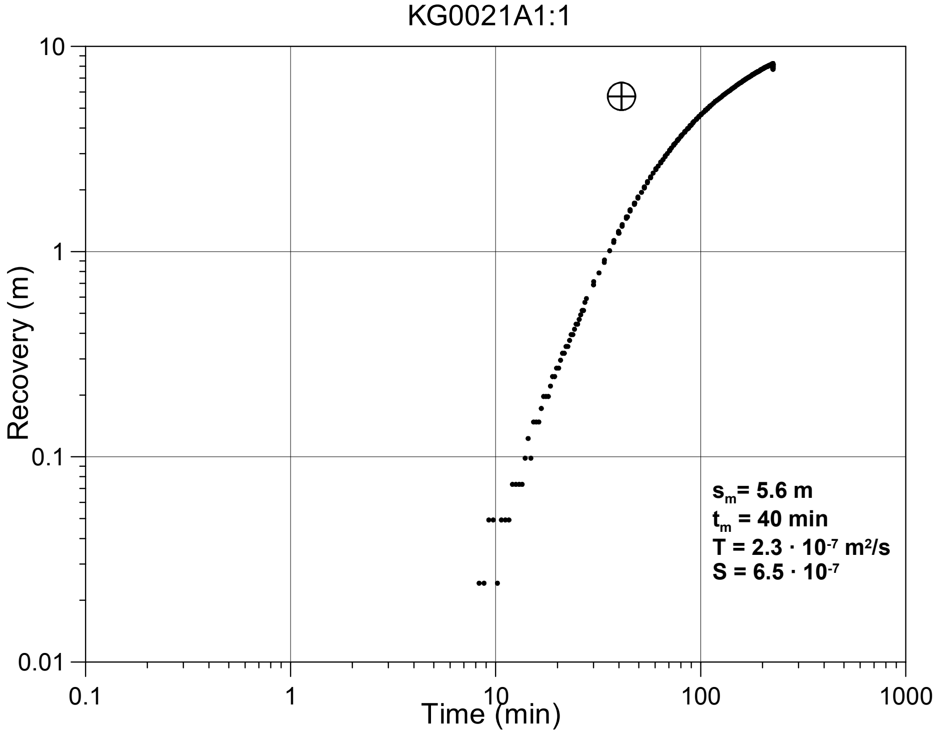


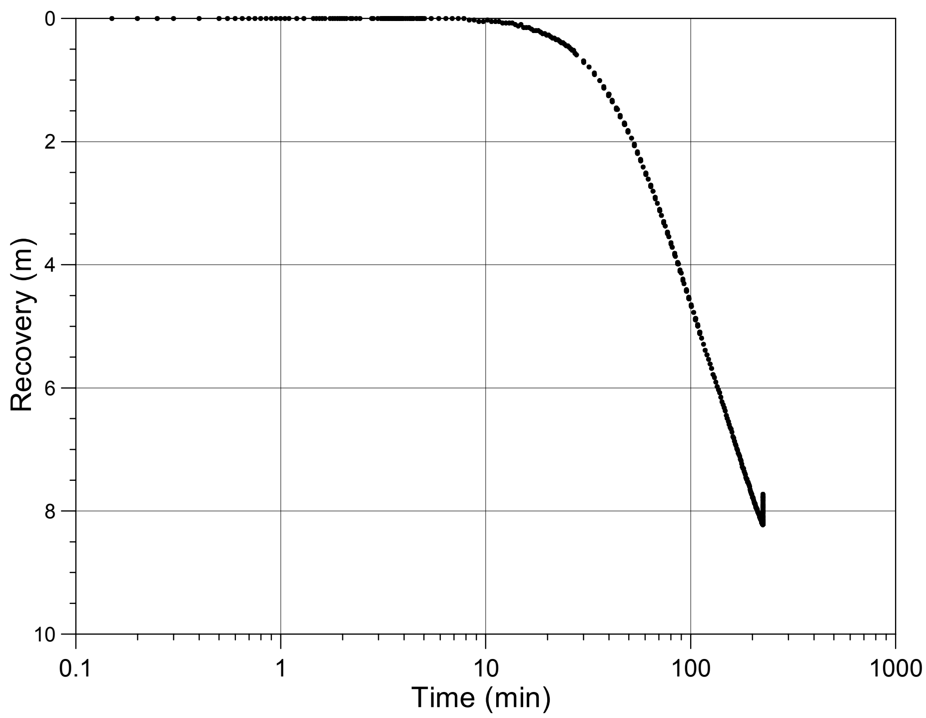
24_KA3566G2_5.GRF 2005-06-14



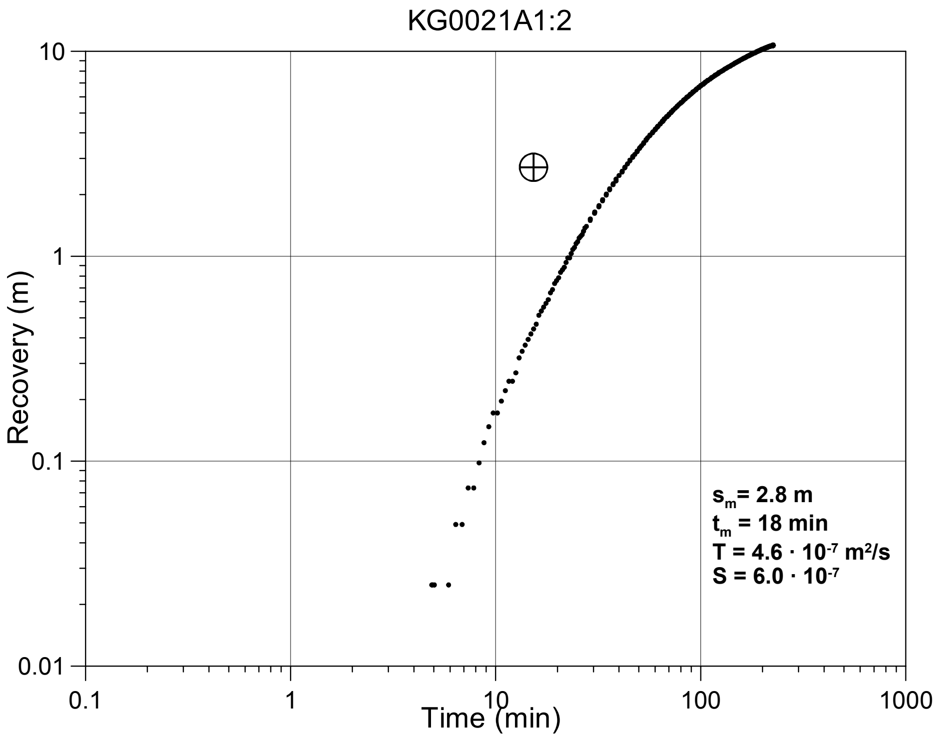


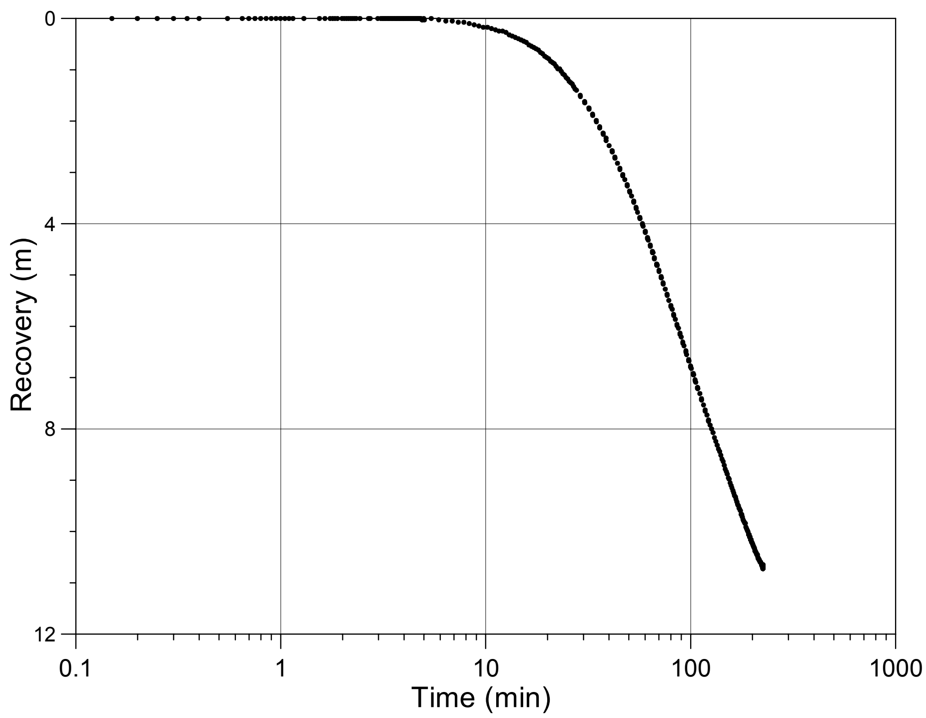
24_KA3573C1_1.GRF 2005-06-14



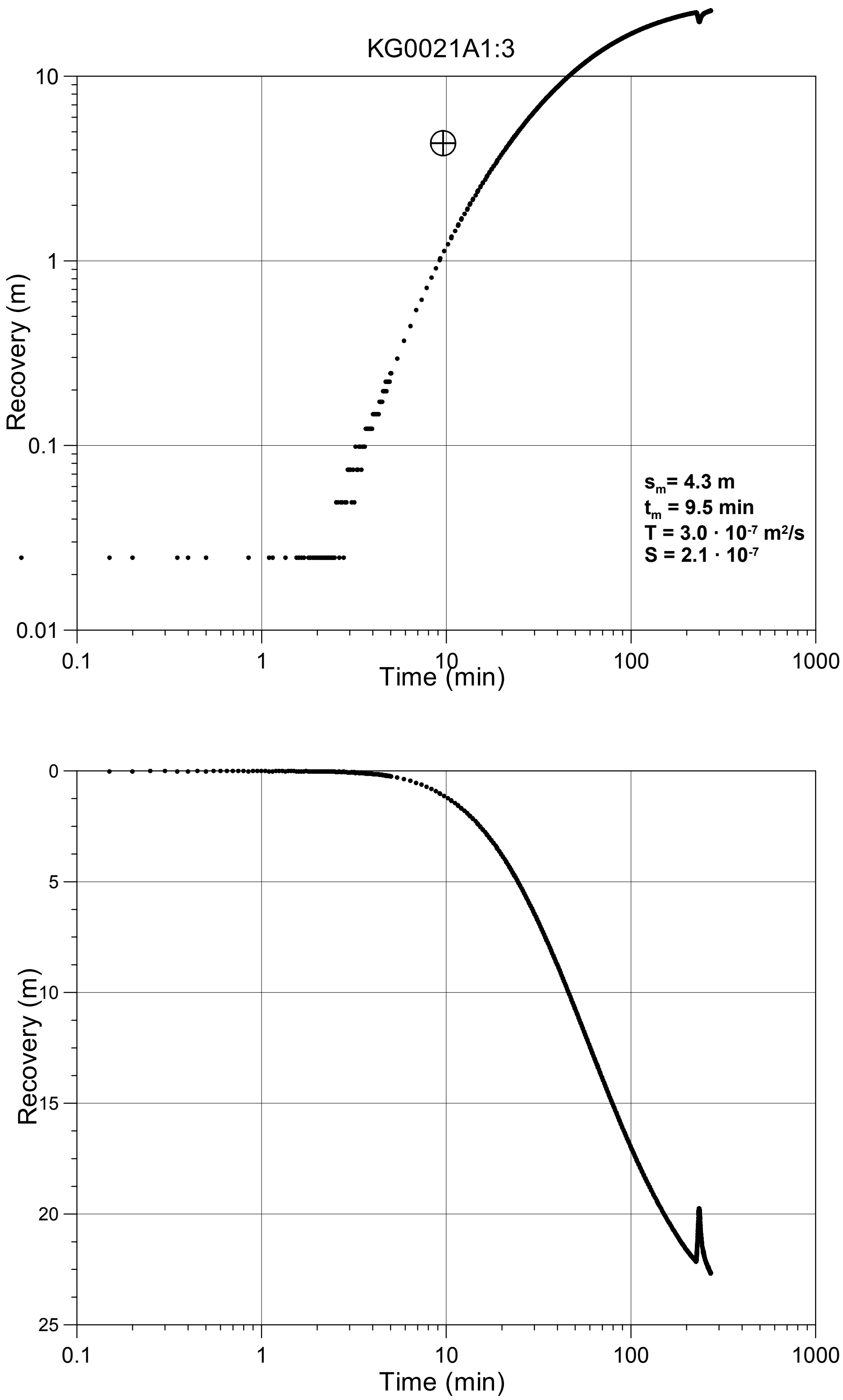


24_KG0021A1_1.GRF 2005-06-14

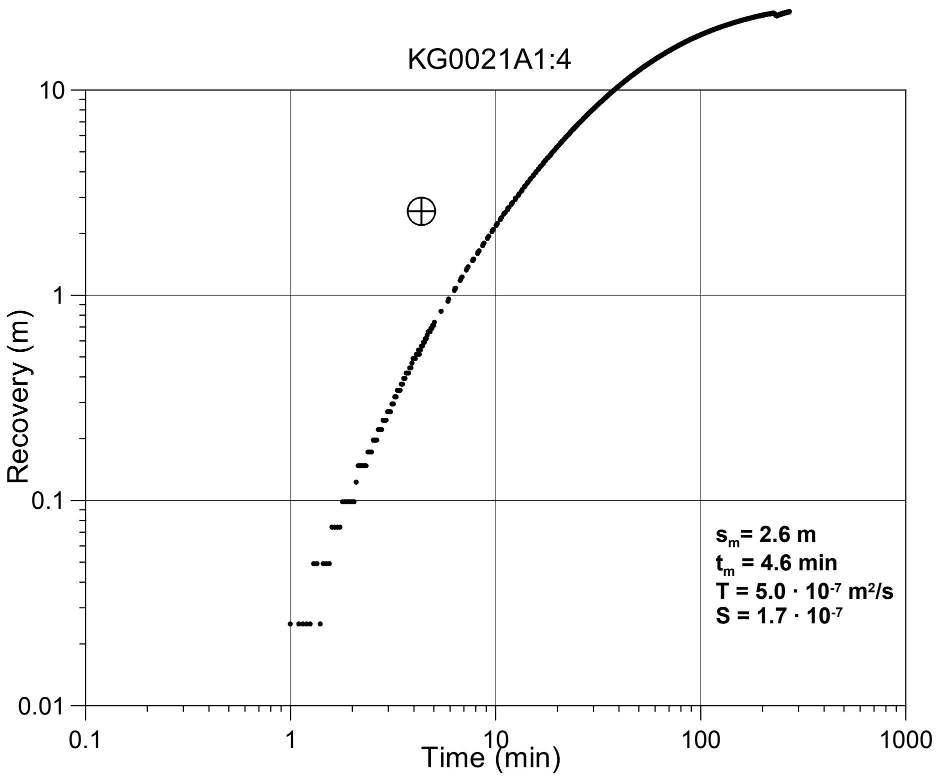


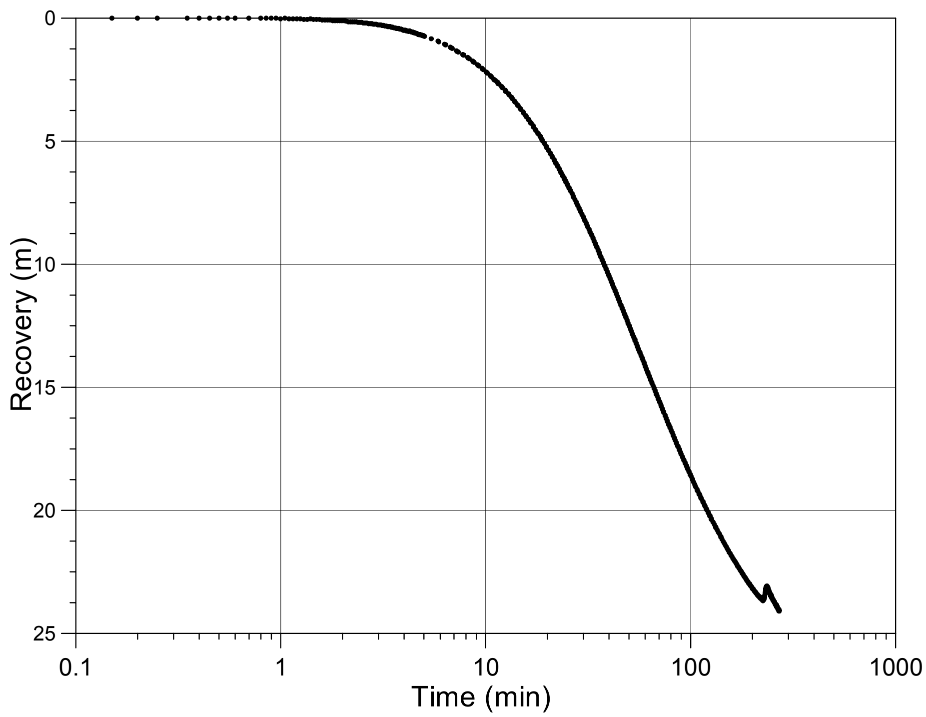


24_KG0021A1_2.GRF 2005-06-14



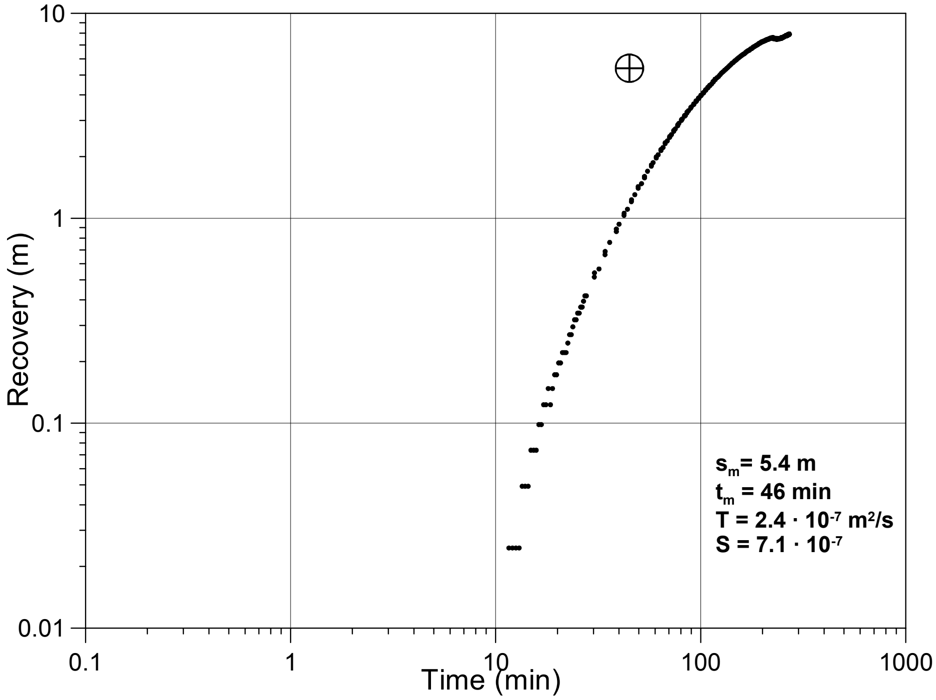
24_KG0021A1_3.GRF 2005-06-14

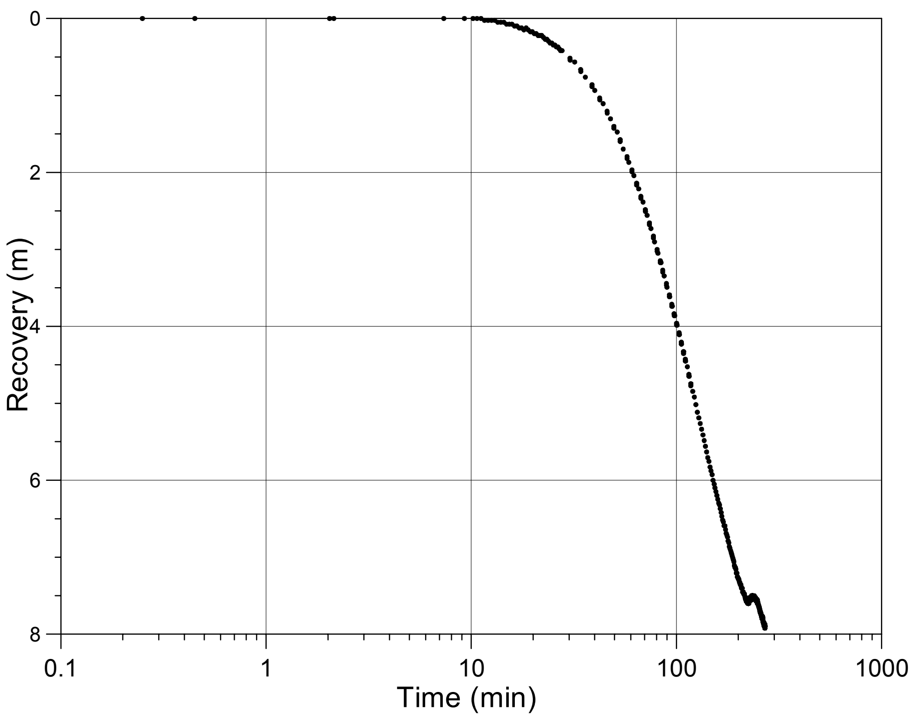




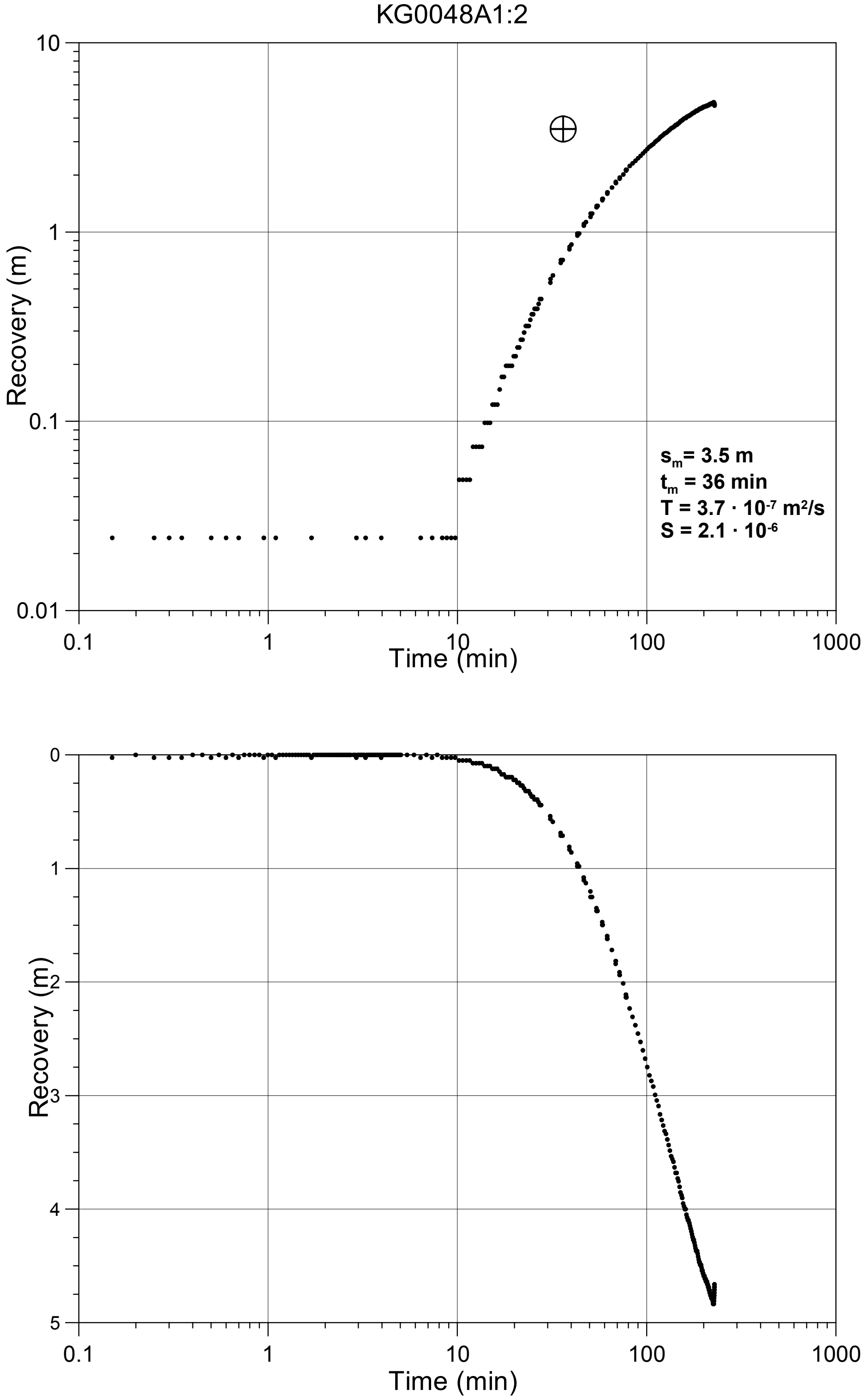
24_KG0021A1_4.GRF 2005-06-14

KG0021A1:5

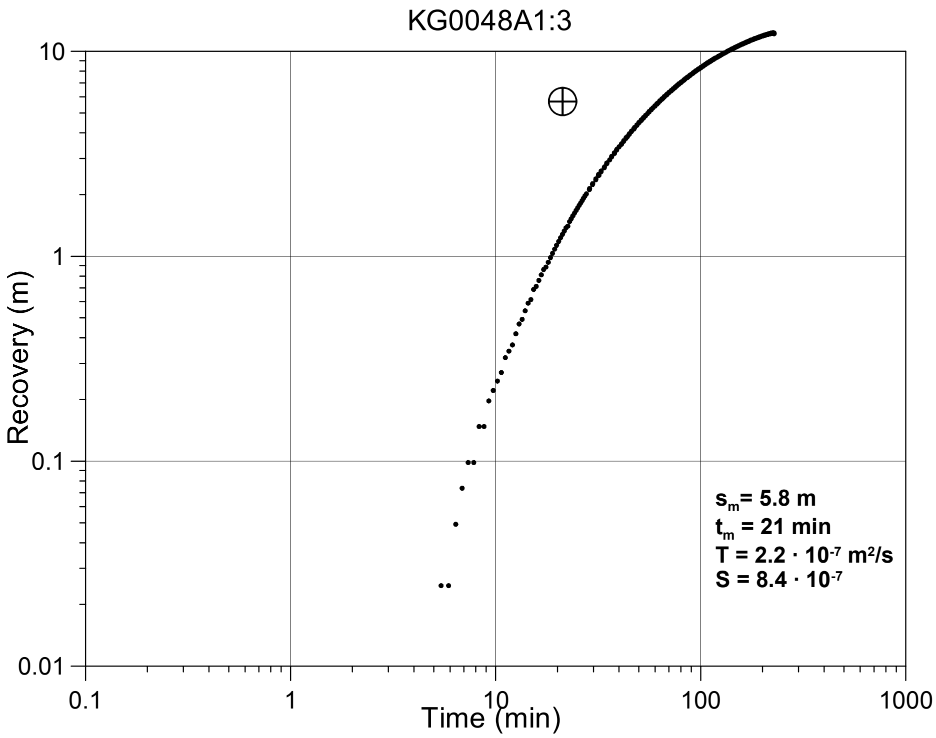


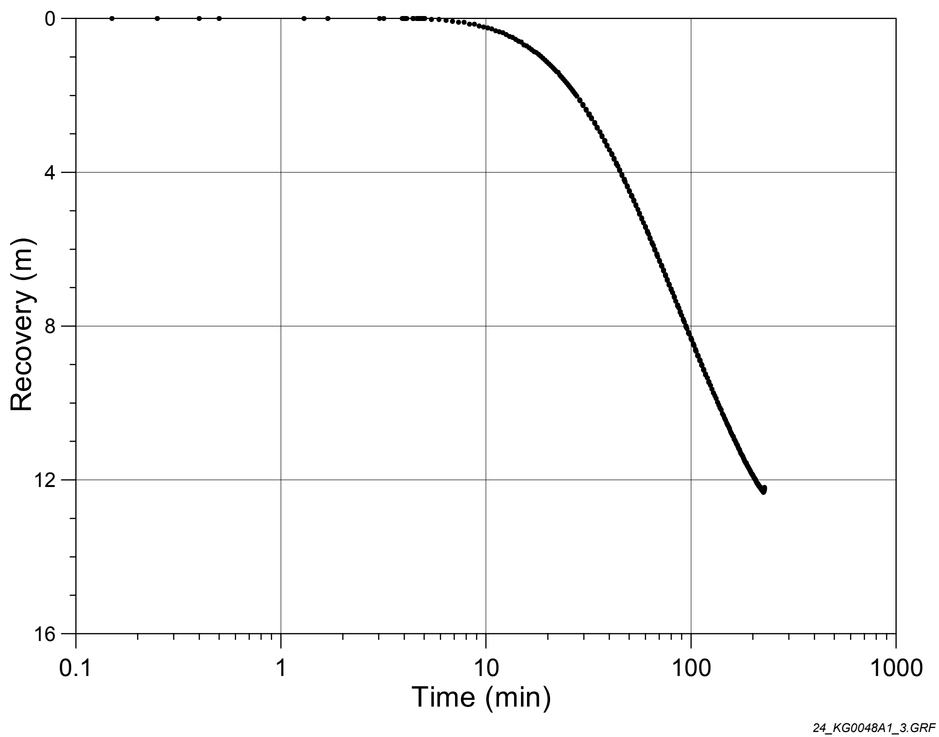


24_KG0021A1_5.GRF 2005-06-14

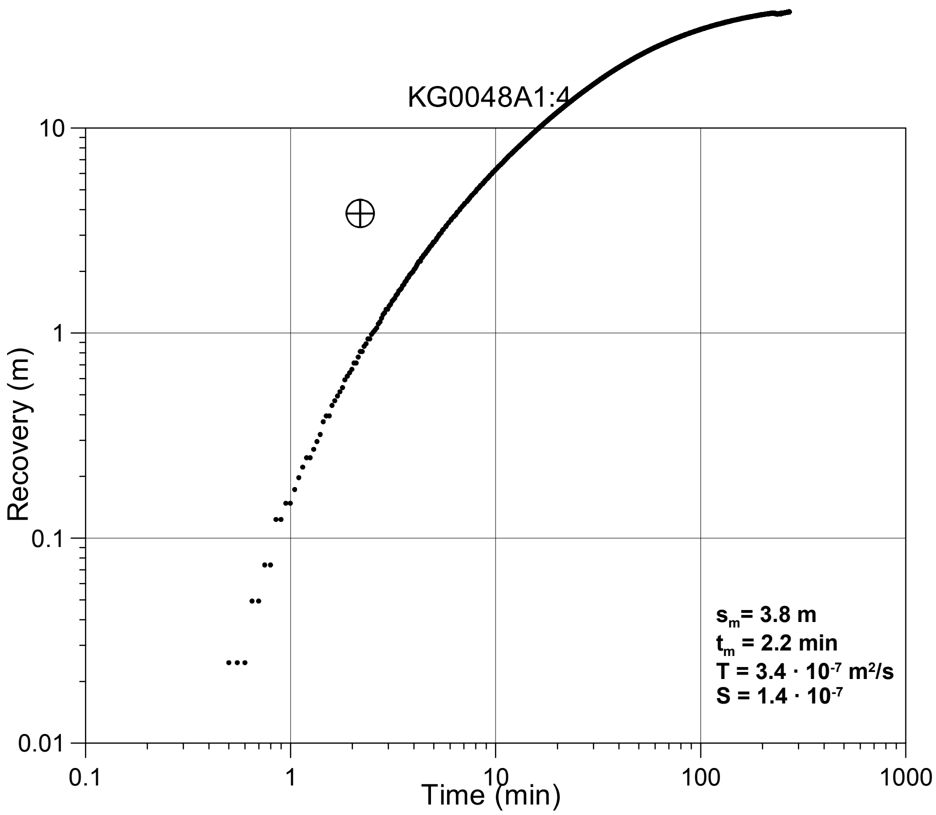


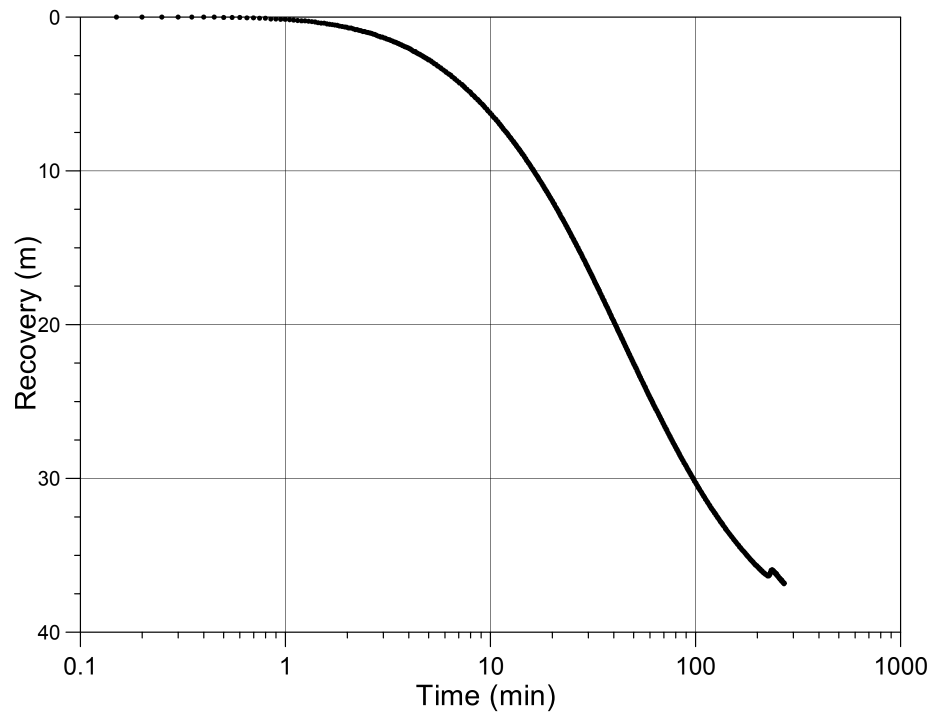
24_KG0048A1_2.GRF 2005-06-14





24_KG0048A1_3.GRF 2005-06-14





24_KG0048A1_4.GRF 2005-06-14

APPENDIX 5

Interference test 5:25 in borehole KG0021A01, section 35.00 m – 36.00 m

Date: 2005-01-19
Field Crew: A. Blom / J. Magnusson
Borehole length: 48.82 m
Borehole diameter: 76 mm

Flowing borehole: KG0021A01, section 3: 35.00 m – 36.00 m

Valve opened: 20050119 16:00.00 Valve closed: 20050119 22:00.00

End of Test: 20050122 16:00

Total flowing time : 360 min
Tot. Pr. Build-up time: 1080 min.

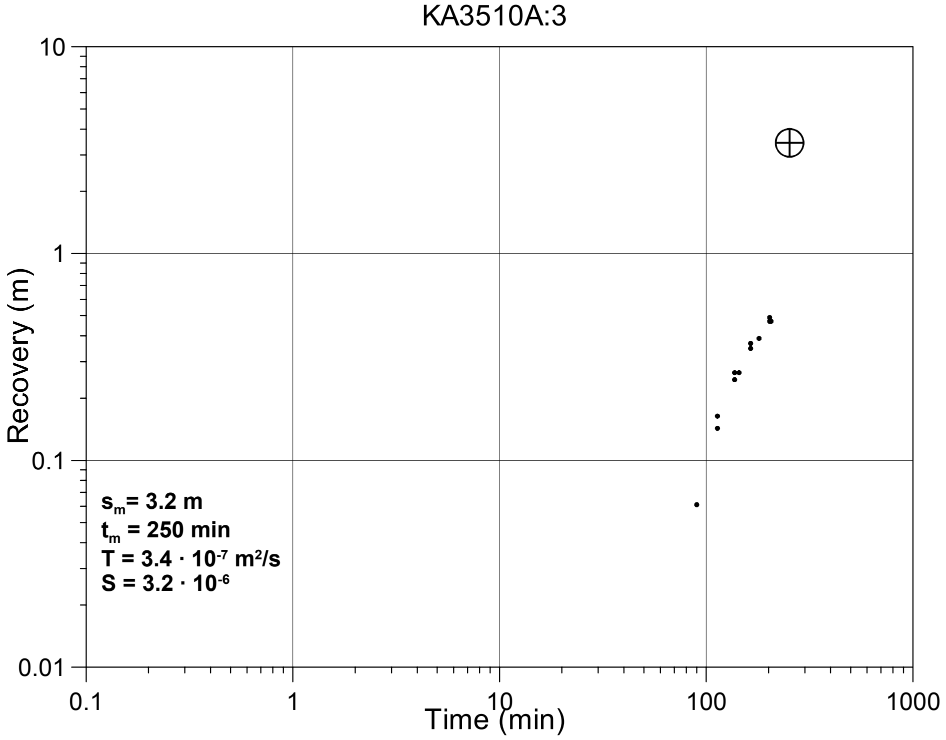
The test was performed as an Interference test. Pressure responses were monitored in 132 borehole sections including the flow section.

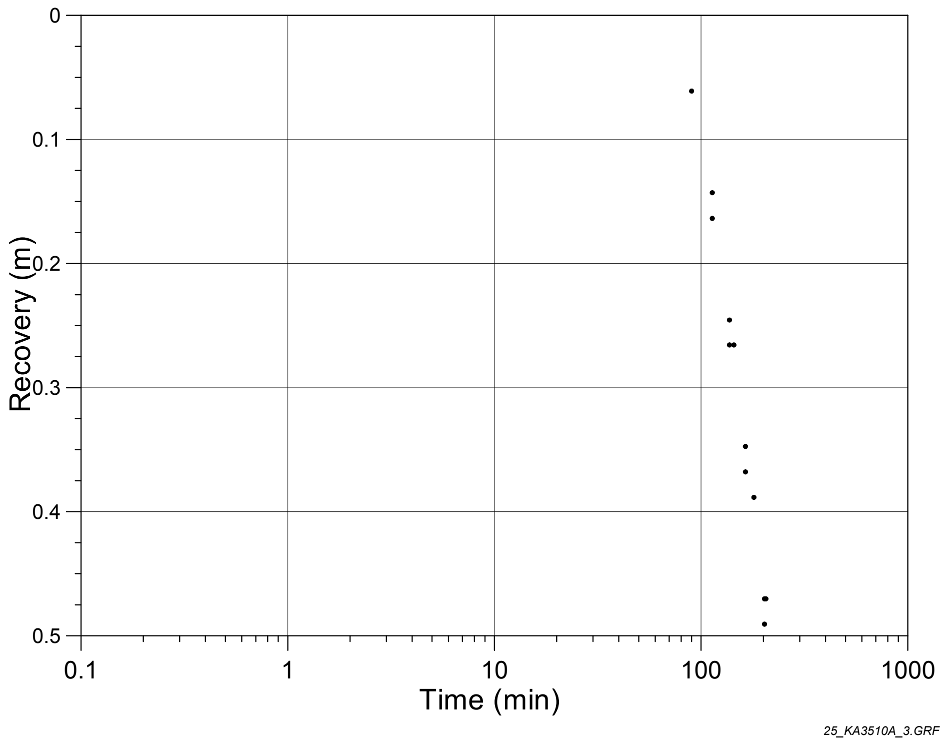
Flow data
Manually measured flow rates of KG0021A01, section 35.00 m – 36.00 m are presented in the table below:

Table Manually measured flow rates, Interference test in KG0021A01, section 35.00 m – 36.00 m. Prototype Repository, January 19 2005

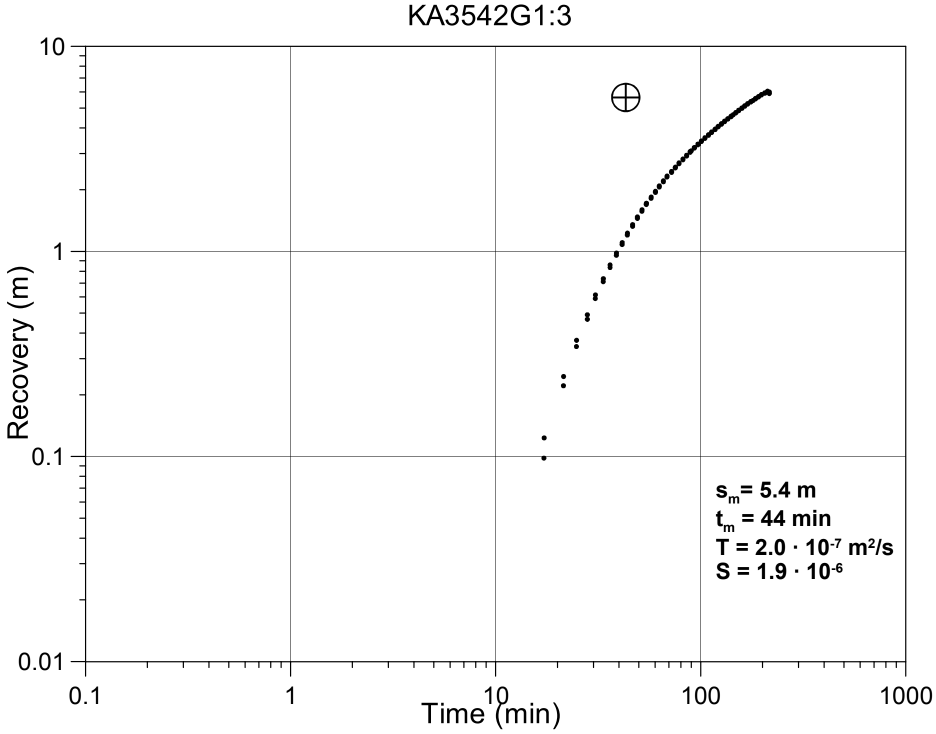
Time	Flow rate (l/min)
16:00:10	4.43E+00
16:00:40	3.48E+00
16:01:30	2.49E+00
16:02:20	1.83E+00
16:08:00	1.07E+00
16:09:00	1.07E+00
16:32:10	8.80E-01
16:33:20	8.80E-01
16:34:30	8.75E-01
18:18:00	8.30E-01
18:19:30	8.30E-01
21:51:00	8.20E-01
21:52:10	8.25E-01
21:53:20	8.25E-01

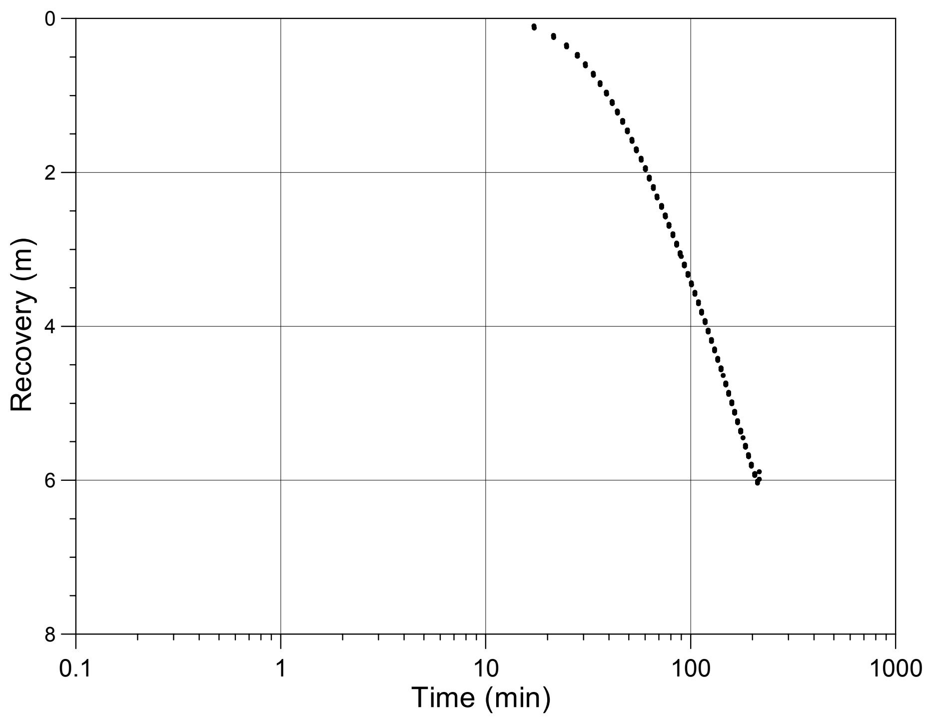
In all cases the matchpoint used is consistent with $p_D = 1$ and $t_D = 1$.



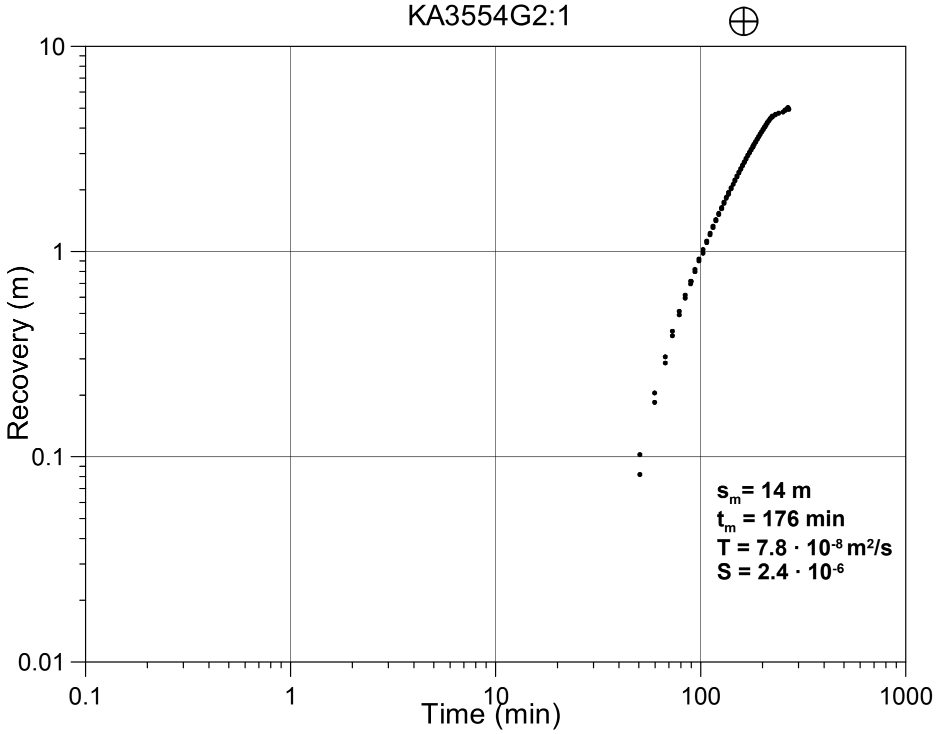


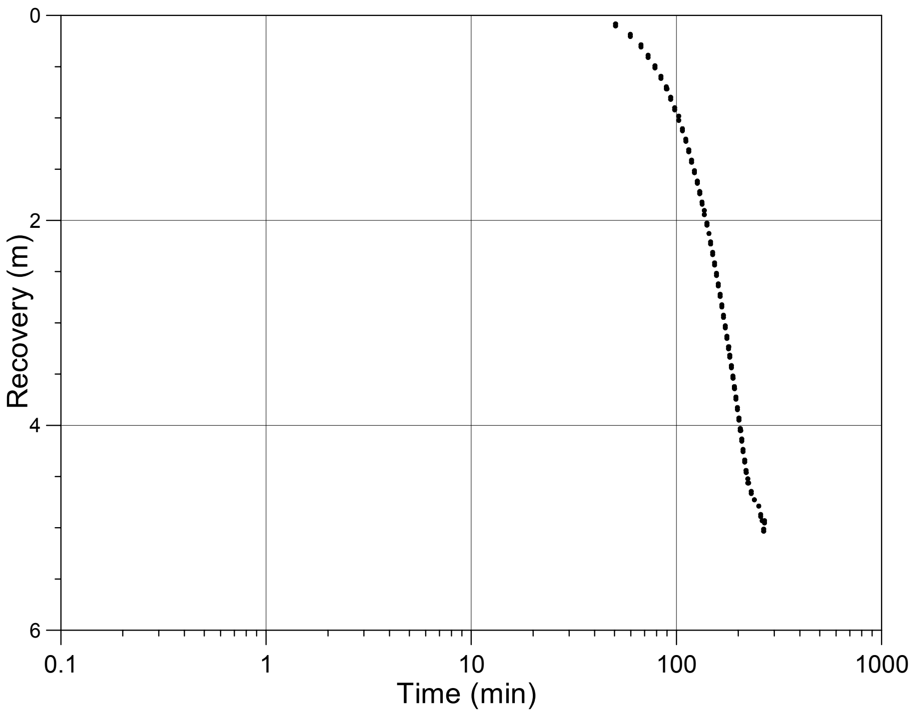
25_KA3510A_3.GRF 2005-06-15



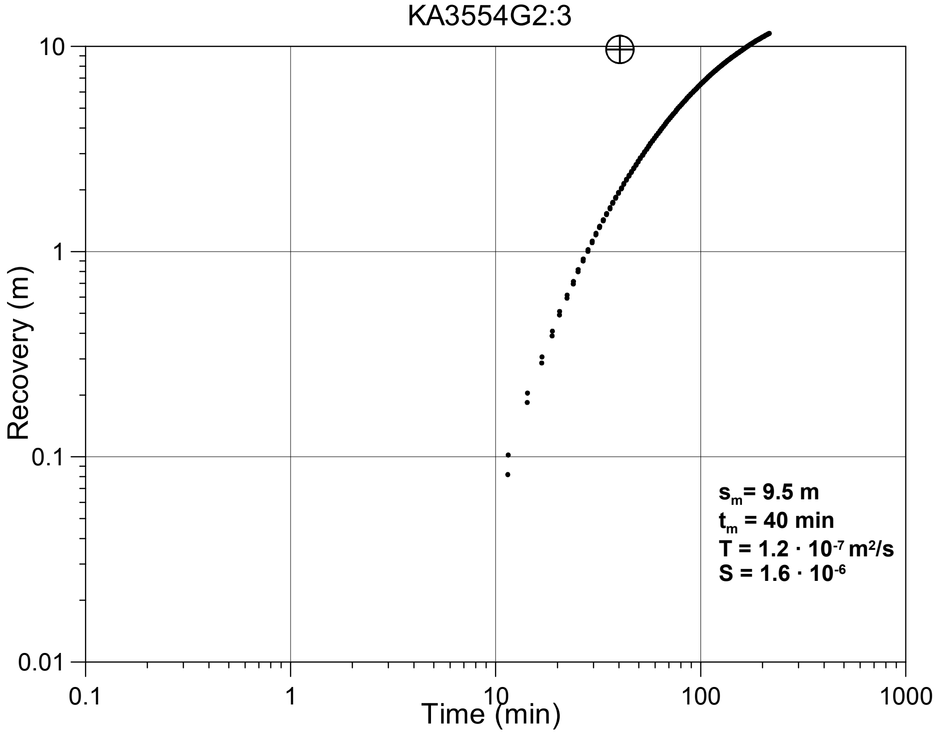


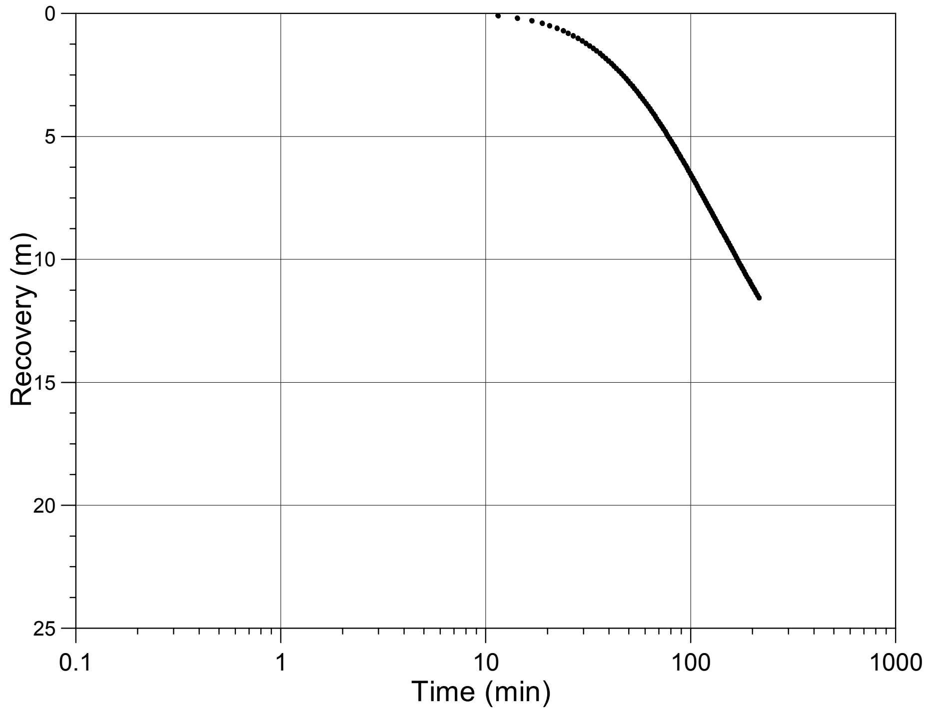
25_KA3542G1_3.GRF 2005-06-15



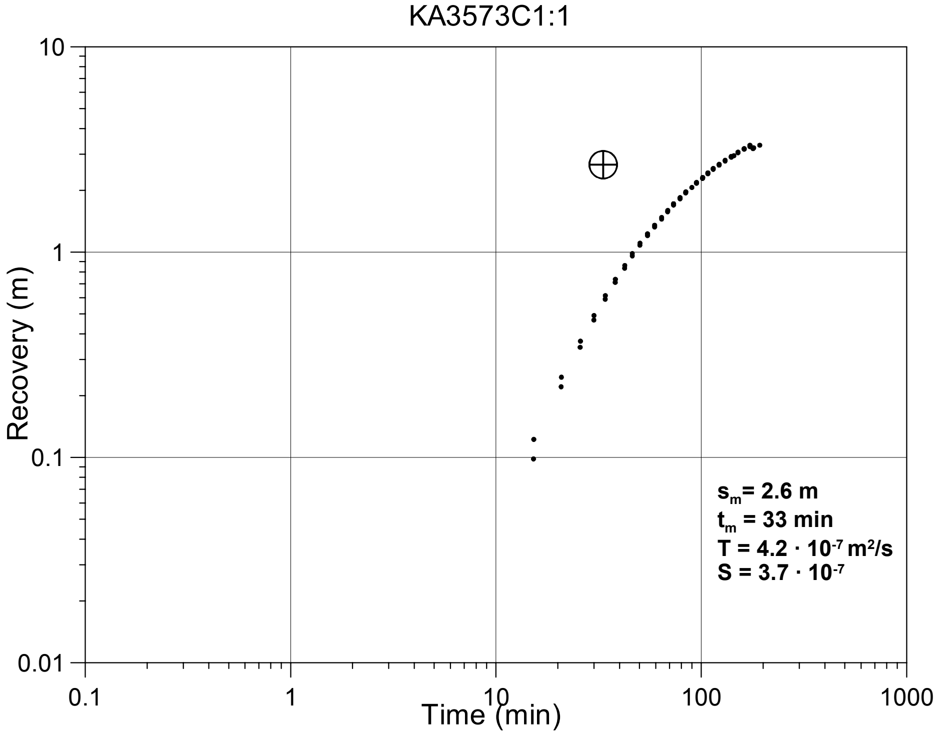


25_KA3554G2_1.GRF 2005-06-15

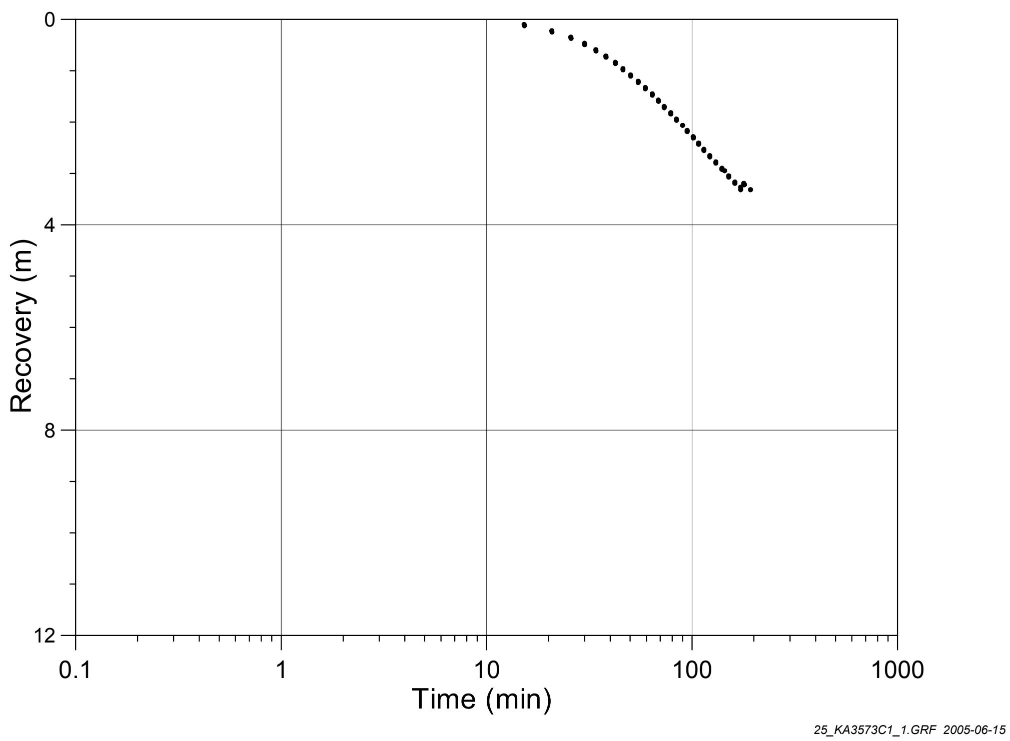




25_KA3554G2_3.GRF 2005-06-15

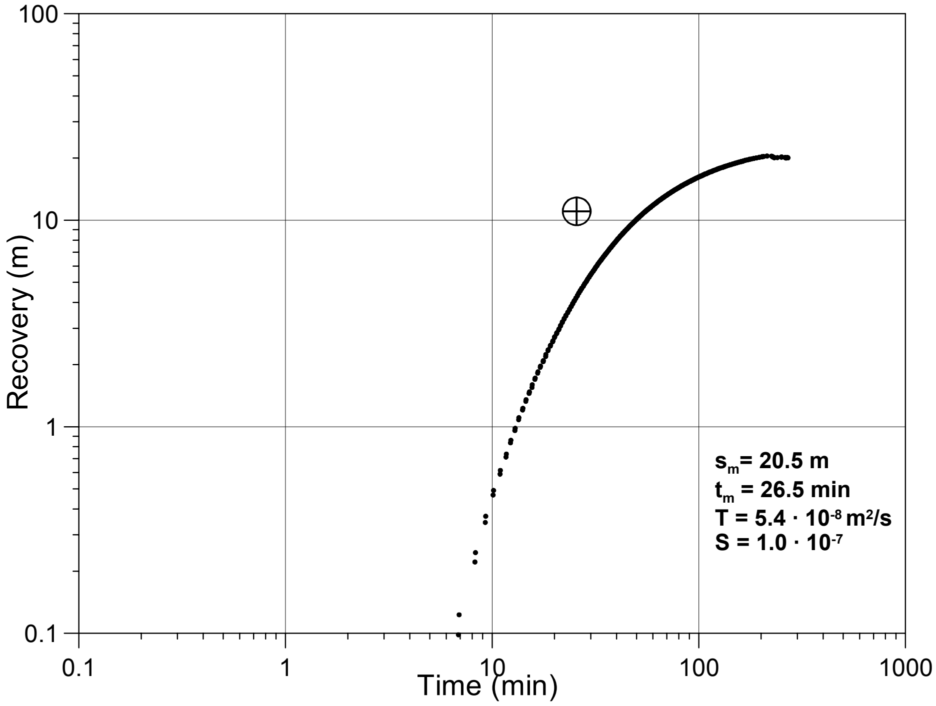


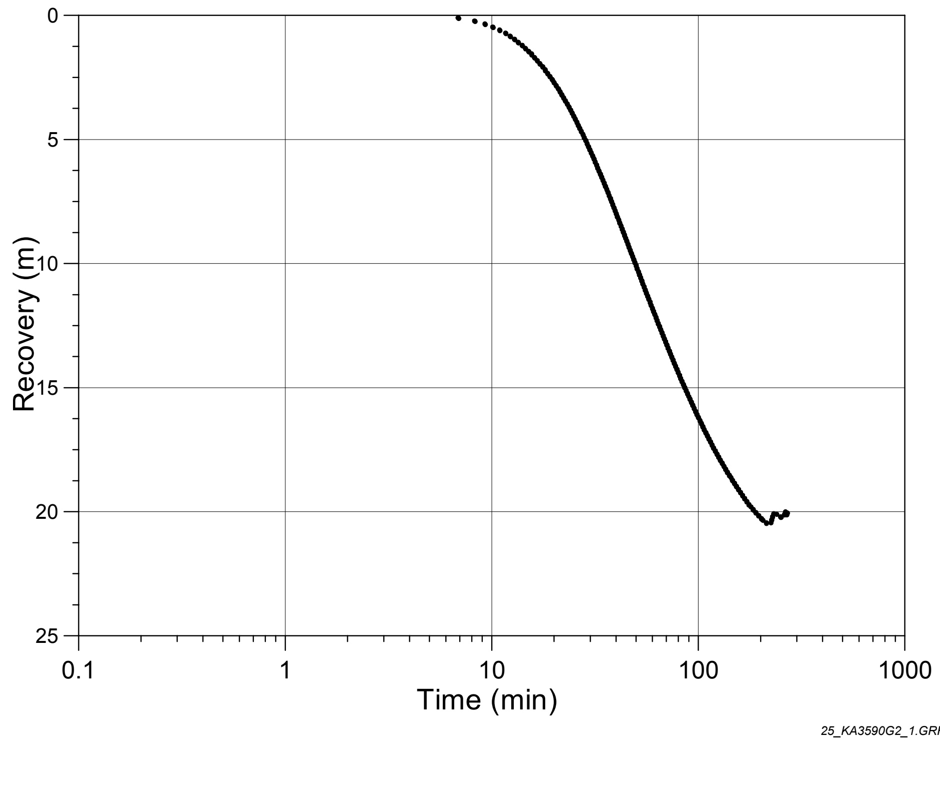
KA3573C1:1
Recovery (m)
Time (min)
10
1
0.1
0.01
0.1
1
10
100
1000
s_m= 2.6 m
t_m = 33 min
T = 4.2 · 10^{-7} m^2/s
S = 3.7 · 10^{-7}



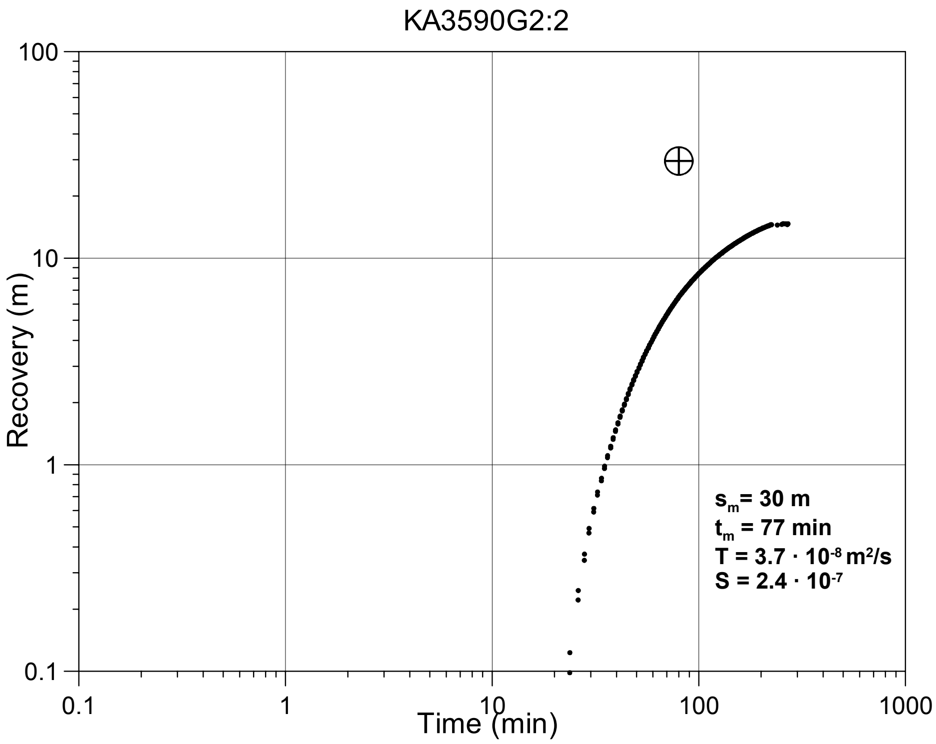
Recovery (m)
Time (min)
0
4
8
12
0.1
1
10
100
1000
25_KA3573C1_1.GRF 2005-06-15

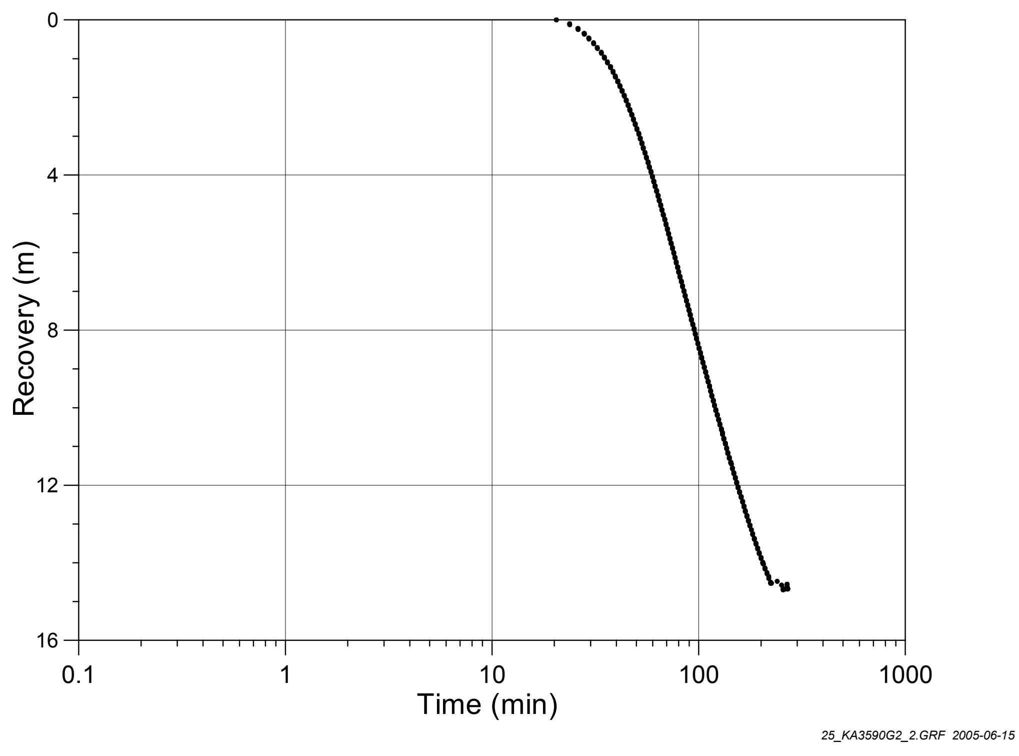
KA3590G2:1

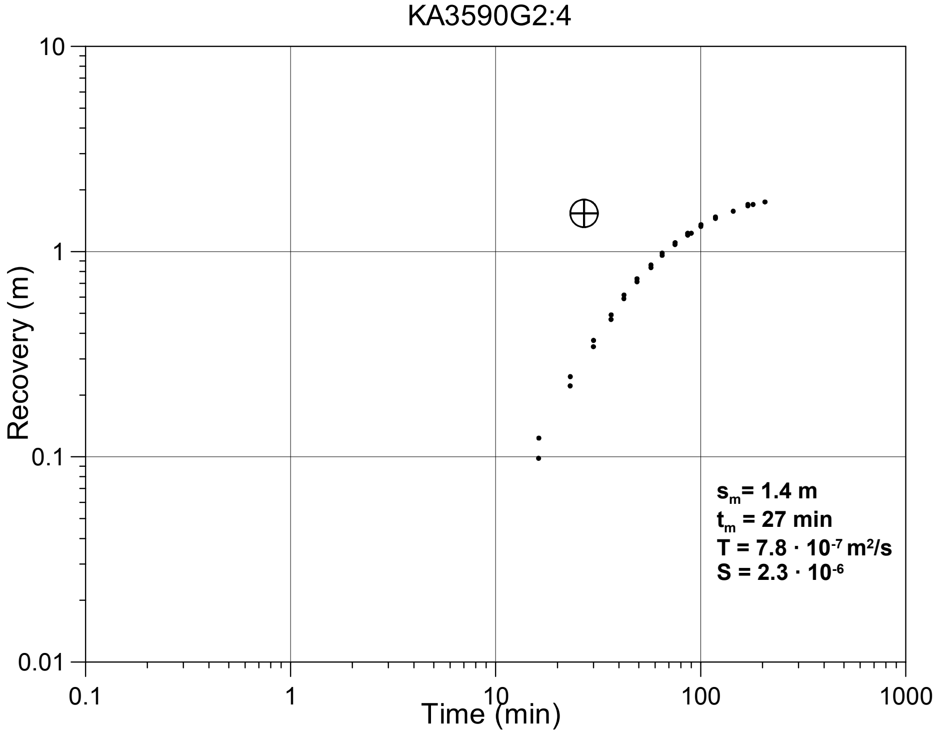


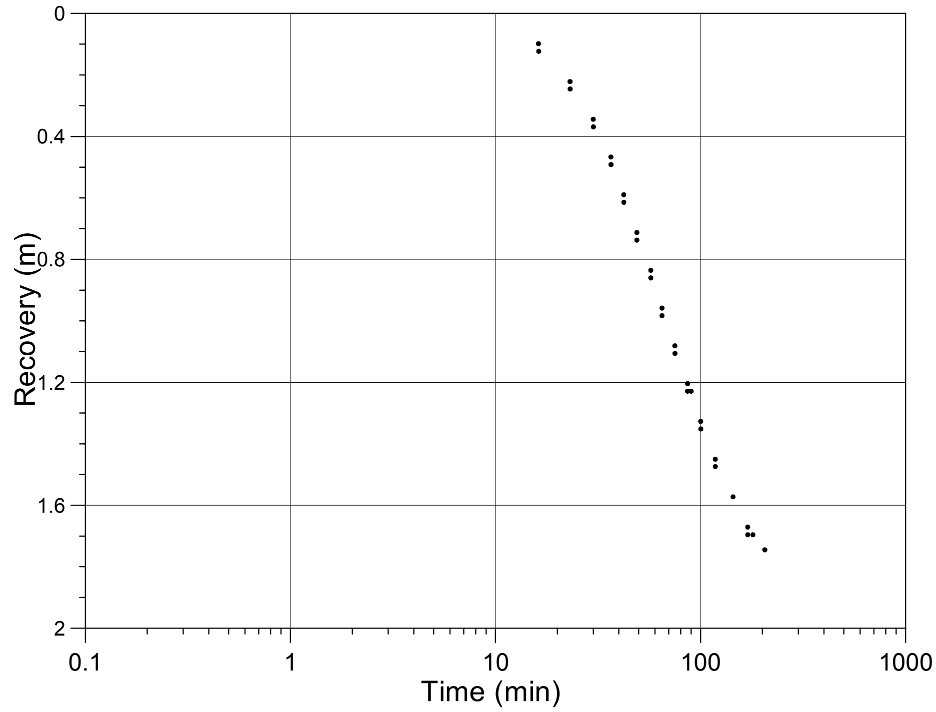


25_KA3590G2_1.GRF 2005-06-15


KA3590G2:2
Recovery (m)
Time (min)
s_m= 30 m
t_m = 77 min
T = 3.7 · 10-8 m²/s
S = 2.4 · 10-7
100
10
1
0.1
0.1
1
10
100
1000

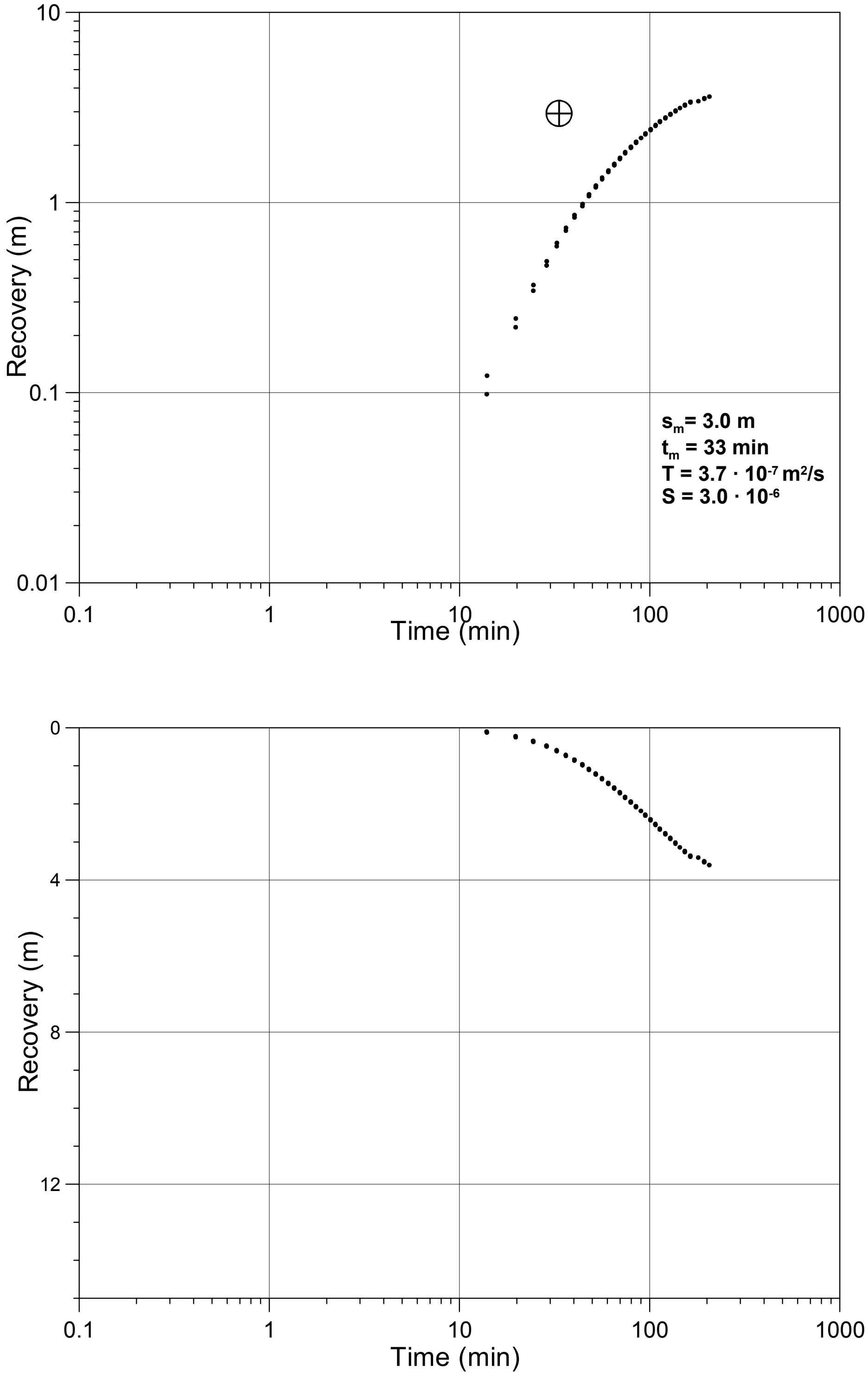

Recovery (m)
Time (min)
0
4
8
12
16
0.1
1
10
100
1000
25_KA3590G2_2.GRF 2005-06-15



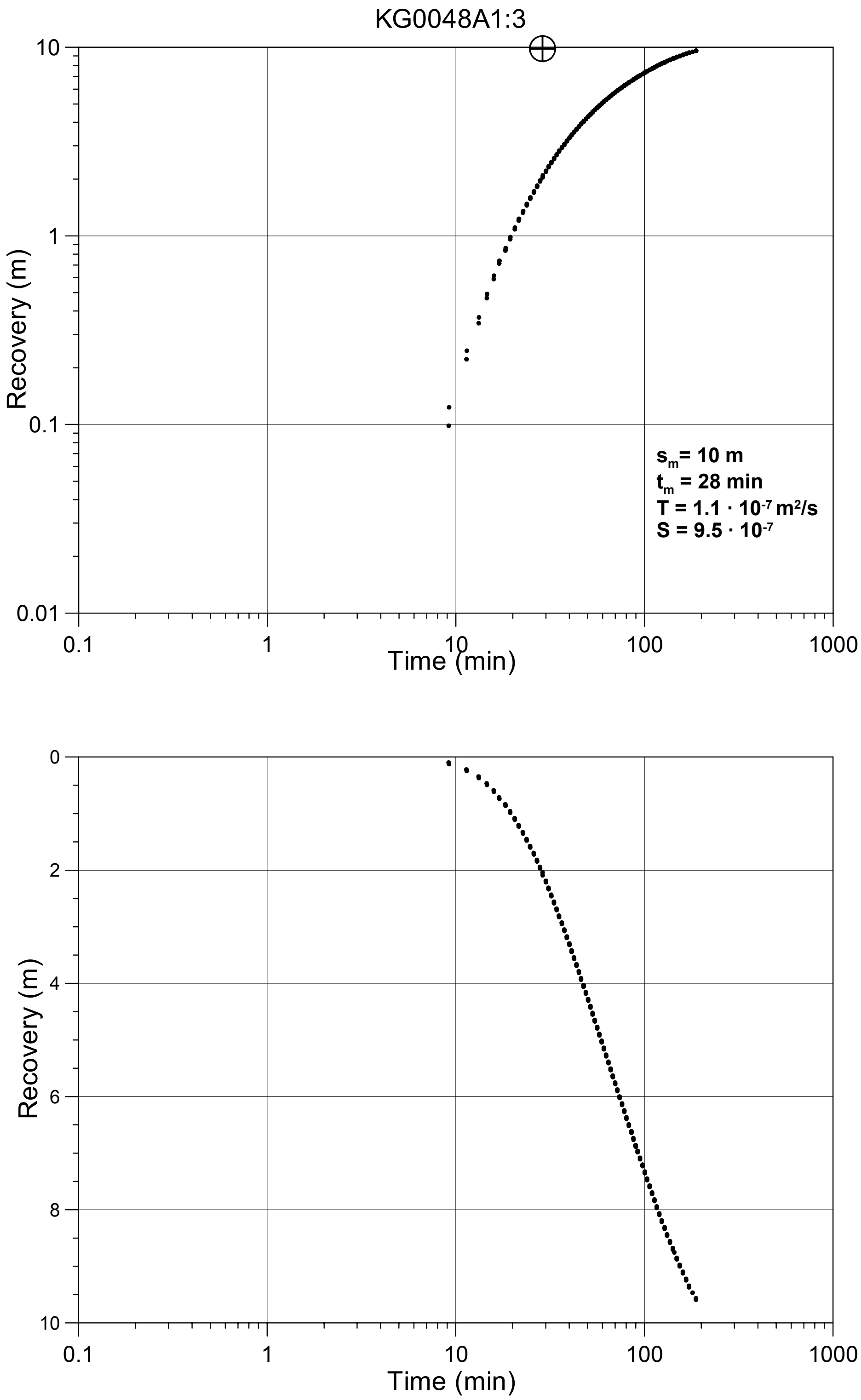


25_KA3590G2_4.GRF 2005-06-15

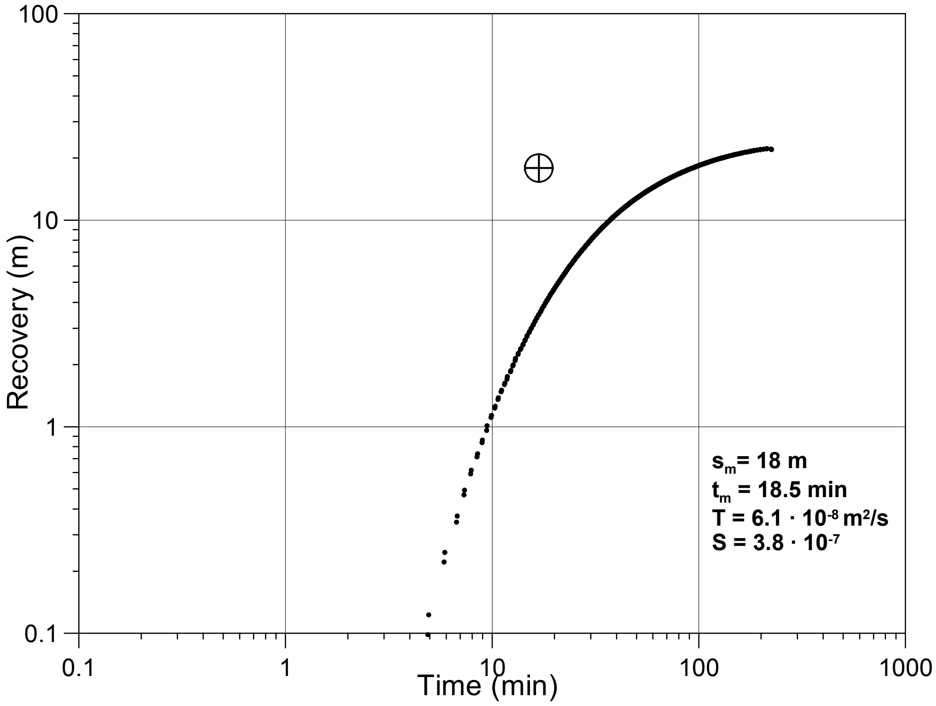
KG0048A1:2

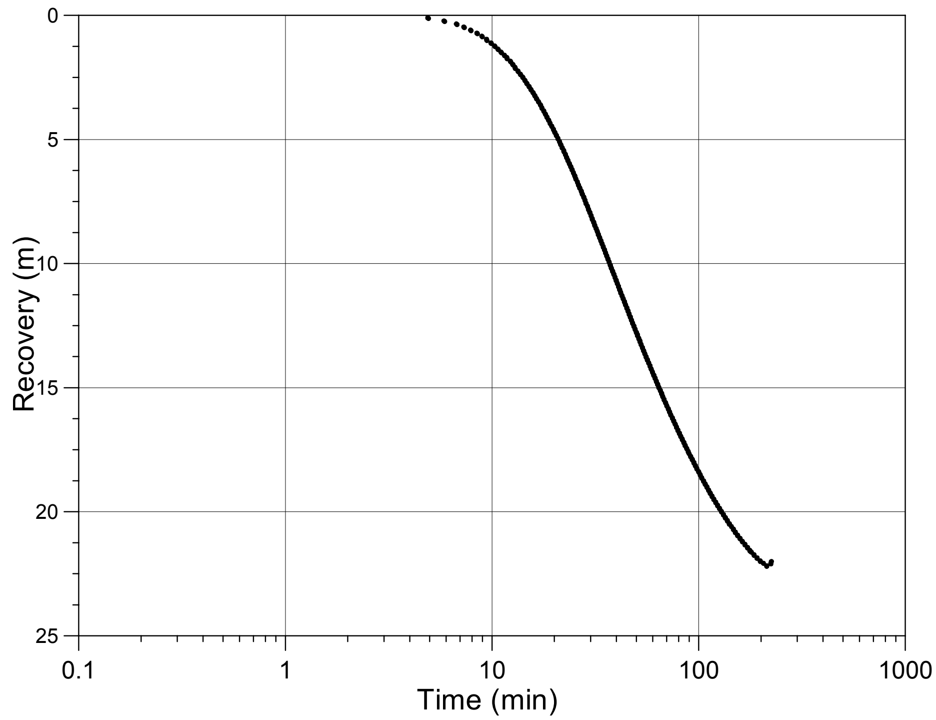


25_KG0048A1_2.GRF 2005-06-15


KG0048A1:3
Recovery (m)
Time (min)
s_m = 10 m
t_m = 28 min
T = 1.1 · 10^-7 m²/s
S = 9.5 · 10^-7
Recovery (m)
Time (min)

KG0048A1:4





25_KG0048A1_4.GRF 2005-06-15

APPENDIX 6

Interference test 5:26 in borehole KG0048A01, section 32.80 m – 33.80 m

Date: 2005-01-23 Field Crew: A. Blom / J. Magnusson
Borehole length: 54.69 m Borehole diameter: 76 mm

Flowing borehole: KG0048A01, section 3: 32.80 m – 33.80 m

Valve opened: 20050123 16:00.00 Valve closed: 20050123 22:00.00

End of Test: 20050124 16:00

Total flowing time : 360 min Tot. Pr. Build-up time: 1080 min.

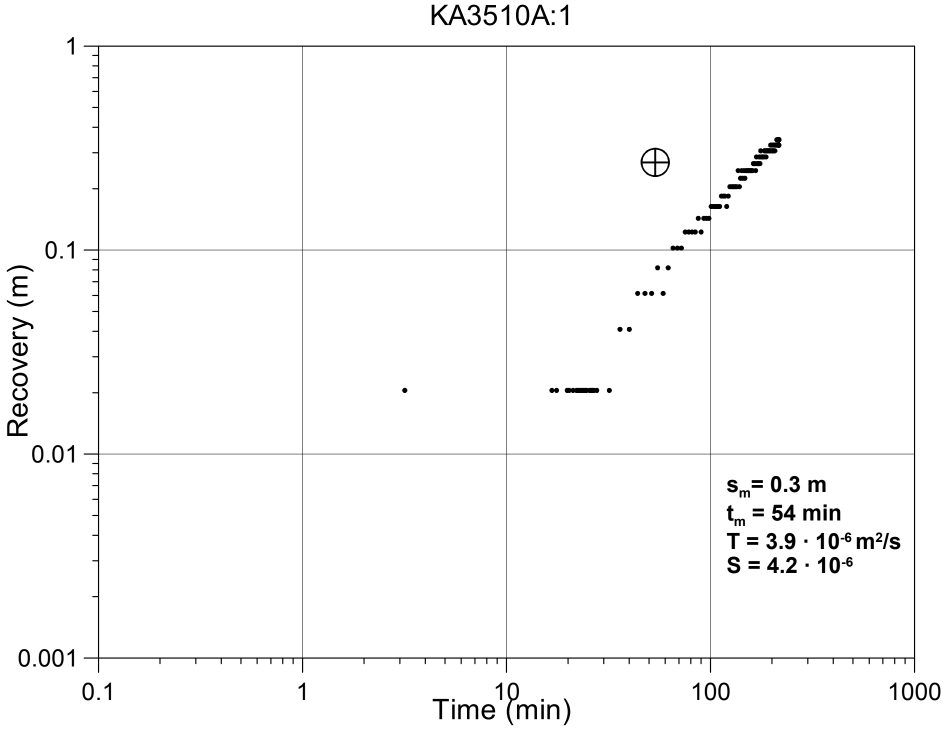
The test was performed as an Interference test. Pressure responses were monitored in 132 borehole sections including the flow section.

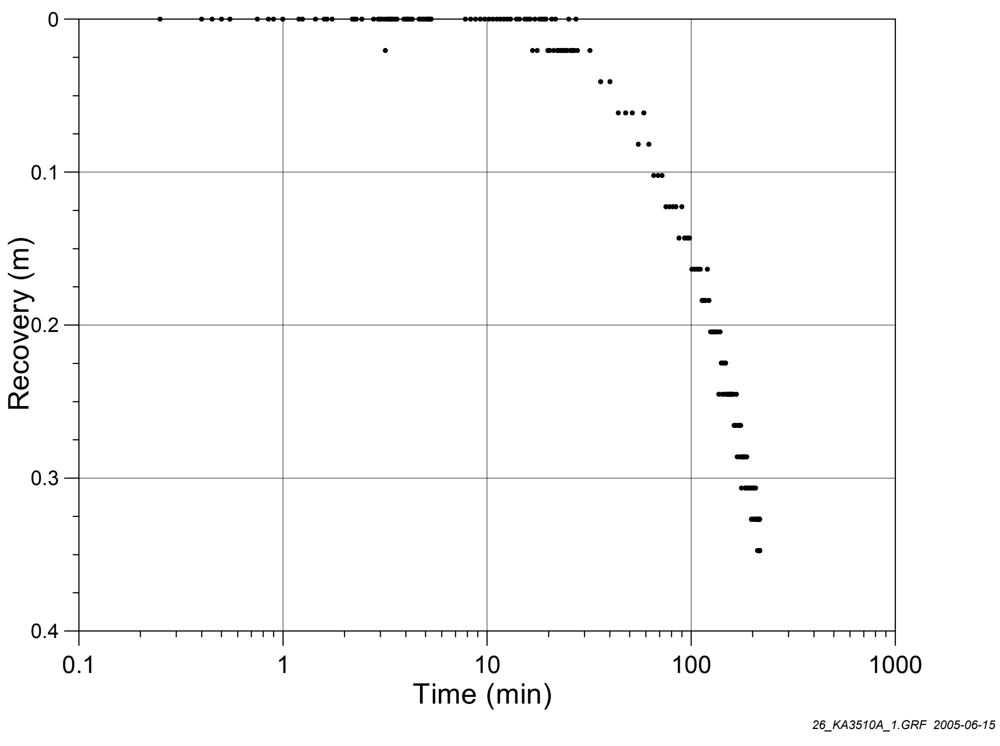
Flow data
Manually measured flow rates of KG0048A01, section 32.80 m – 33.80 m are presented in the table below:

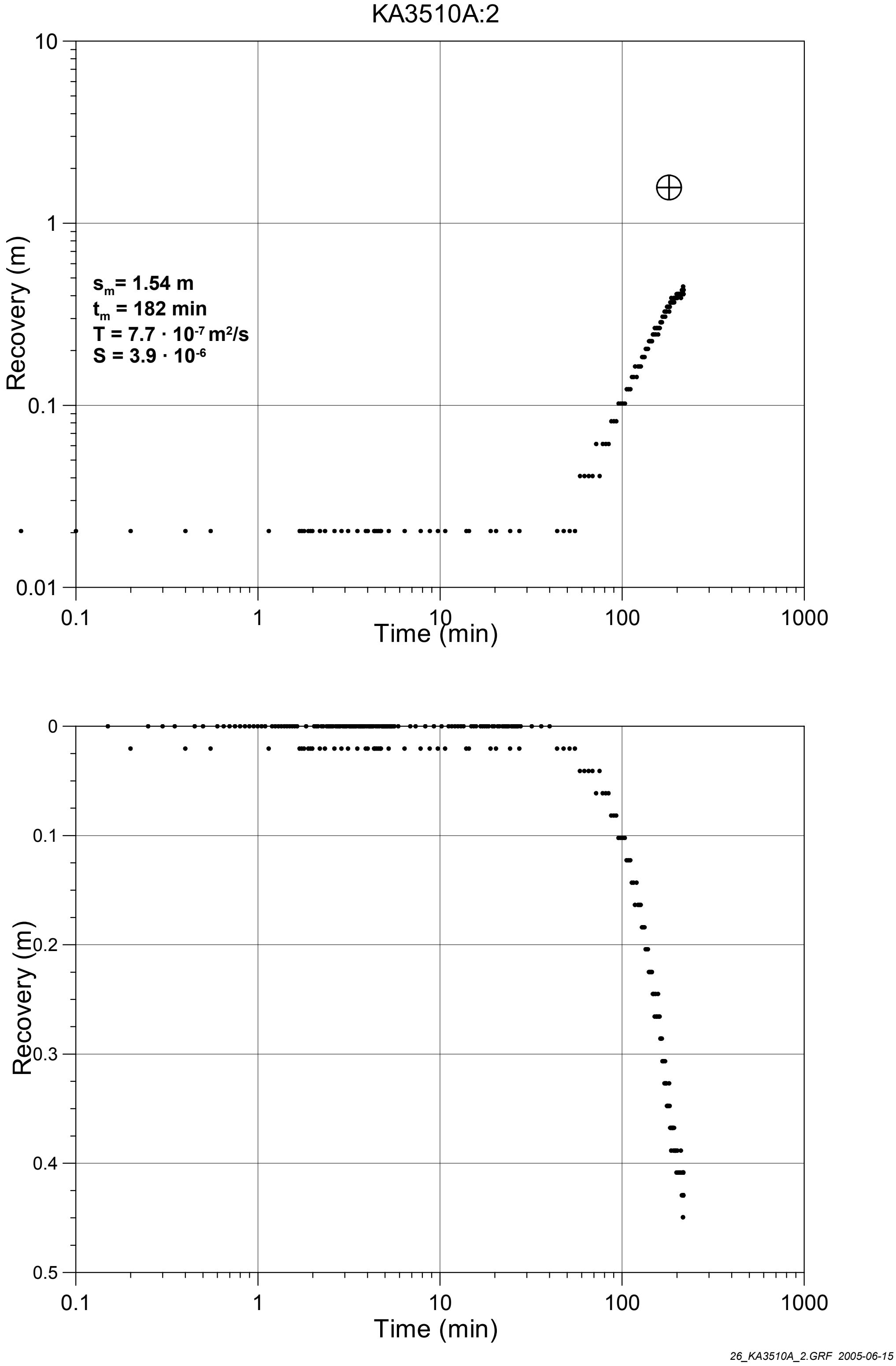
Table Manually measured flow rates, Interference test in KG0021A01, section 32.80 m – 33.80 m. Prototype Repository, January 23 2005

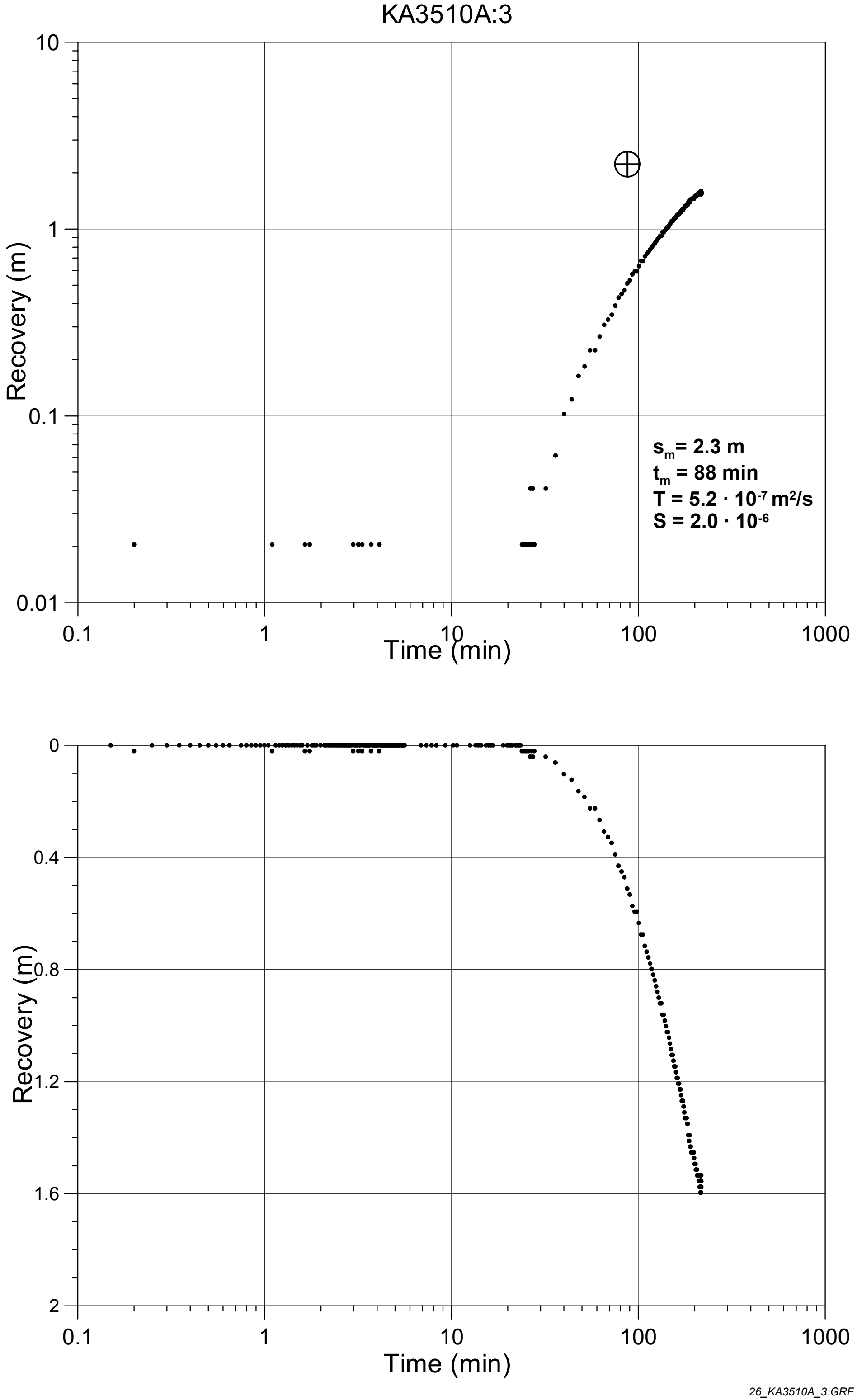
Time	Flow rate (l/min)
16:00:10	1.38E+00
16:01:00	1.17E+00
16:02:00	1.08E+00
16:08:00	9.60E-01
16:32:00	9.30E-01
21:30:00	9.00E-01
21:55:00	8.96E-01

In all cases the matchpoint used is consistent with $p_D = 1$ and $t_D = 1$.

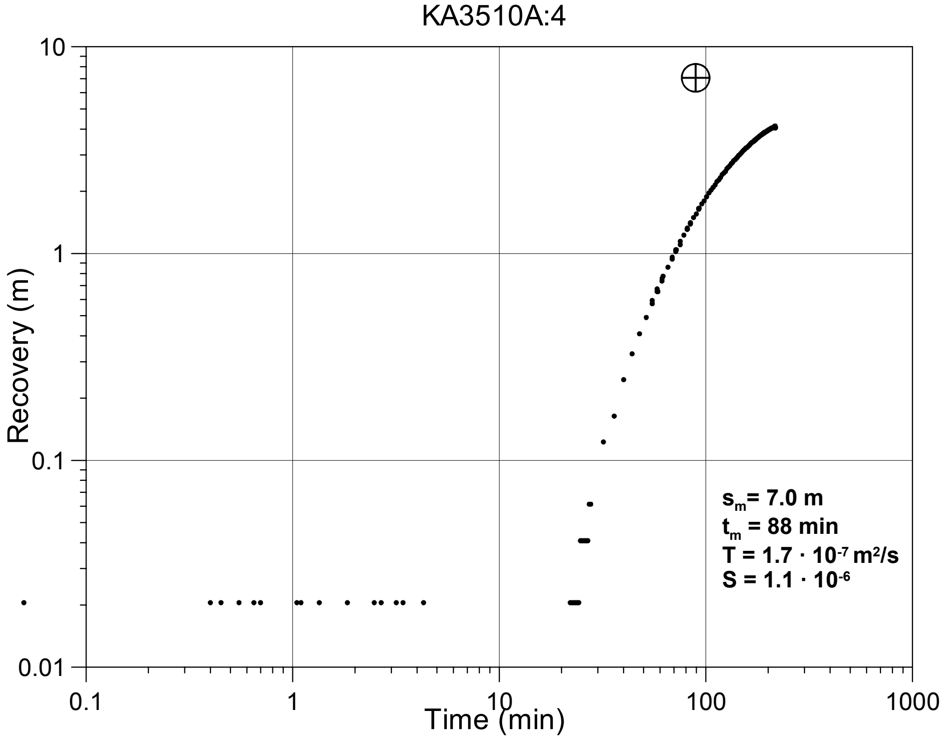

KA3510A:1
Recovery (m)
Time (min)
s_m= 0.3 m
t_m = 54 min
T = 3.9 · 10^{-6} m^2/s
S = 4.2 · 10^{-6}
1
0.1
0.01
0.001
0.1
1
10
100
1000

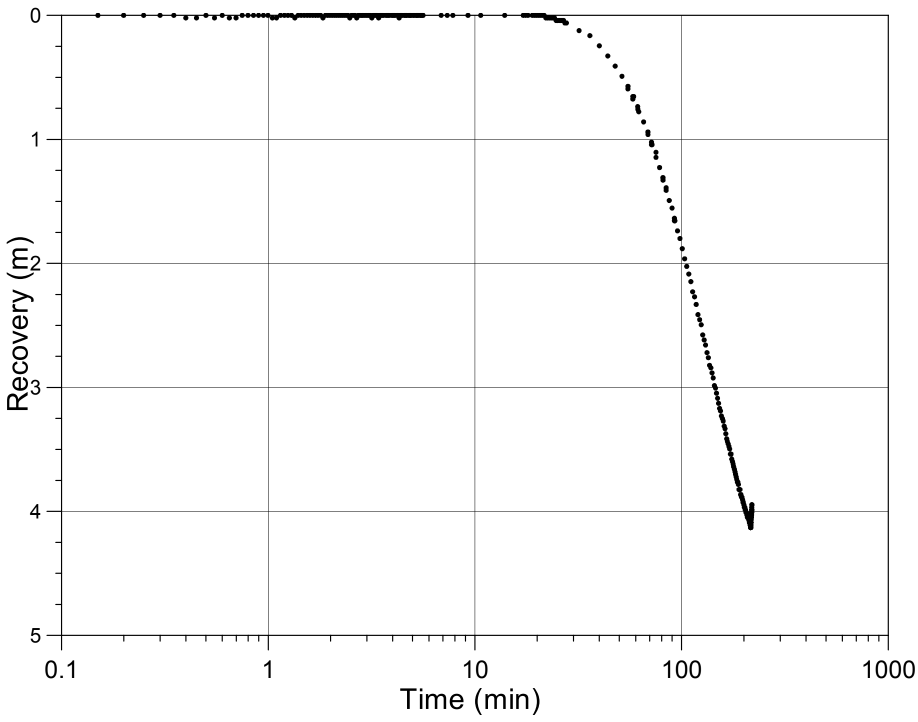

Recovery (m)
Time (min)
0
0.1
0.2
0.3
0.4
0.1
1
10
100
1000
26_KA3510A_1.GRF 2005-06-15


KA3510A:2
Recovery (m)
Time (min)
s_m= 1.54 m
t_m = 182 min
T = 7.7 · 10-7 m2/s
S = 3.9 · 10-6
10
1
0.1
0.01
0.1
1
10
100
1000
Recovery (m)
Time (min)
0
0.1
0.2
0.3
0.4
0.5
26_KA3510A_2.GRF 2005-06-15

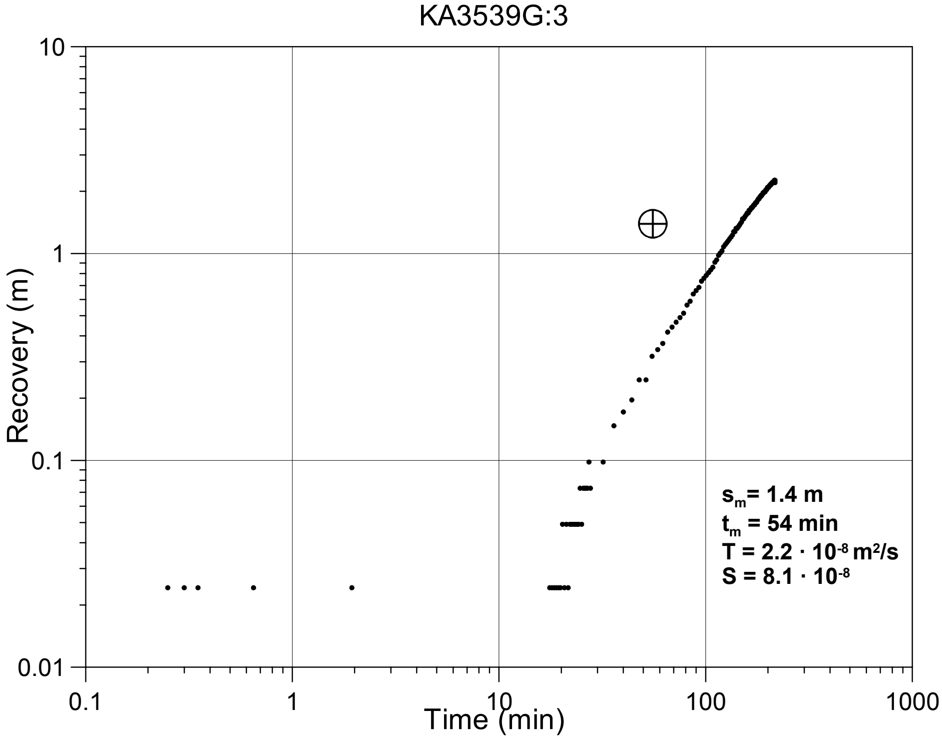


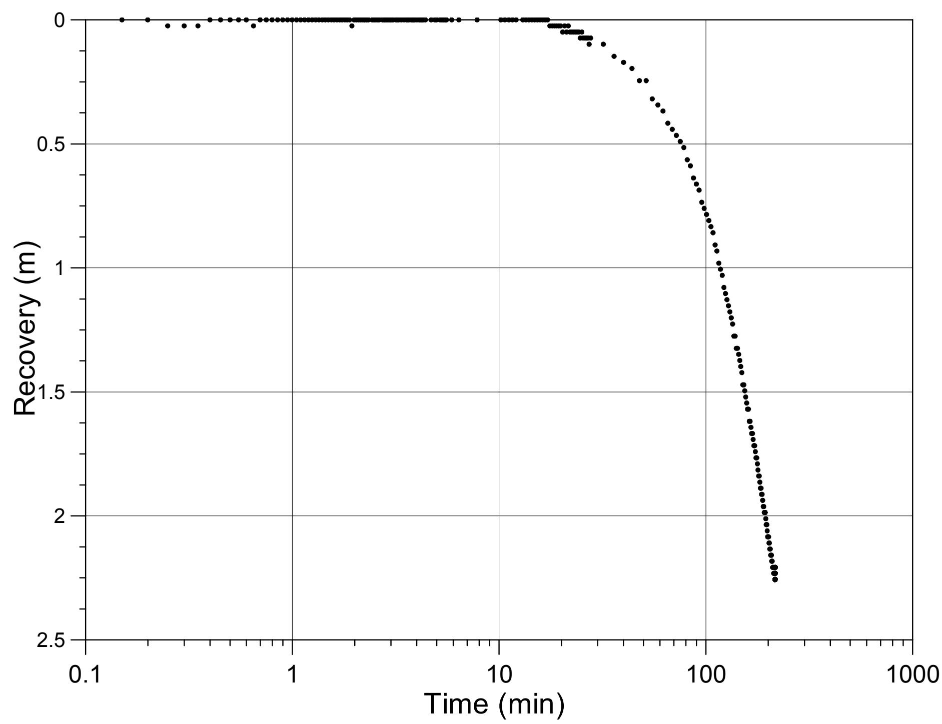
26_KA3510A_3.GRF 2005-06-15





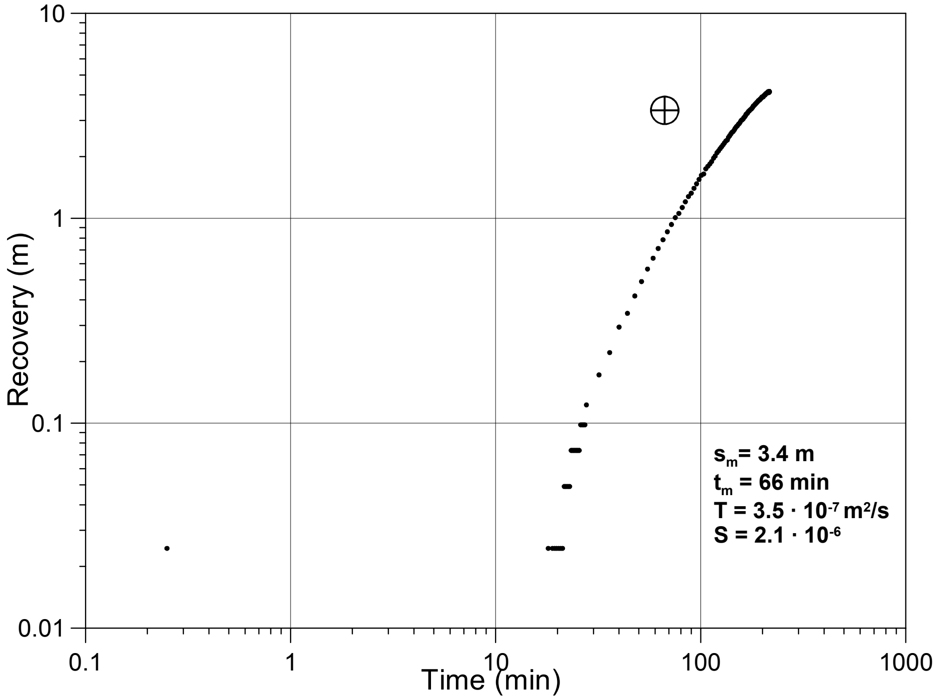
26_KA3510A_4.GRF 2005-06-15

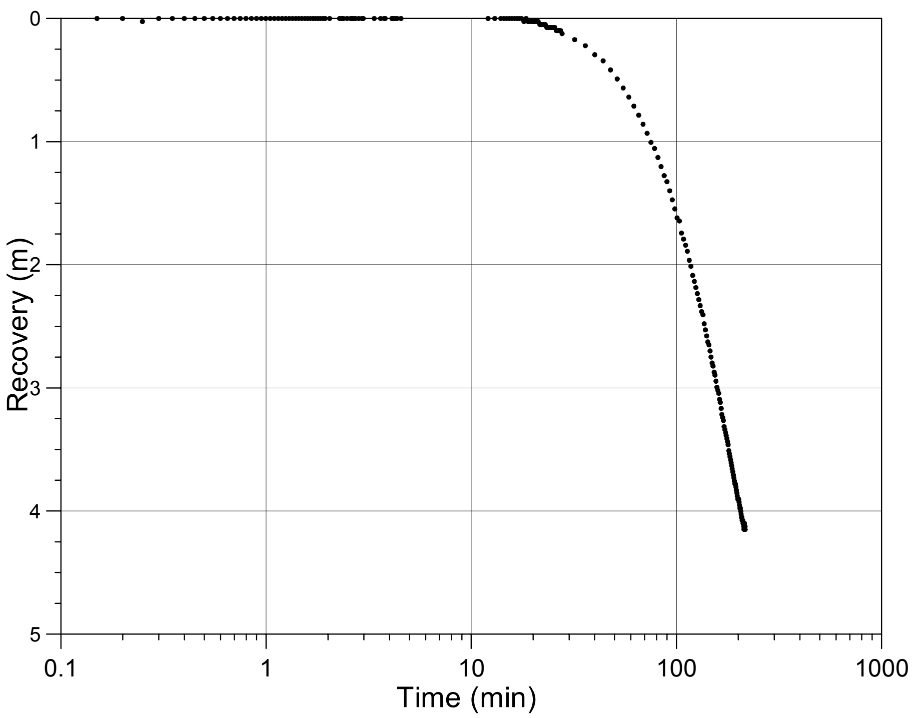




26_KA3539G_3.GRF 2005-06-15

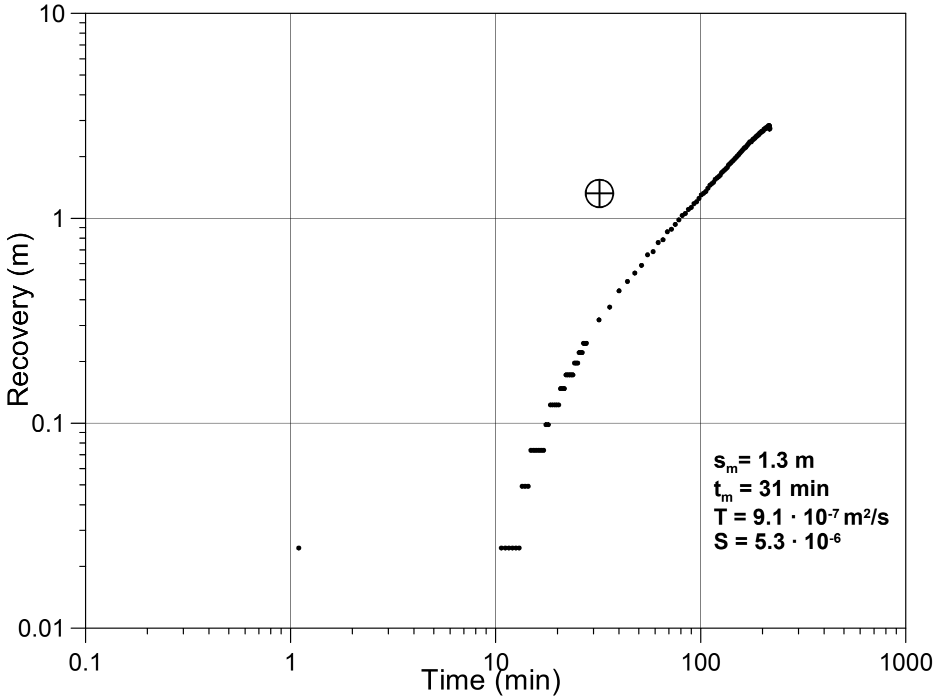
KA3542G1:2

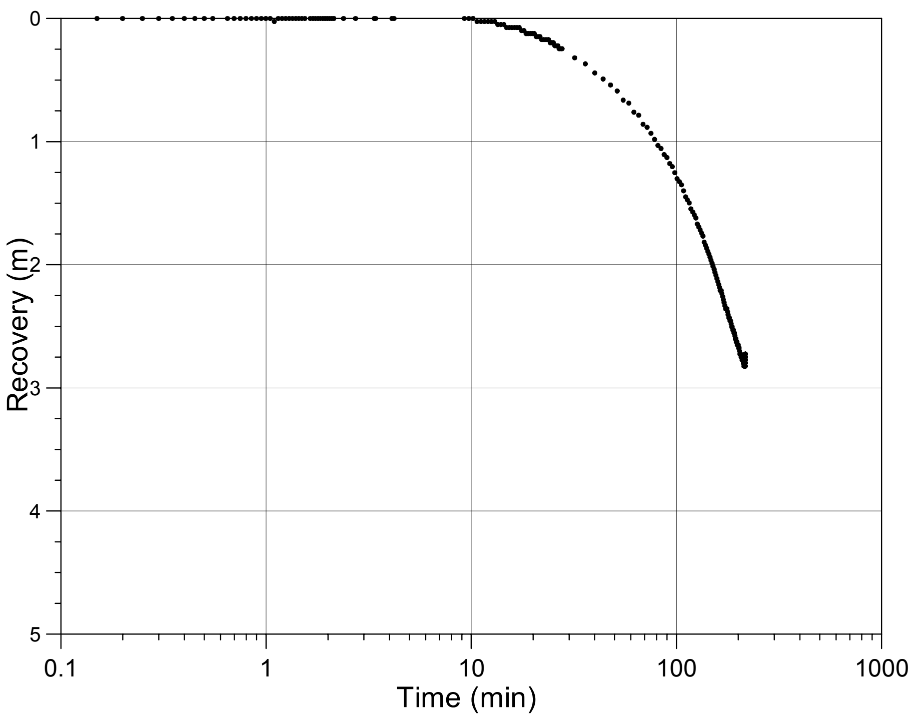




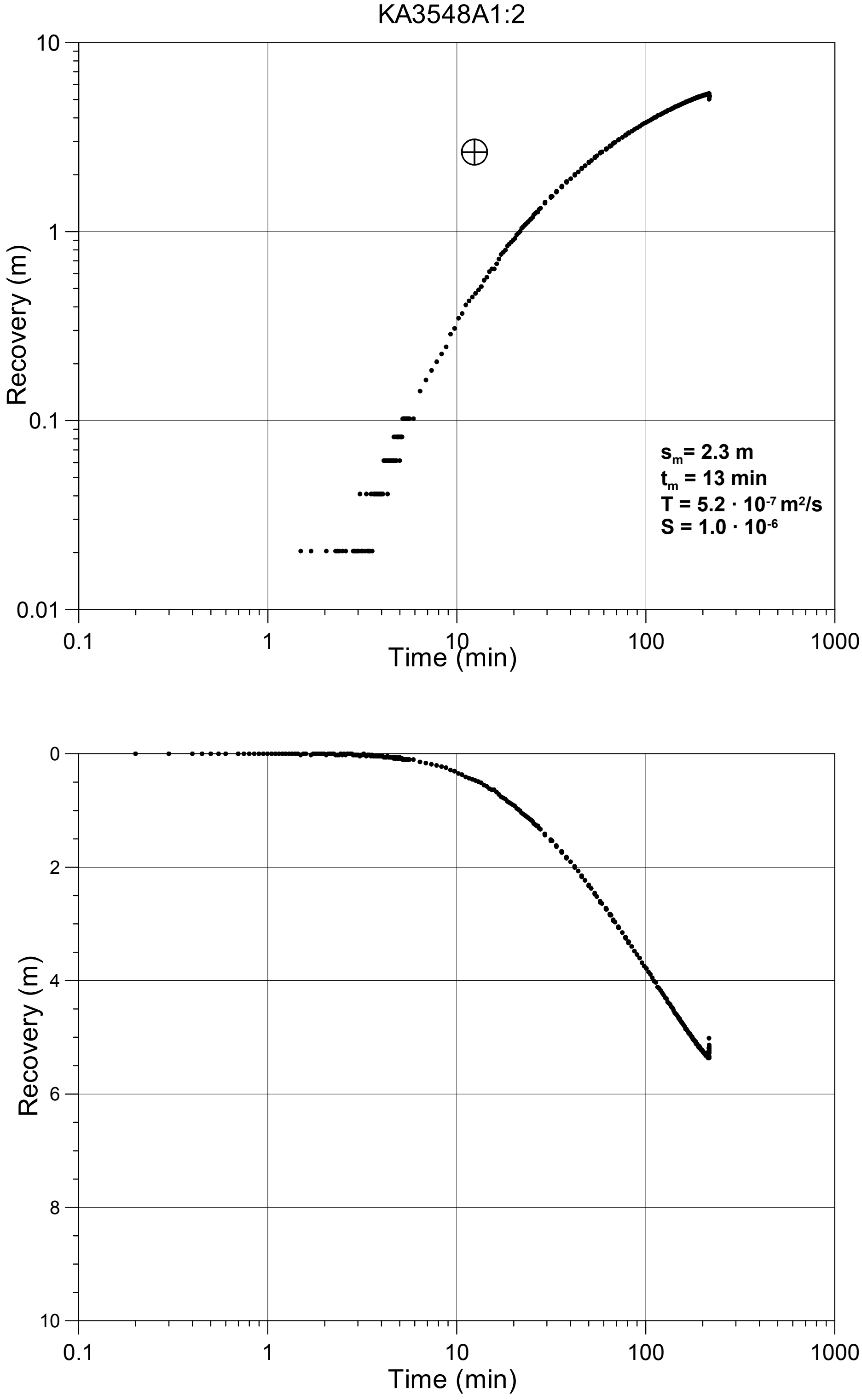
26_KA3542G1_2.GRF 2005-06-15

KA3542G2:5



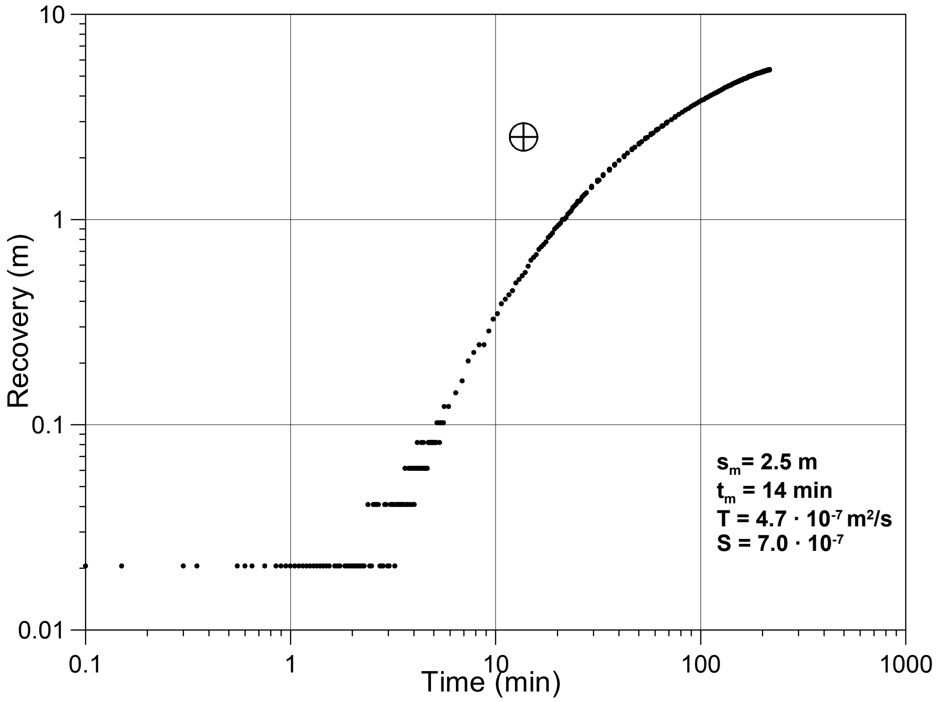


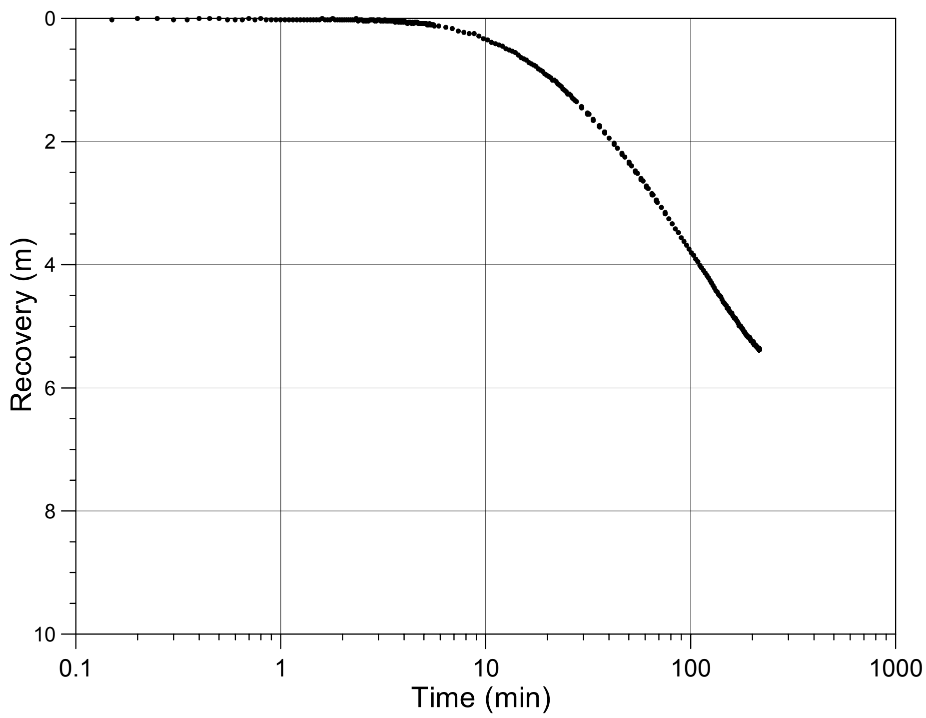
26_KA3542G2_5.GRF 2005-06-15



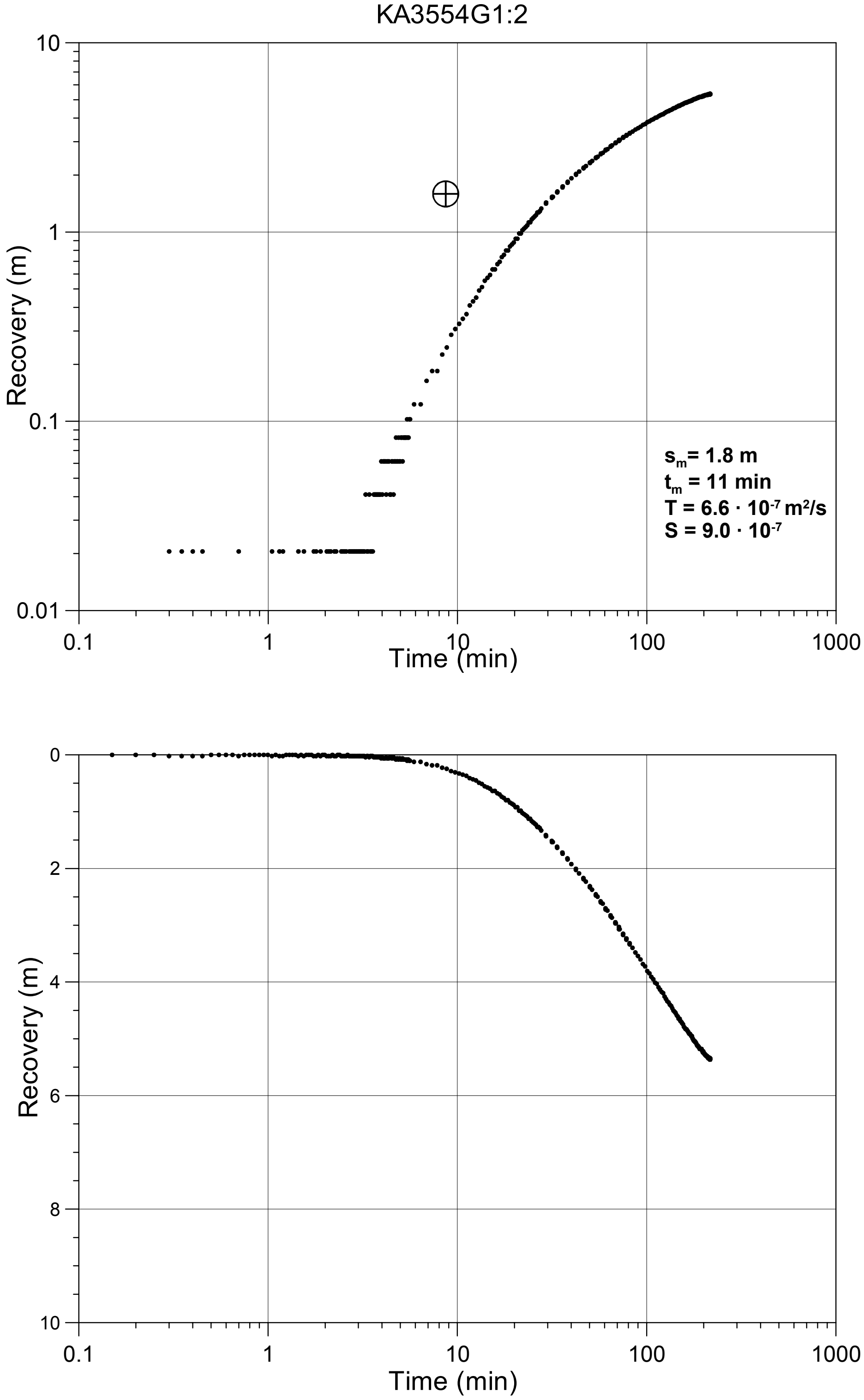
26_KA3548A1_2.GRF 2005-06-15

KA3554G1:1

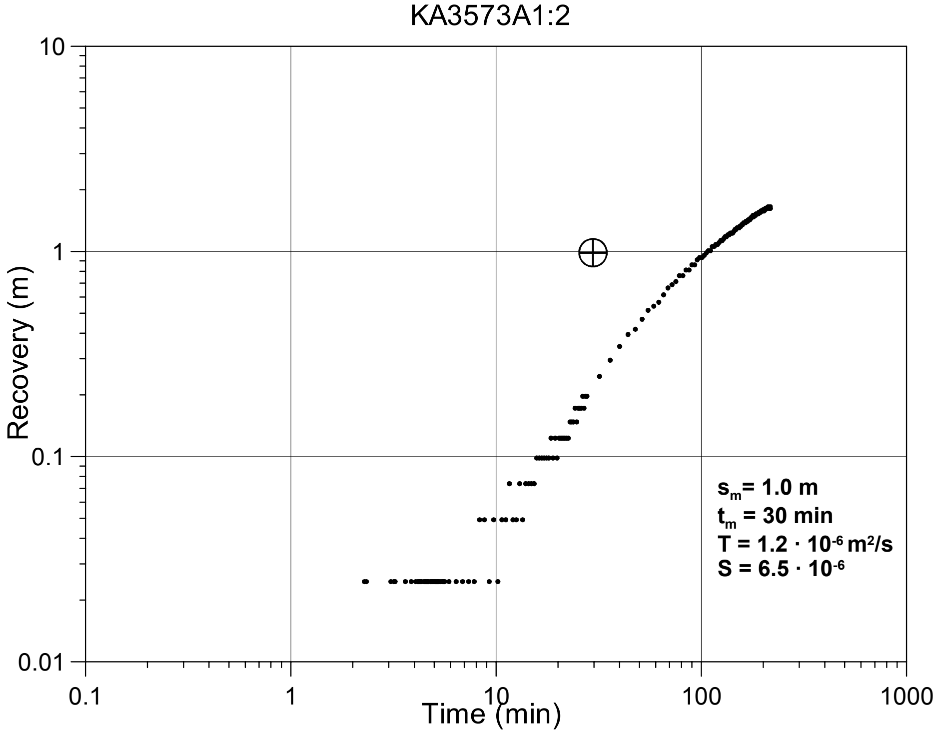


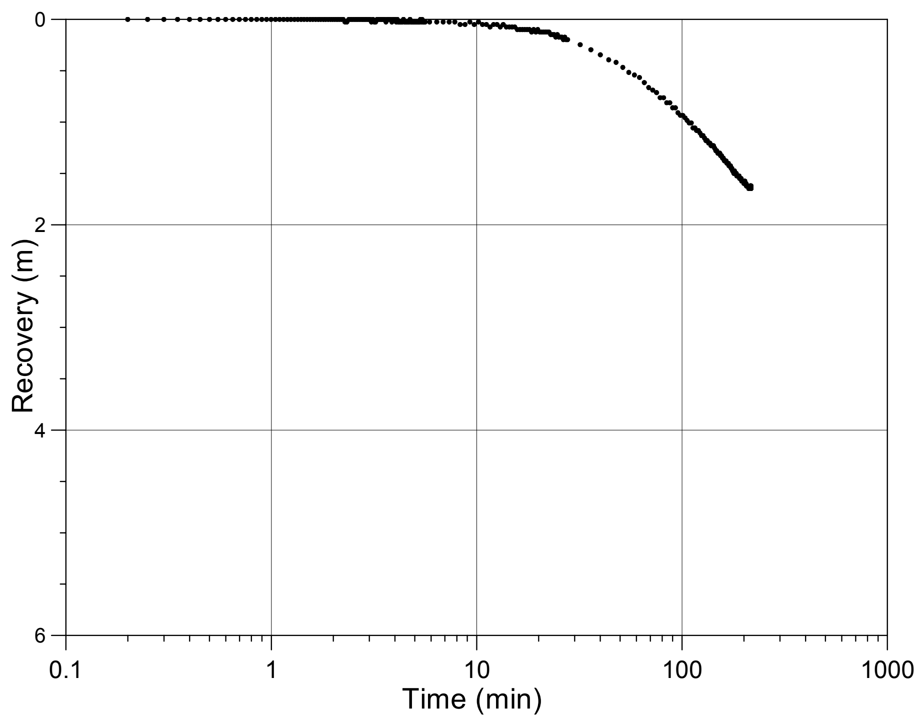


26_KA3554G1_1.GRF 2005-06-15

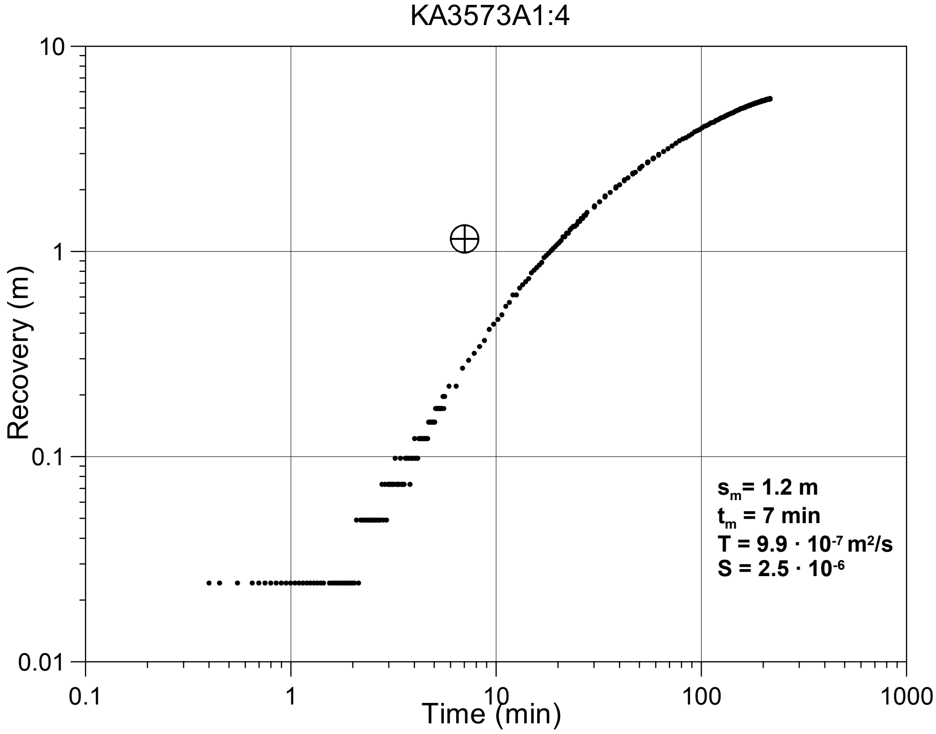


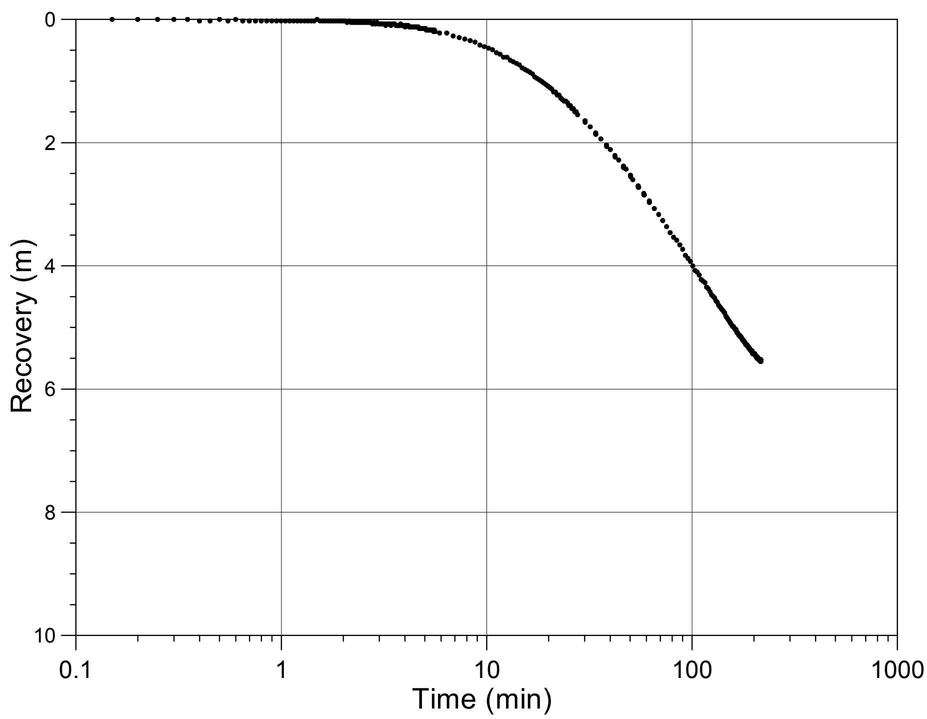
26_KA3554G1_2.GRF 2005-06-15



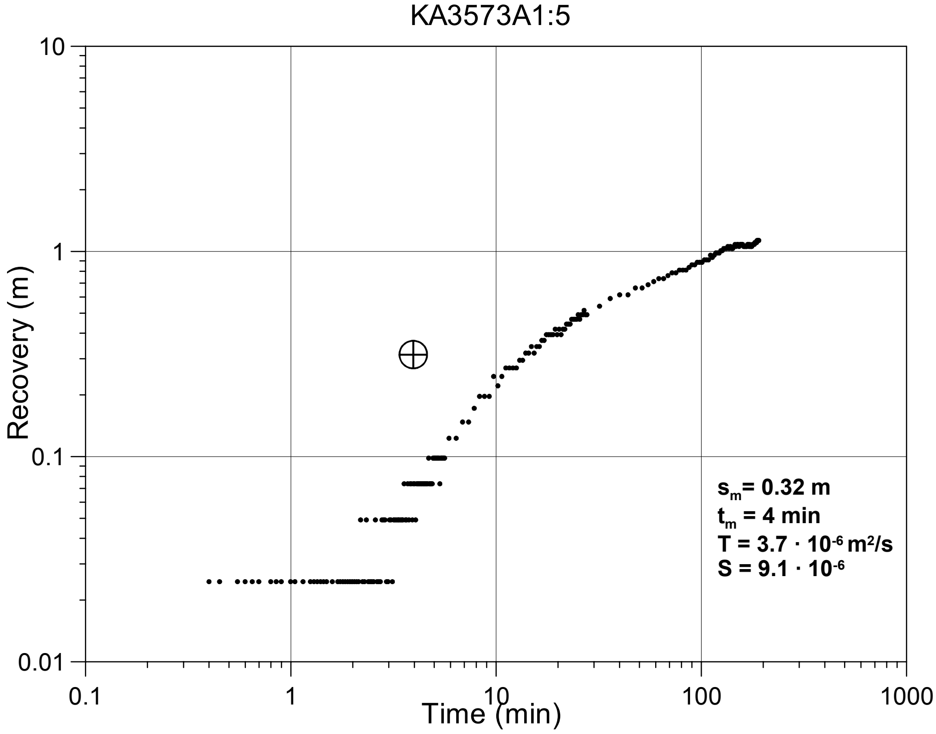


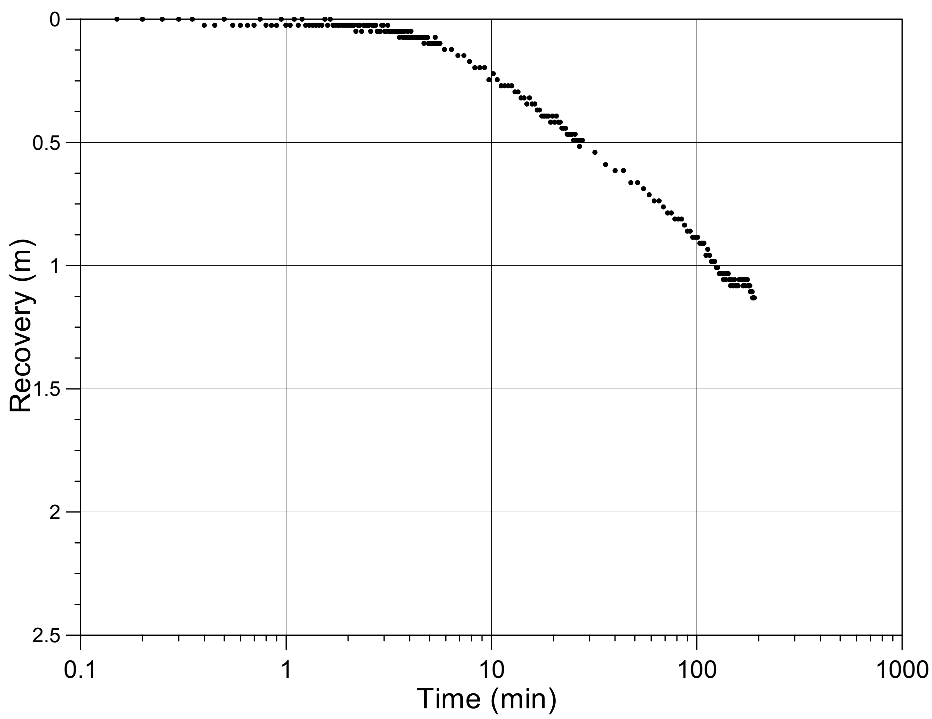
26_KA3573A1_2.GRF 2005-06-15



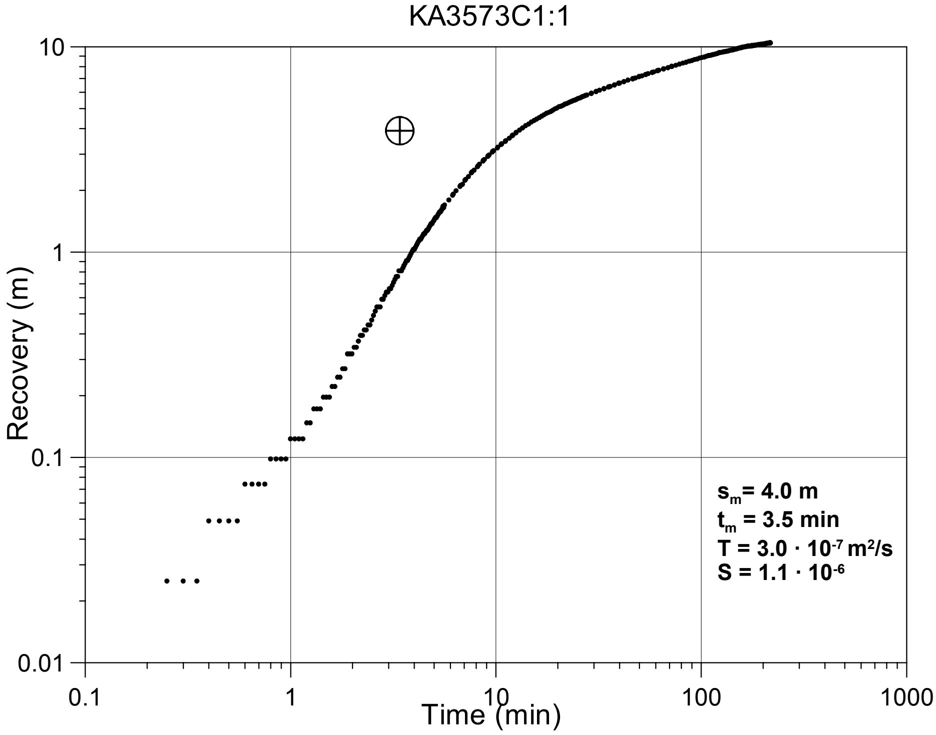


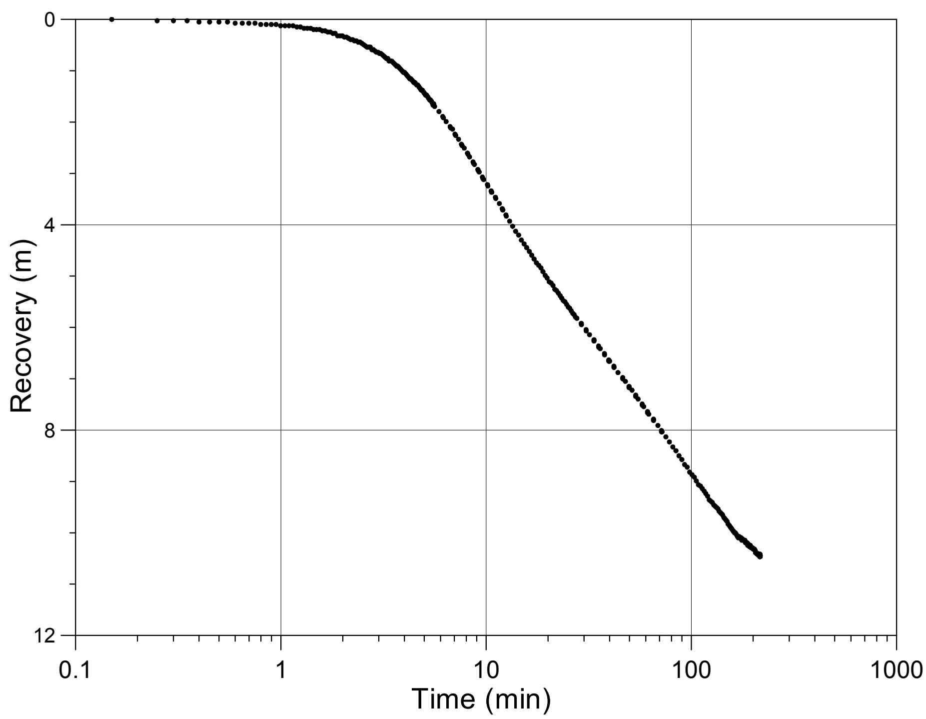
26_KA3573A1_4.GRF 2005-06-15





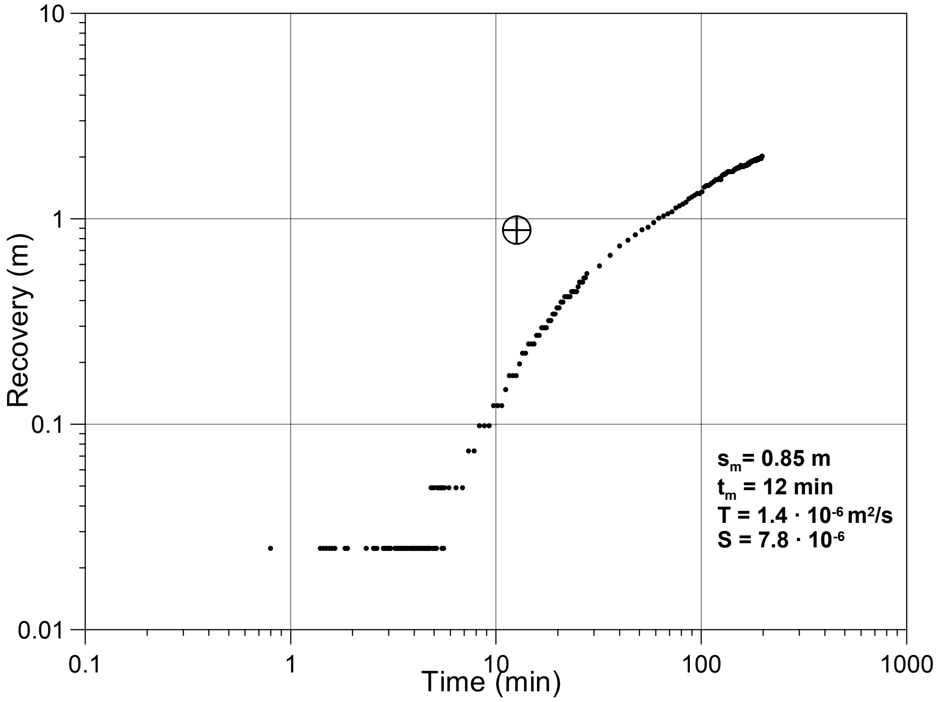
26_KA3573A1_5.GRF 2005-06-15

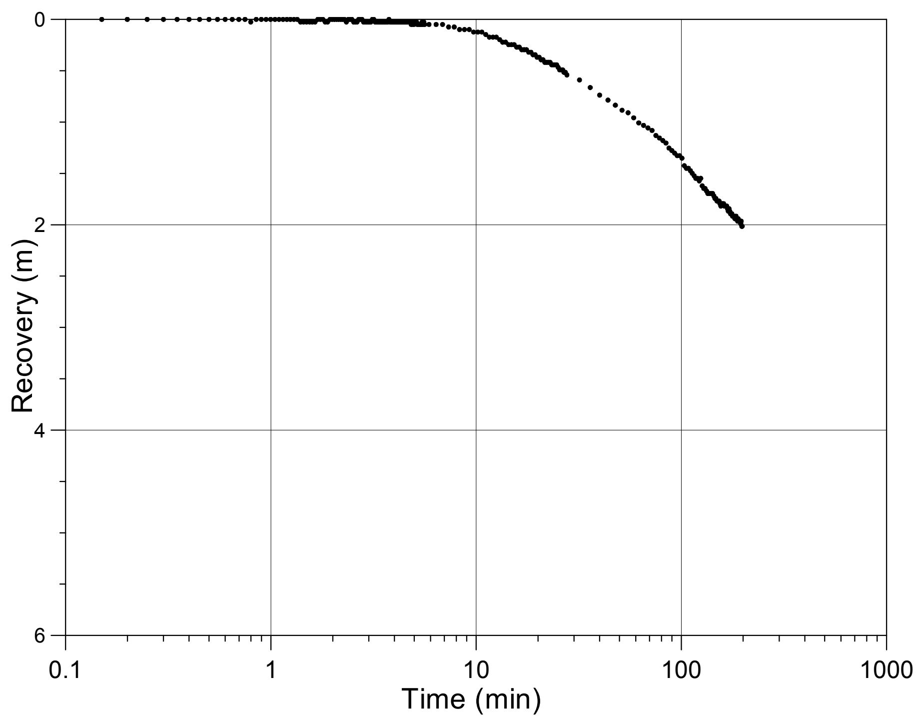




26_KA3573C1_1.GRF 2005-06-15

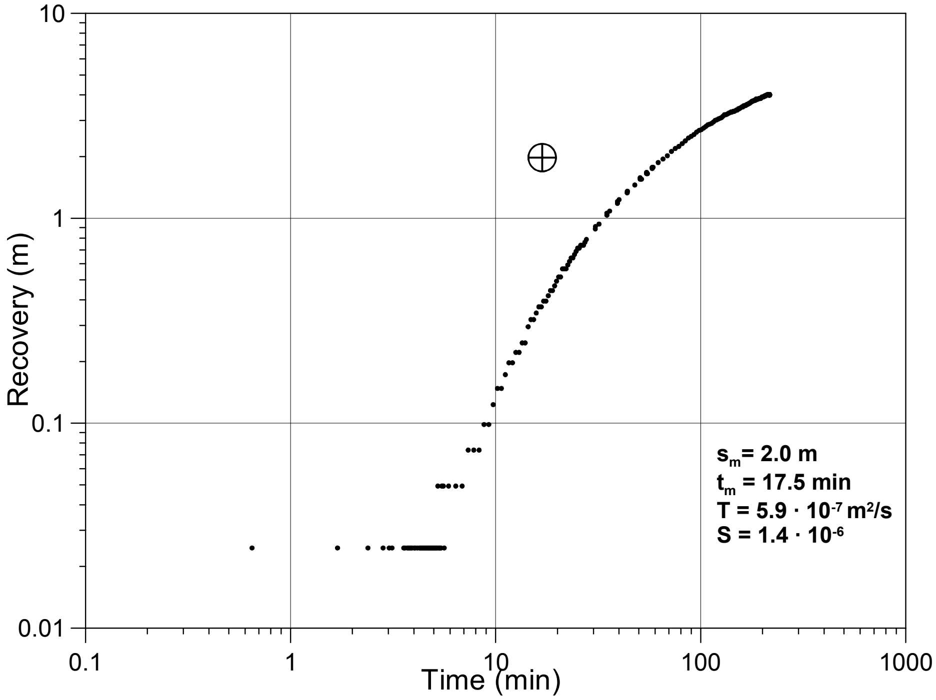
KA3588C1:1

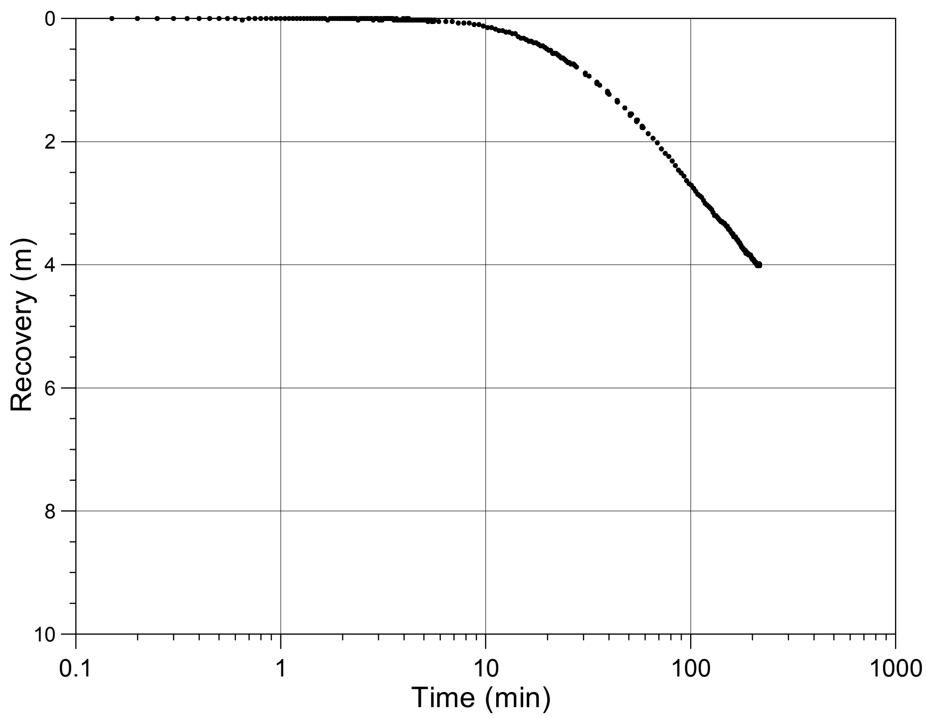




26_KA3588C1_1.GRF 2005-06-15

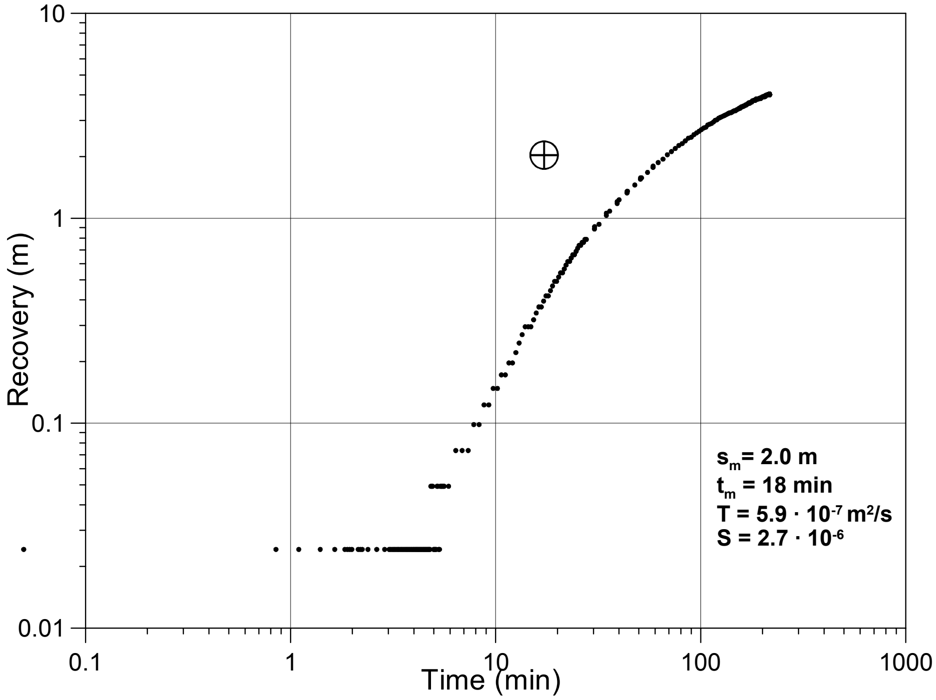
KA3590G1:1

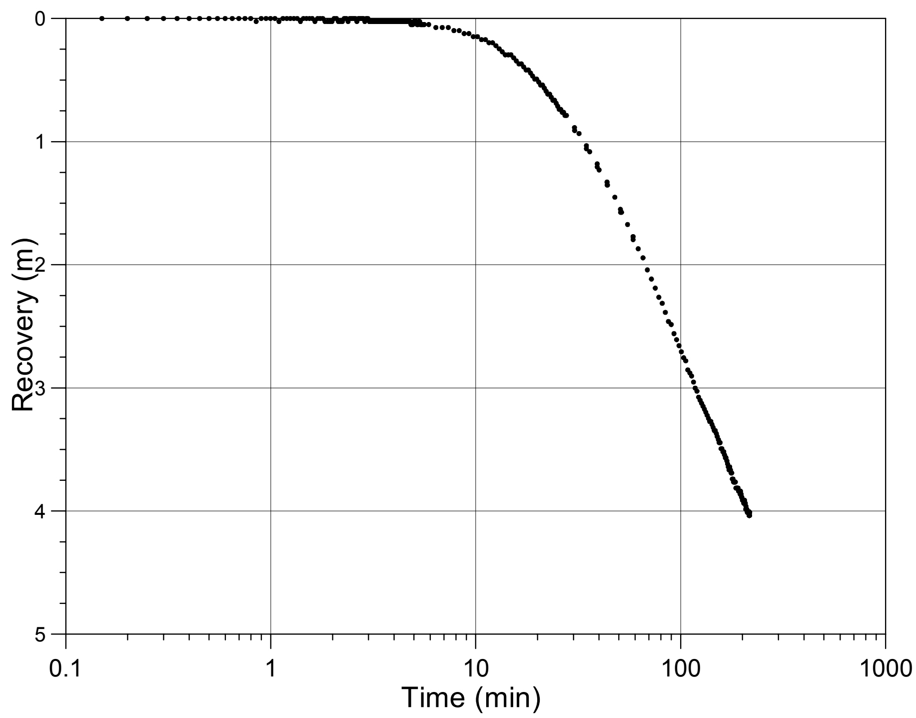




26_KA3590G1_1.GRF 2005-06-15

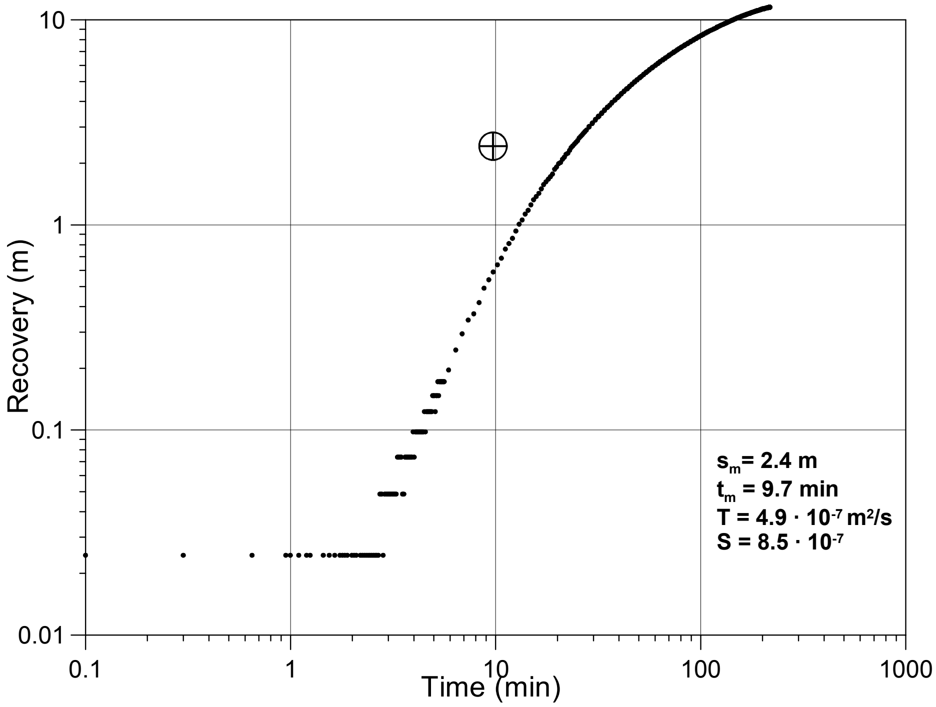
KA3590G1:2

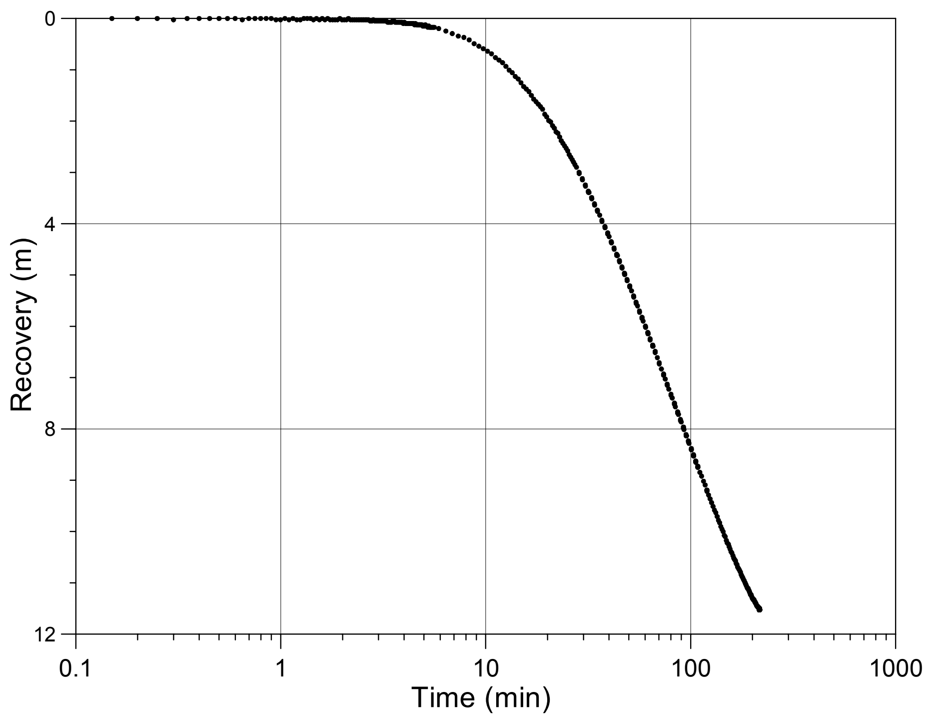




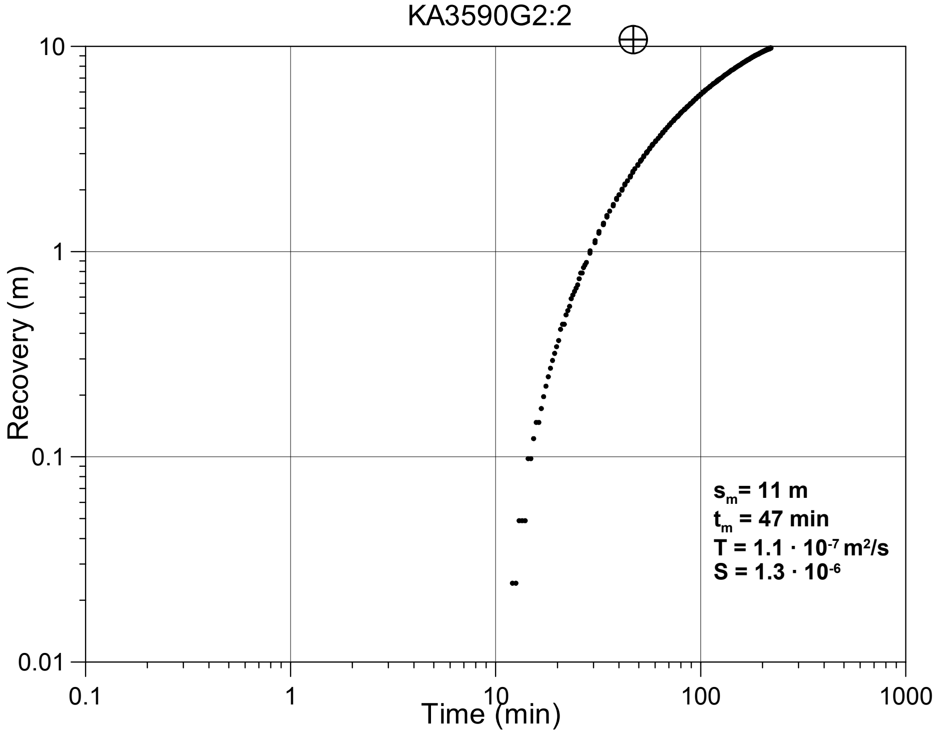
26_KA3590G1_2.GRF 2005-06-15

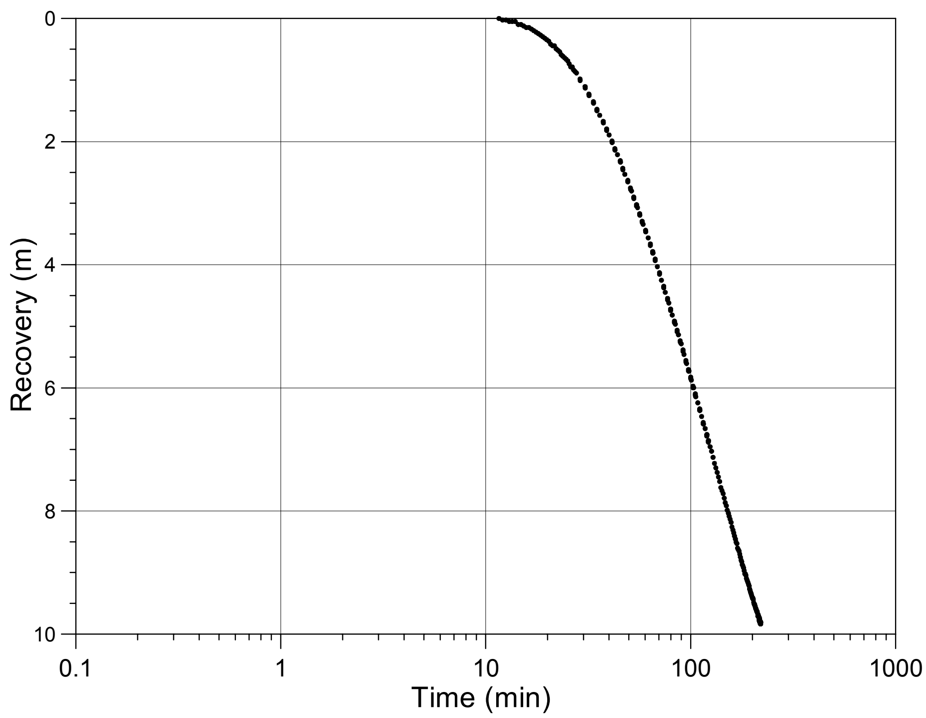
KA3590G2:1





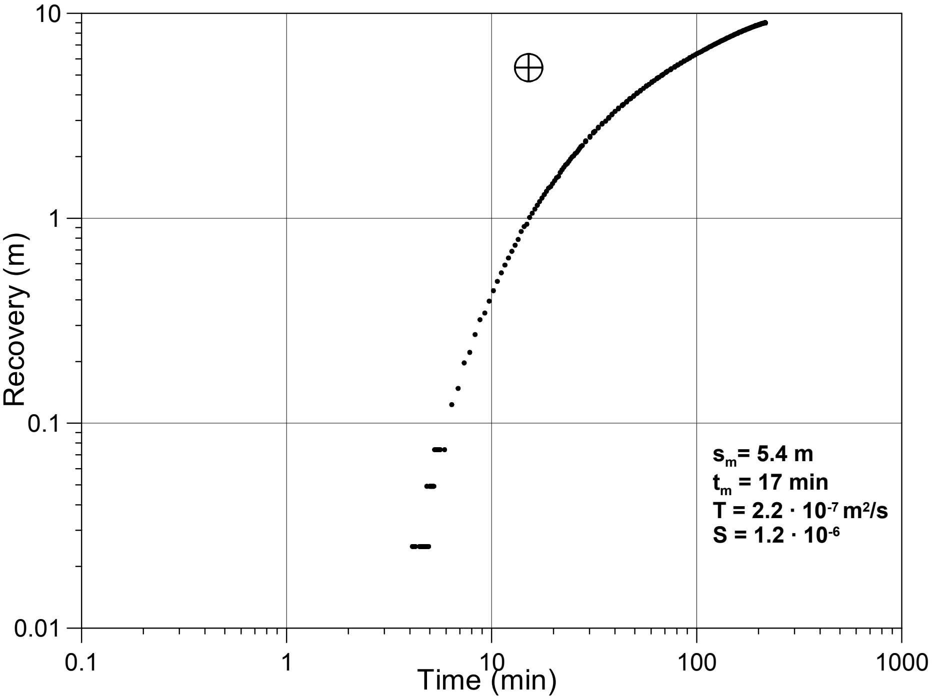
26_KA3590G2_1.GRF 2005-06-15

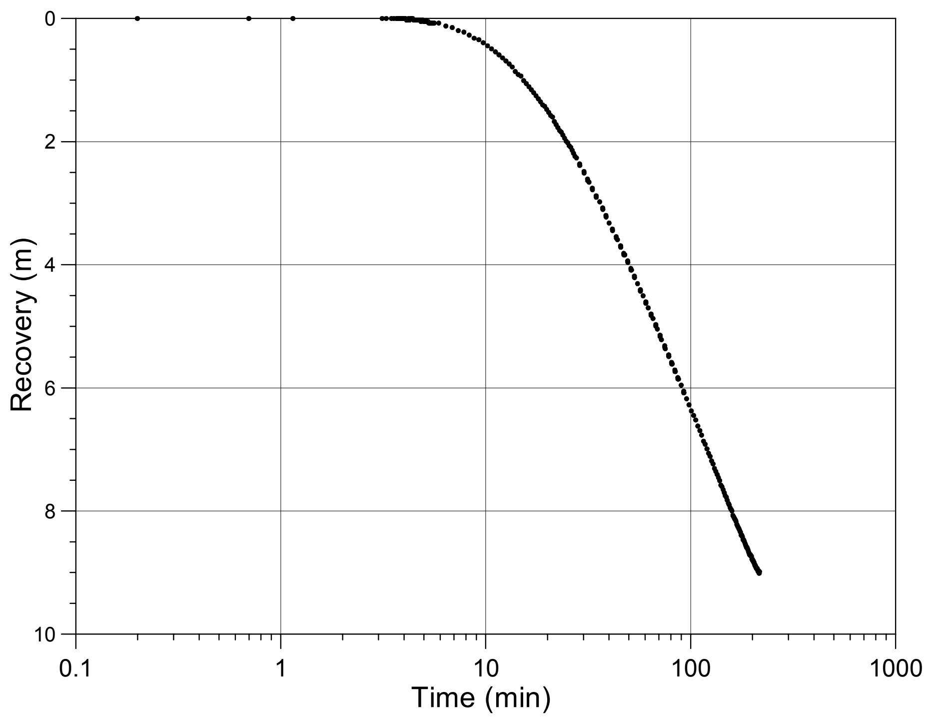




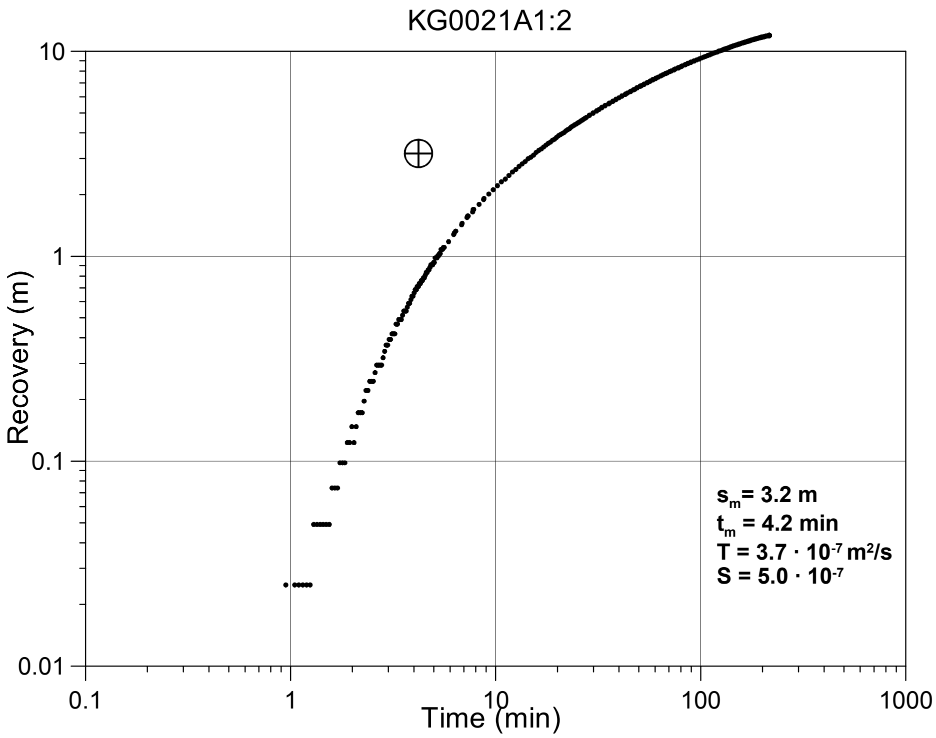
26_KA3590G2_2.GRF 2005-06-15

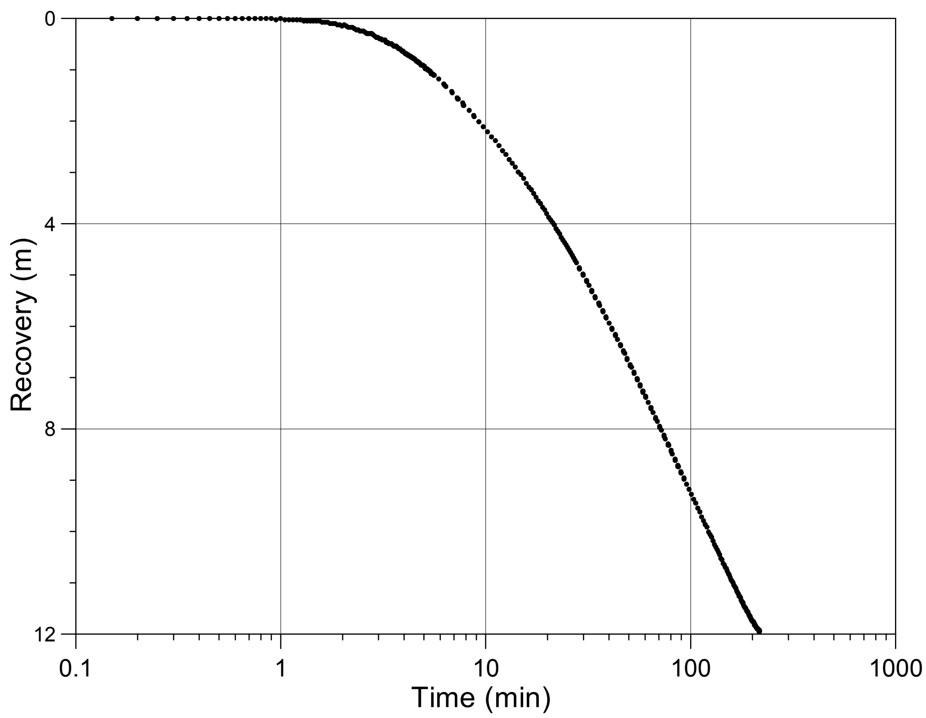
KG0021A1:1



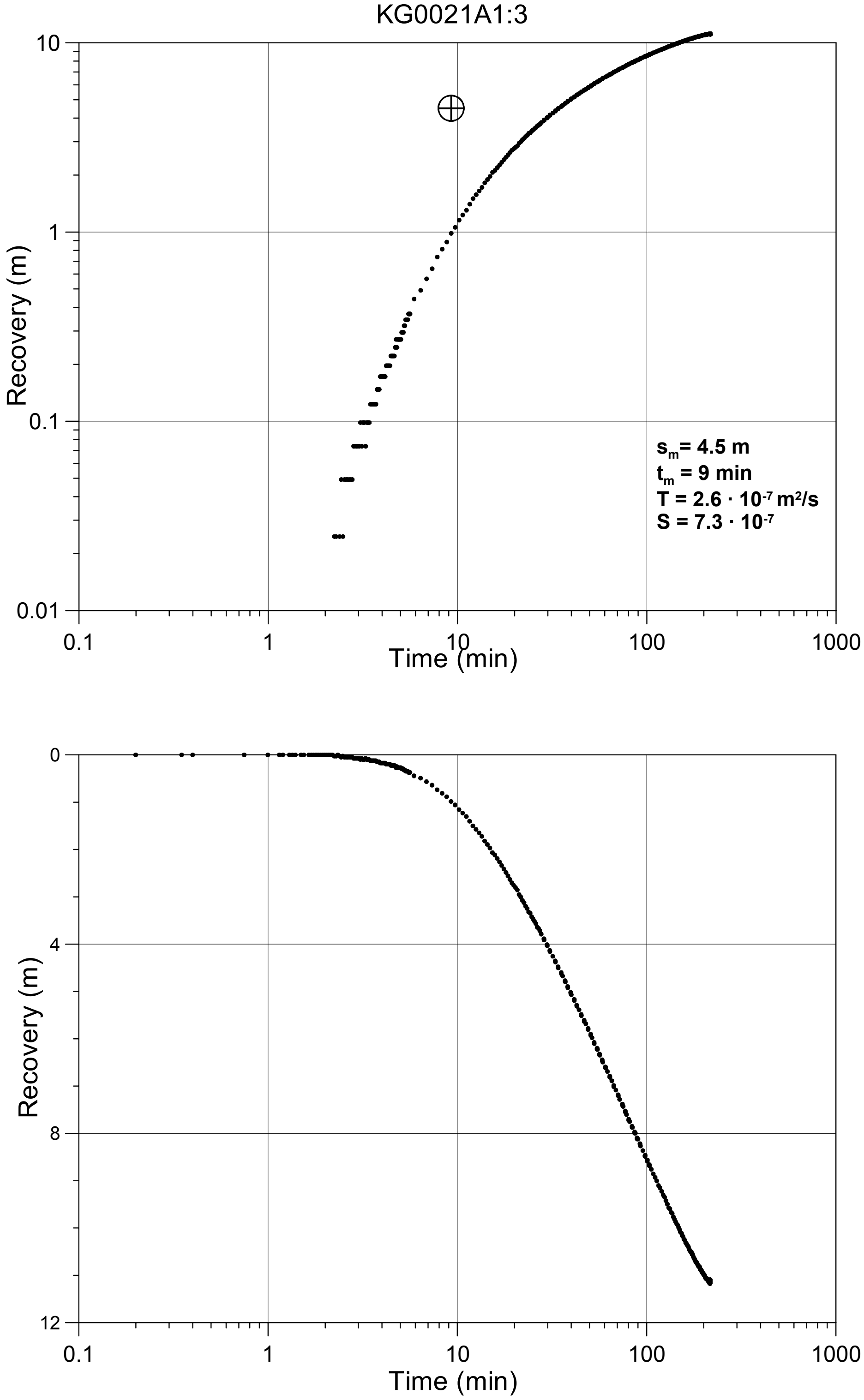


26_KG0021A1_1.GRF 2005-06-15

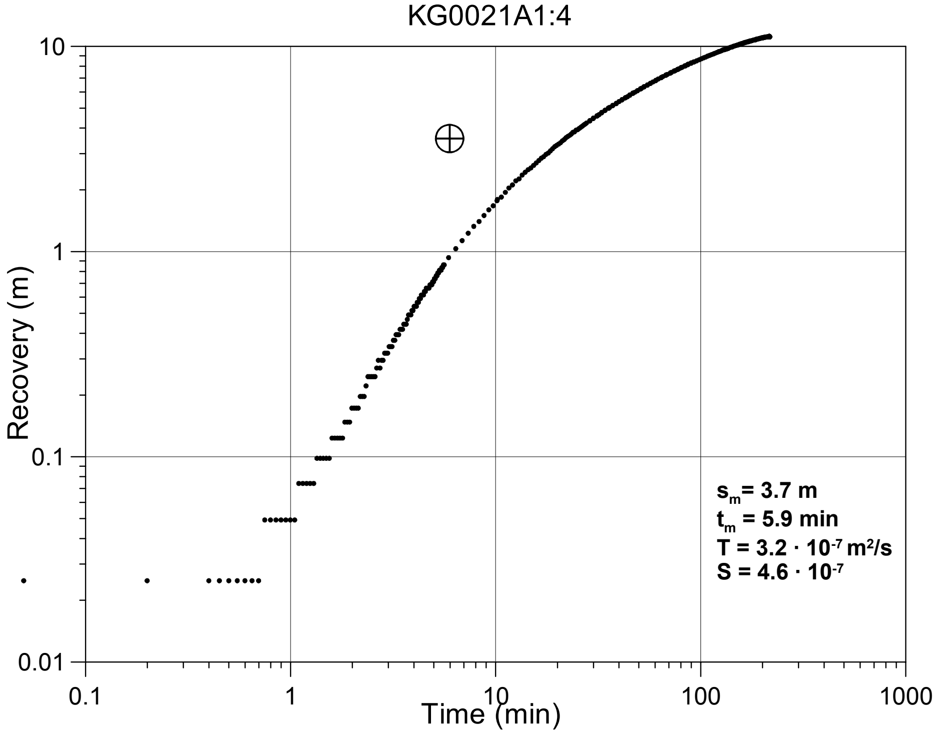


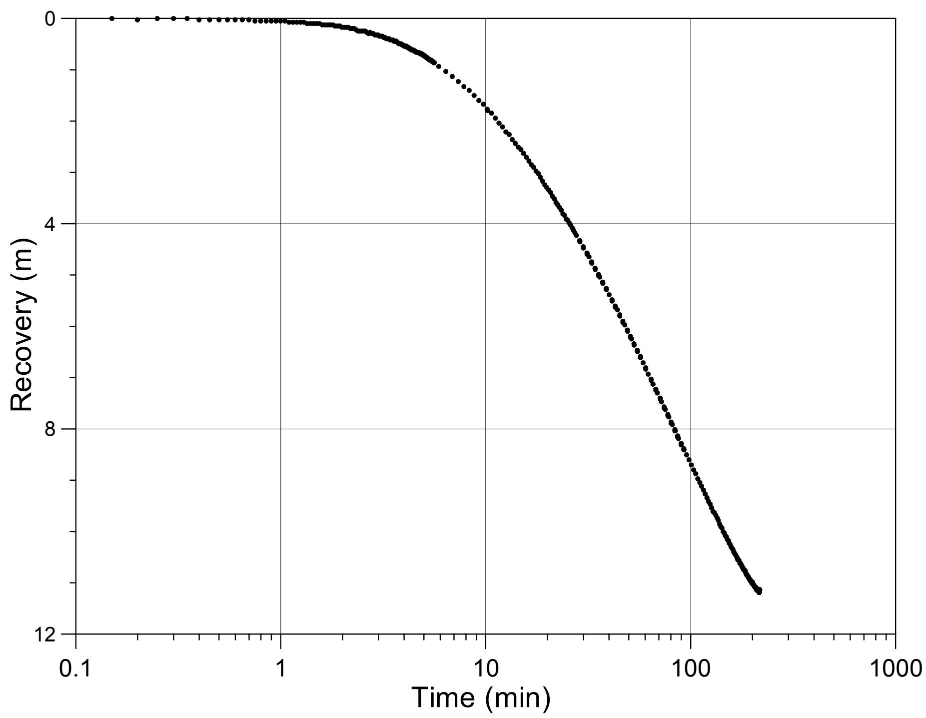


26_KG0021A1_2.GRF 2005-06-15



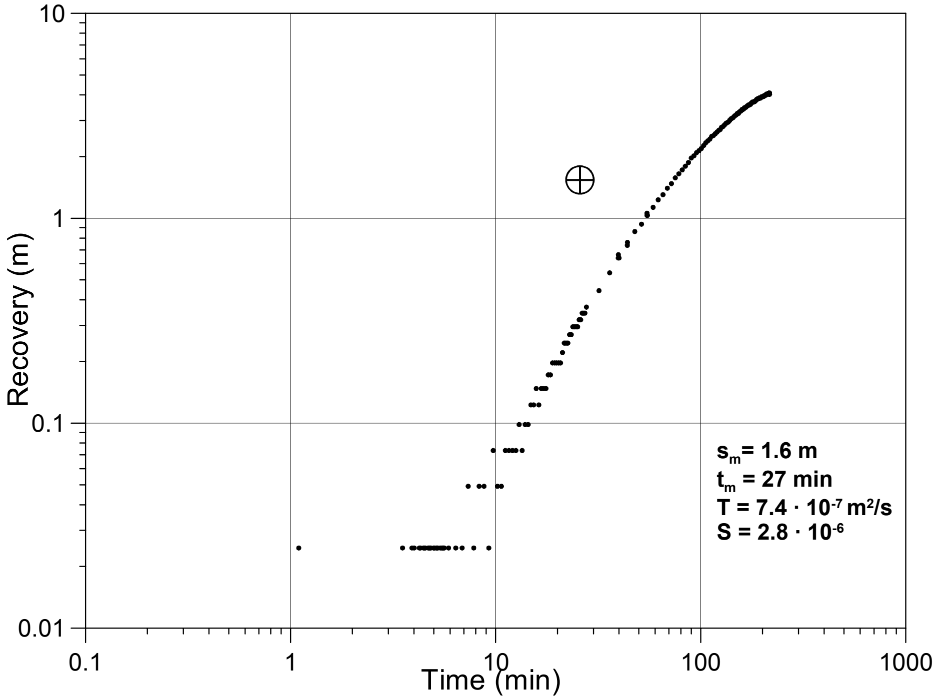
26_KG0021A1_3.GRF 2005-06-15

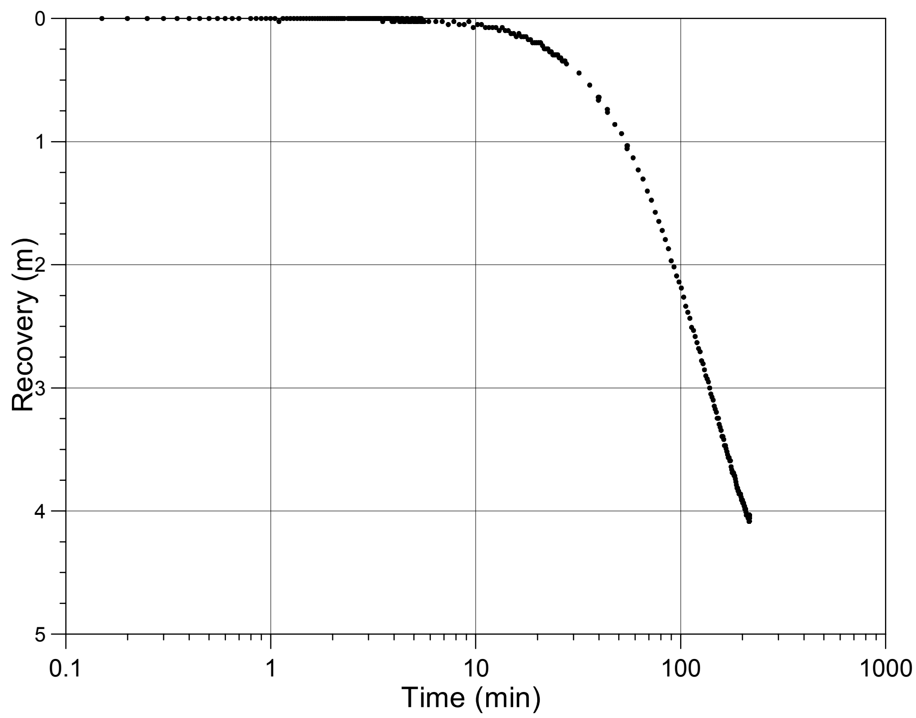




26_KG0021A1_4.GRF 2005-06-15

KG0021A1:5





26_KG0021A1_5.GRF 2005-06-15

APPENDIX 7

Interference test 5:27 in borehole KA3573A, section 10.50 m – 12.50 m

Date: 2005-01-25 Field Crew: A. Blom / J. Magnusson
Borehole length: 40.07 m Borehole diameter: 76 mm

Flowing borehole: KA3573A, section 4: 10.50 m – 12.50 m

Valve opened: 20050125 19:00.00 Valve closed: 20050126 15:00.00

End of Test: 20050128 19:00

Total flowing time : 1200 min Tot. Pr. Build-up time: 3120 min.

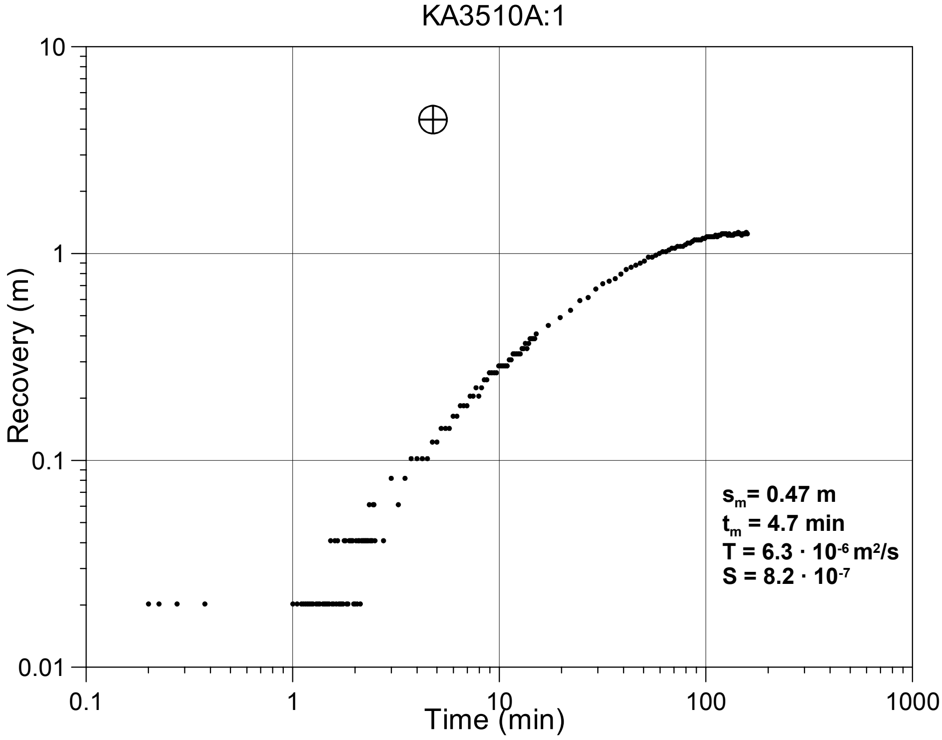
The test was performed as an Interference test. Pressure responses were monitored in 132 borehole sections including the flow section.

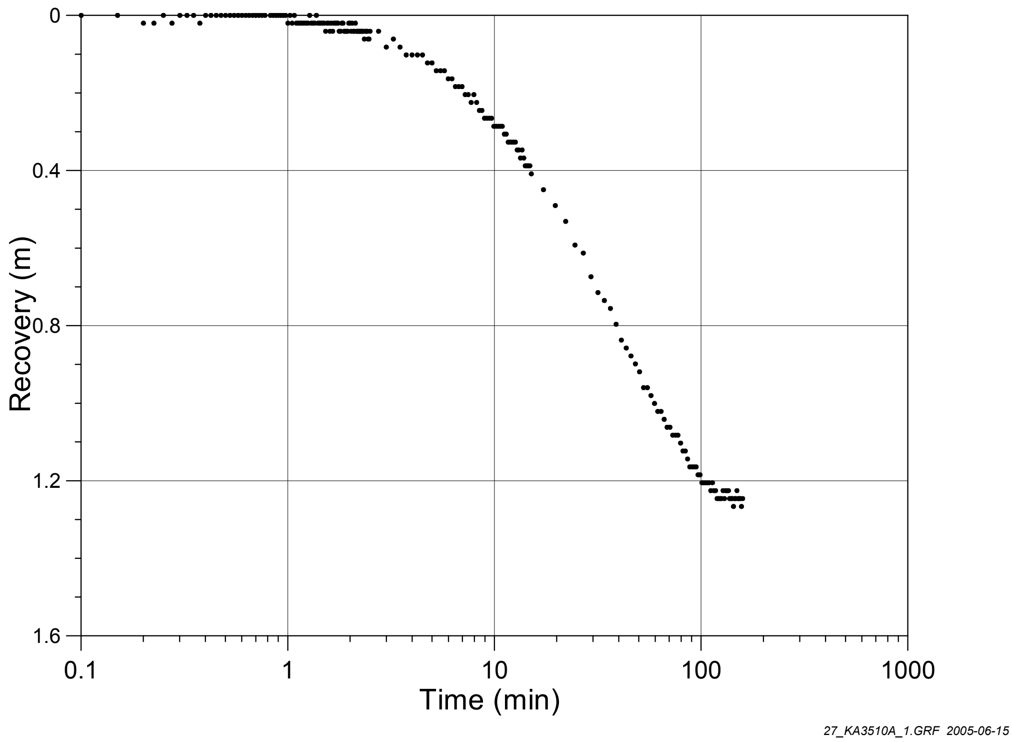
Flow data
Manually measured flow rates of KA3573A, section 10.50 m – 12.50 m are presented in the table below:

Table Manually measured flow rates, Interference test in KA3573A, section 10.50 m – 12.50 m. Prototype Repository, January 25 2005

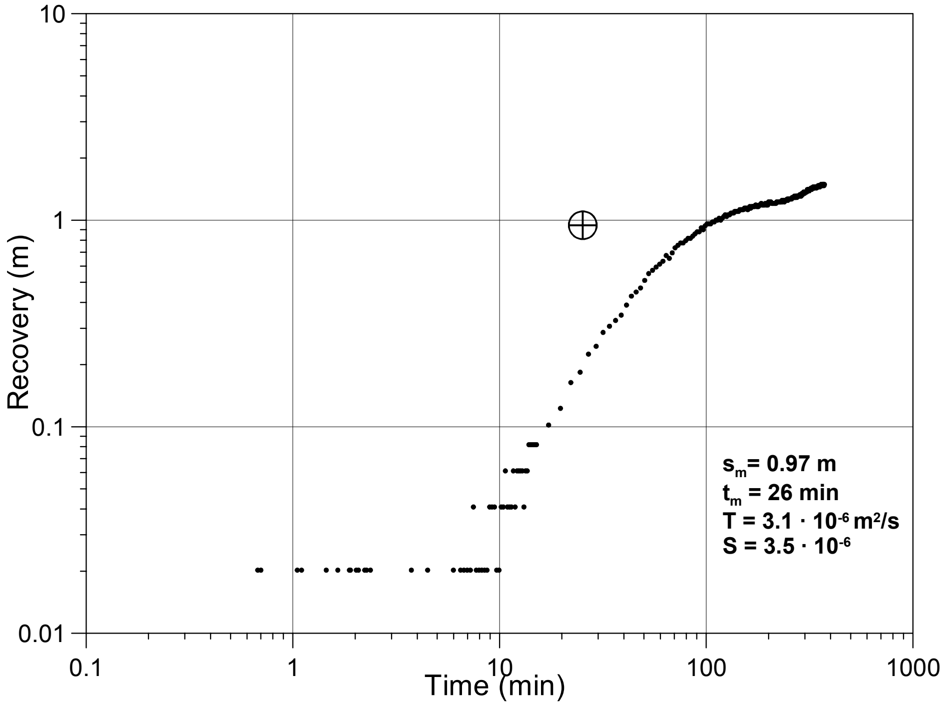
Time		Flow rate (l/min)
2005-01-25	19:00:00	-
	19:00:10	2.45
	19:01:10	2.40
	19:02:10	2.39
	19:03:10	2.38
	19:07:00	2.37
	19:32:00	2.36
2005-01-26	08:37:00	2.28
	08:44:00	2.24
	10:35:00	2.28
	14:51:00	2.28
	14:52:00	2.28
	15:00:00	2.24

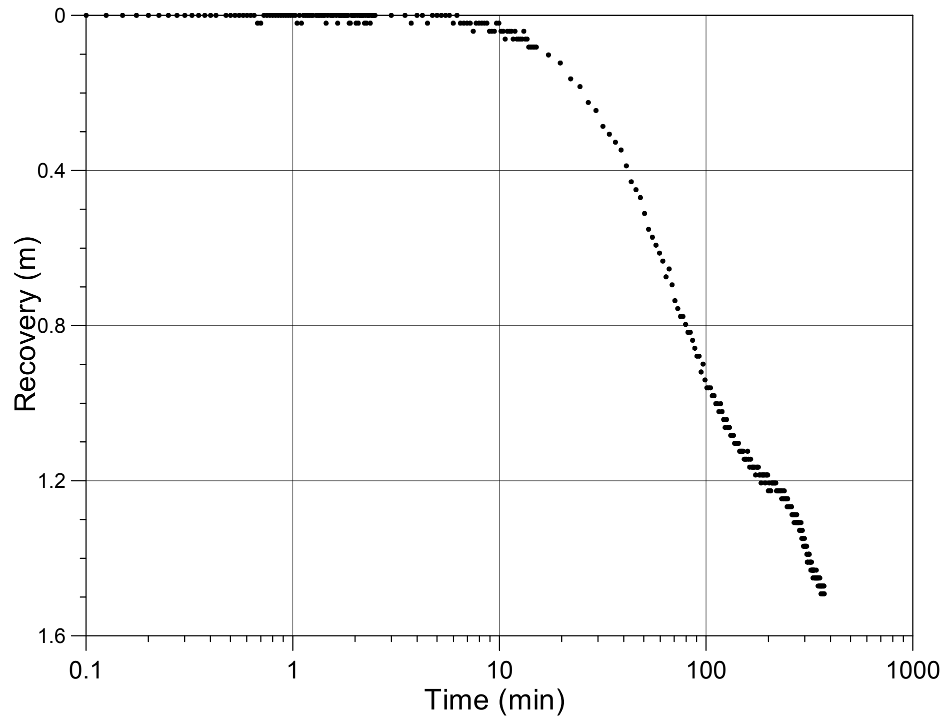
In all cases the matchpoint used is consistent with $p_D = 1$ and $t_D = 1$.


KA3510A:1
Recovery (m)
Time (min)
10
1
0.1
0.01
0.1
1
10
100
1000
s_m= 0.47 m
t_m = 4.7 min
T = 6.3 · 10^{-6} m^2/s
S = 8.2 · 10^{-7}


Recovery (m)
Time (min)
0
0.4
0.8
1.2
1.6
0.1
1
10
100
1000
27_KA3510A_1.GRF 2005-06-15

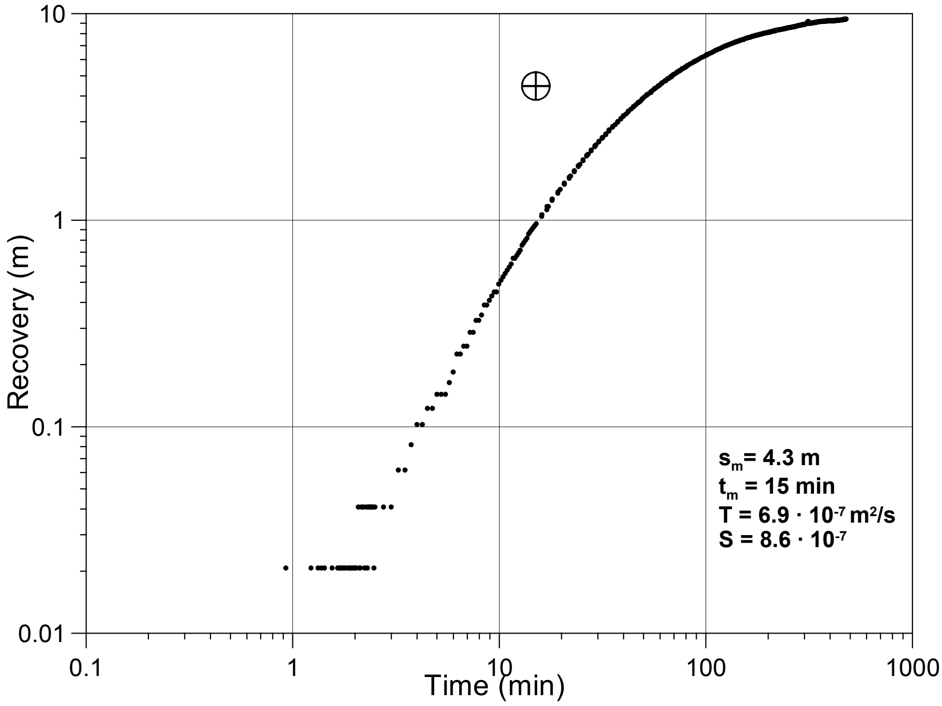
KA3510A:2

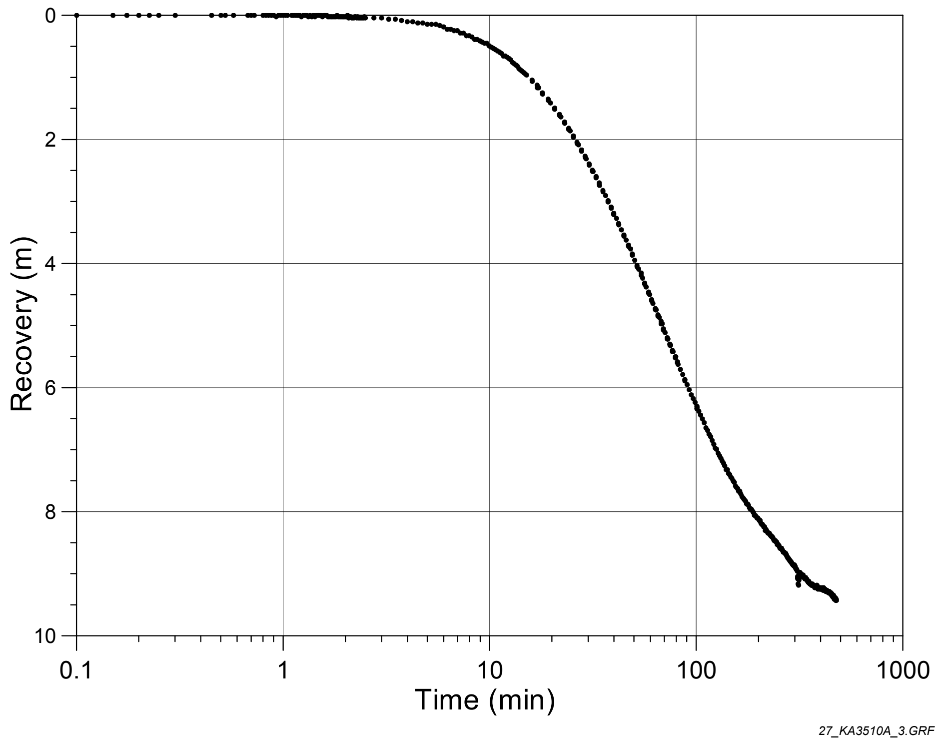




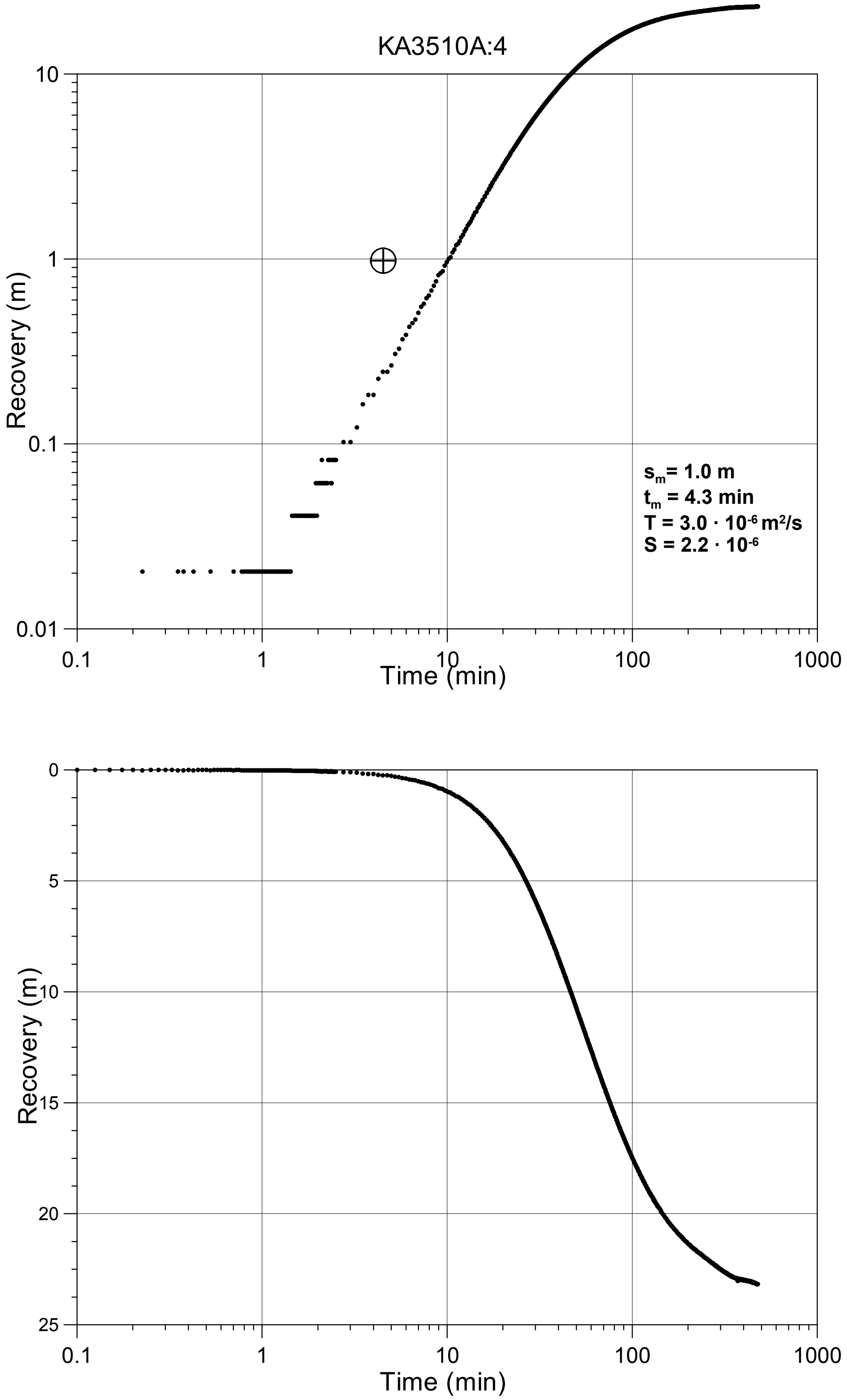
27_KA3510A_2.GRF 2005-06-15

KA3510A:3

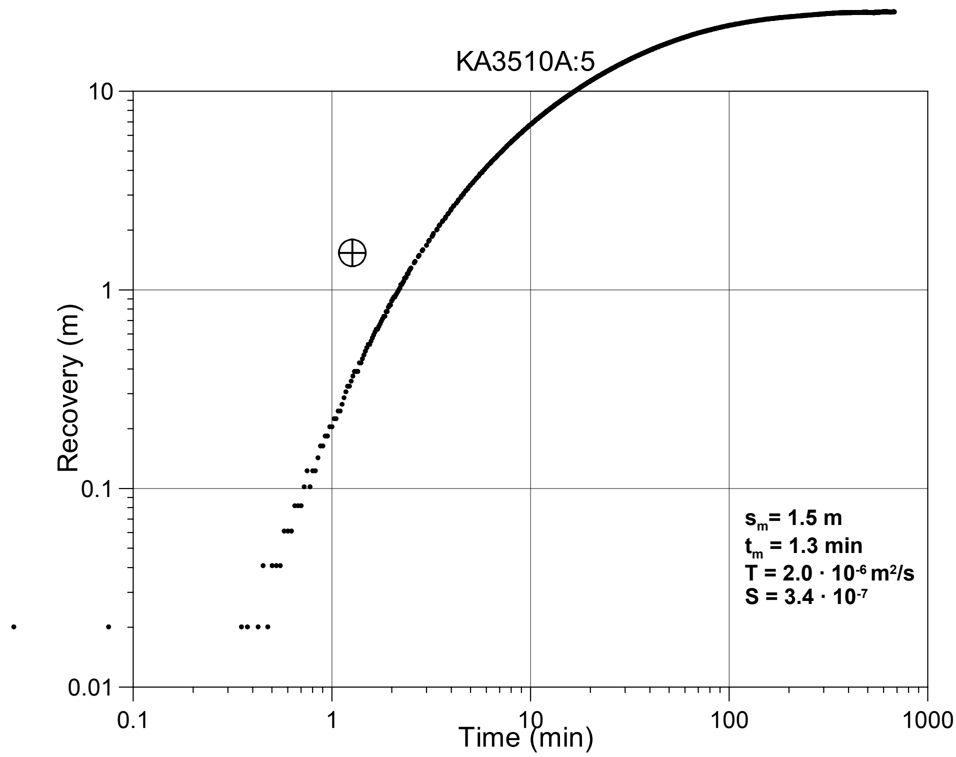


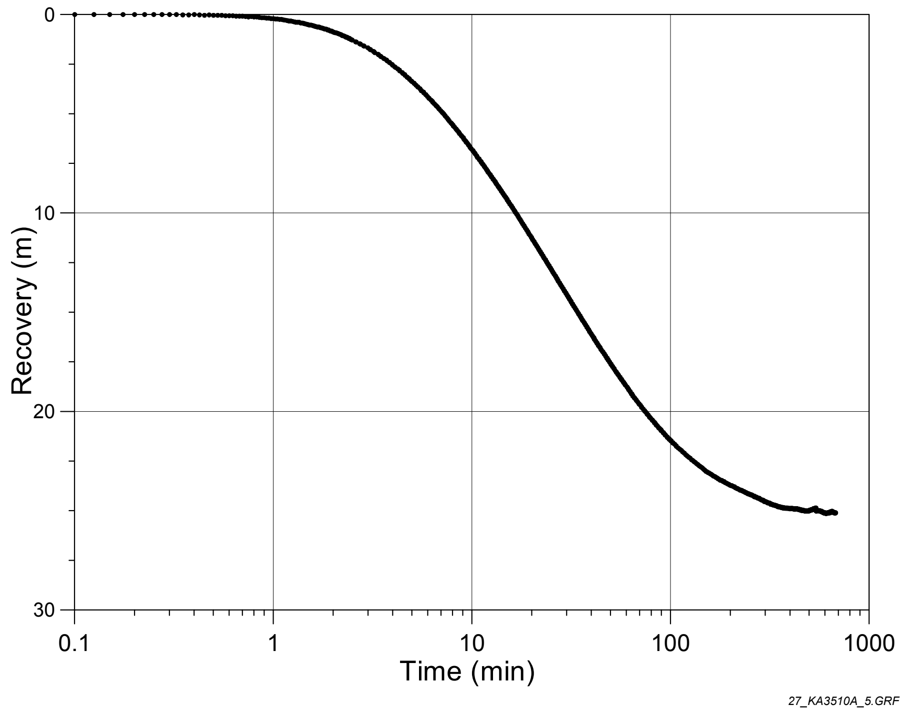


27_KA3510A_3.GRF 2005-06-15



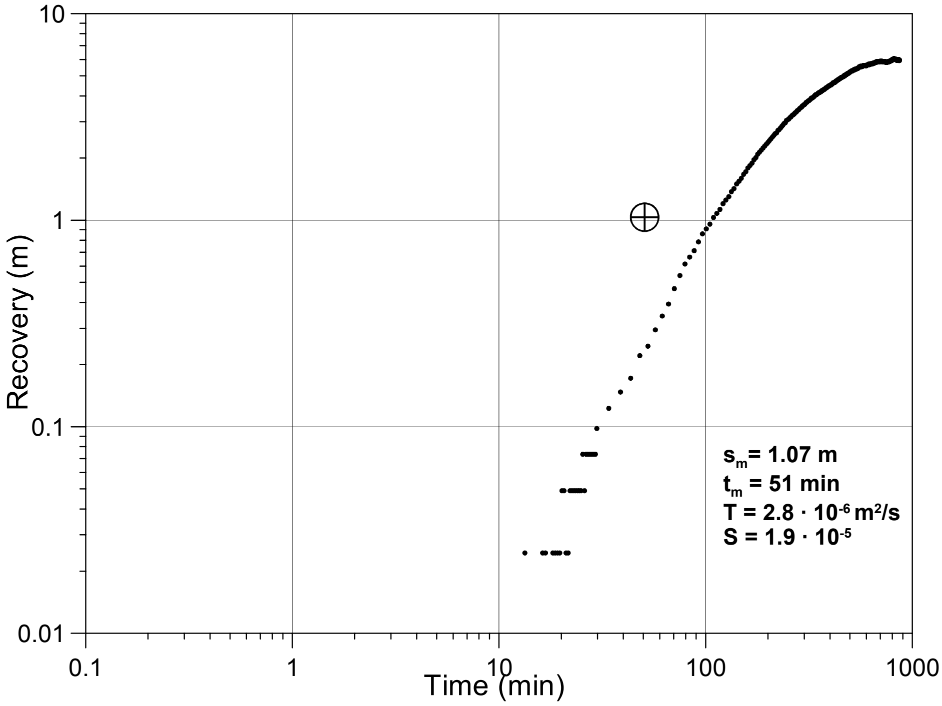
27_KA3510A_4.GRF 2005-06-15

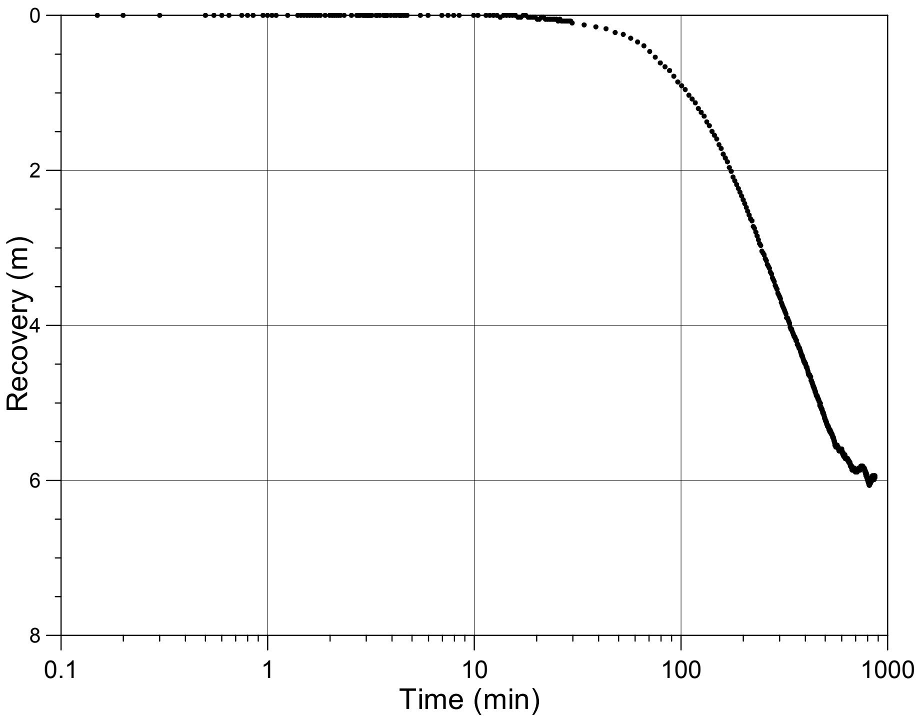




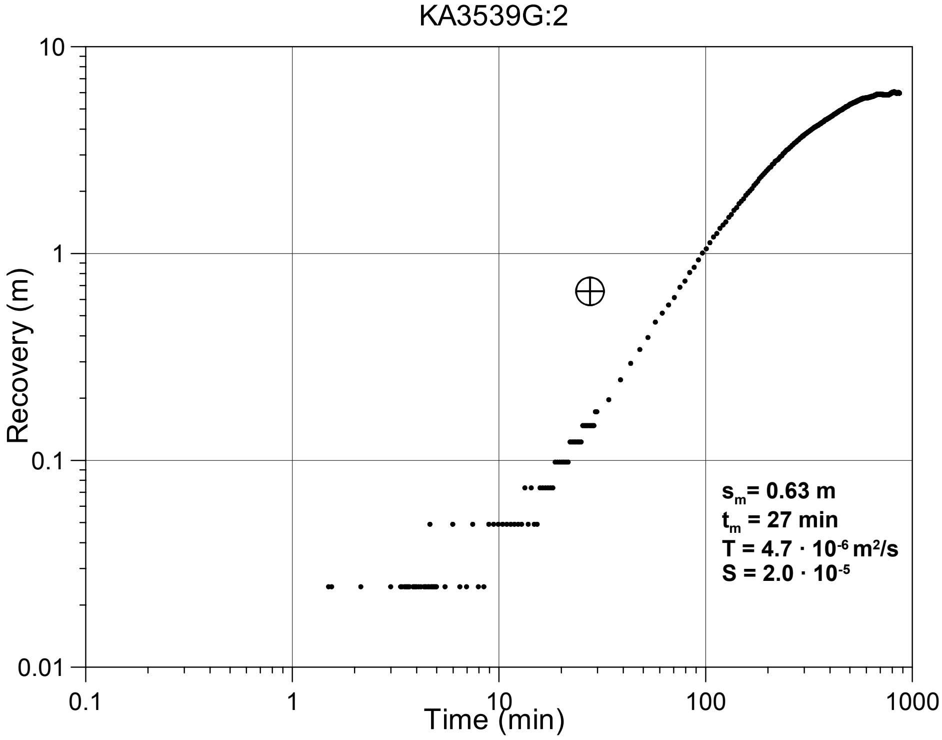
27_KA3510A_5.GRF 2005-06-15

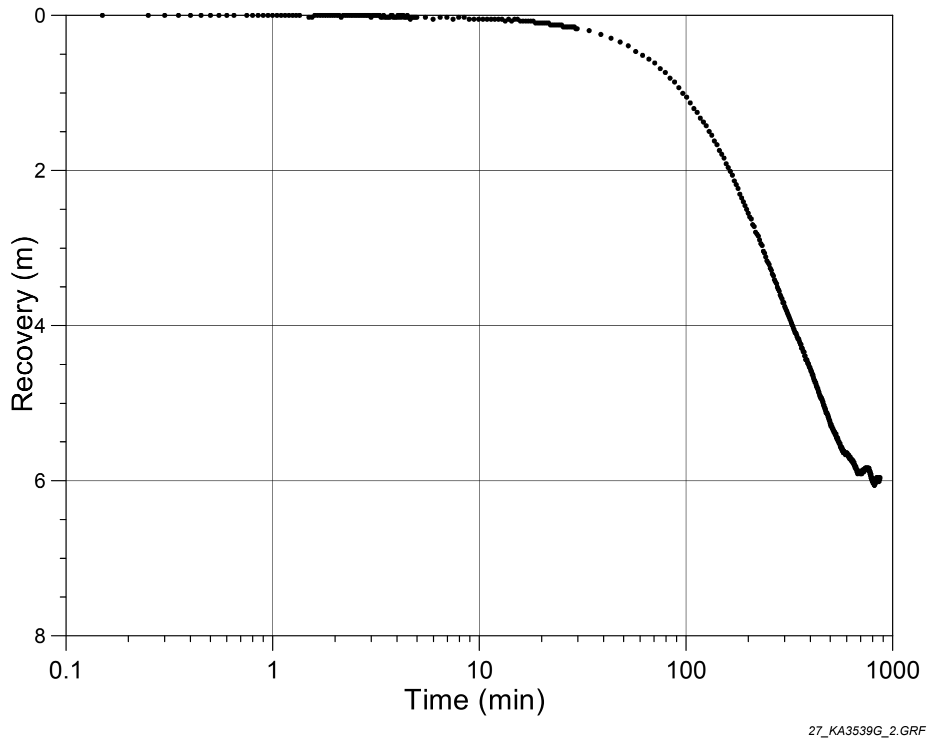
KA3539G:1





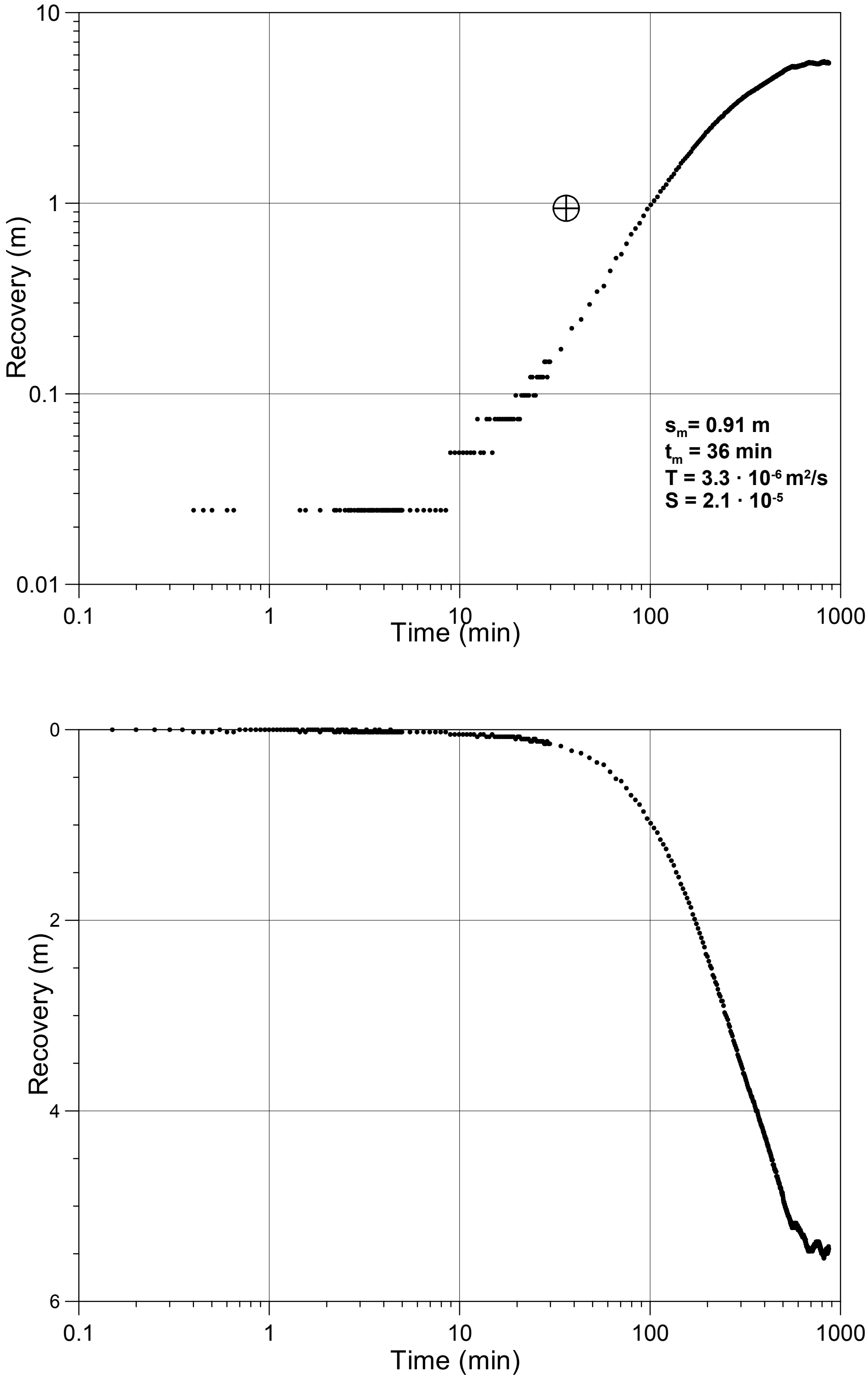
27_KA3539G_1.GRF 2005-06-15



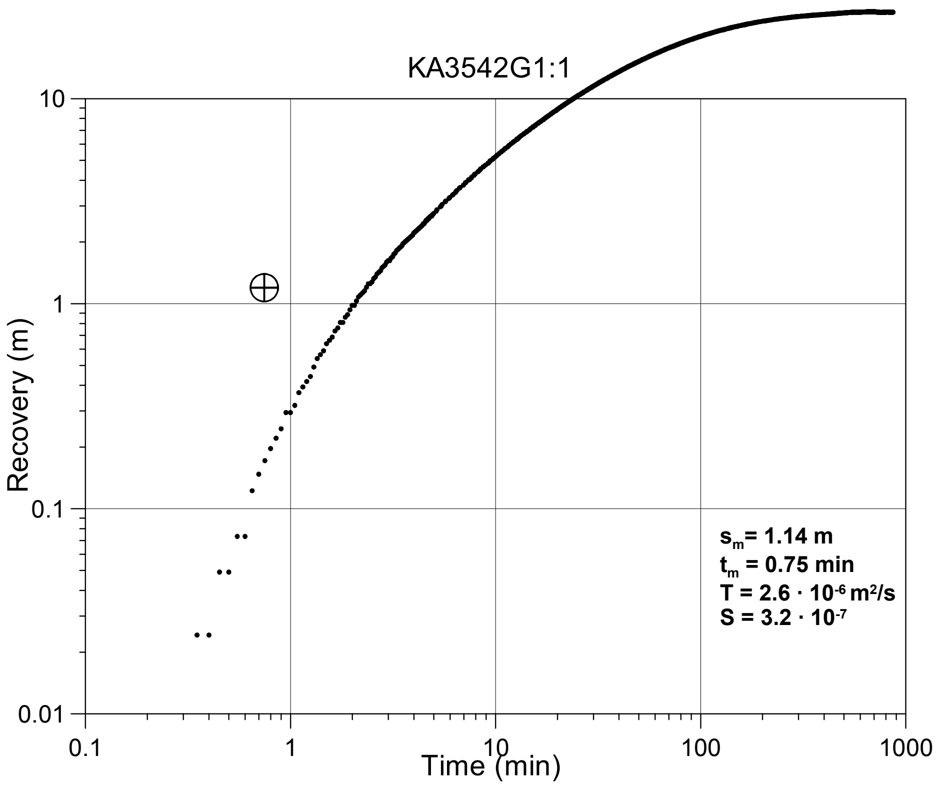


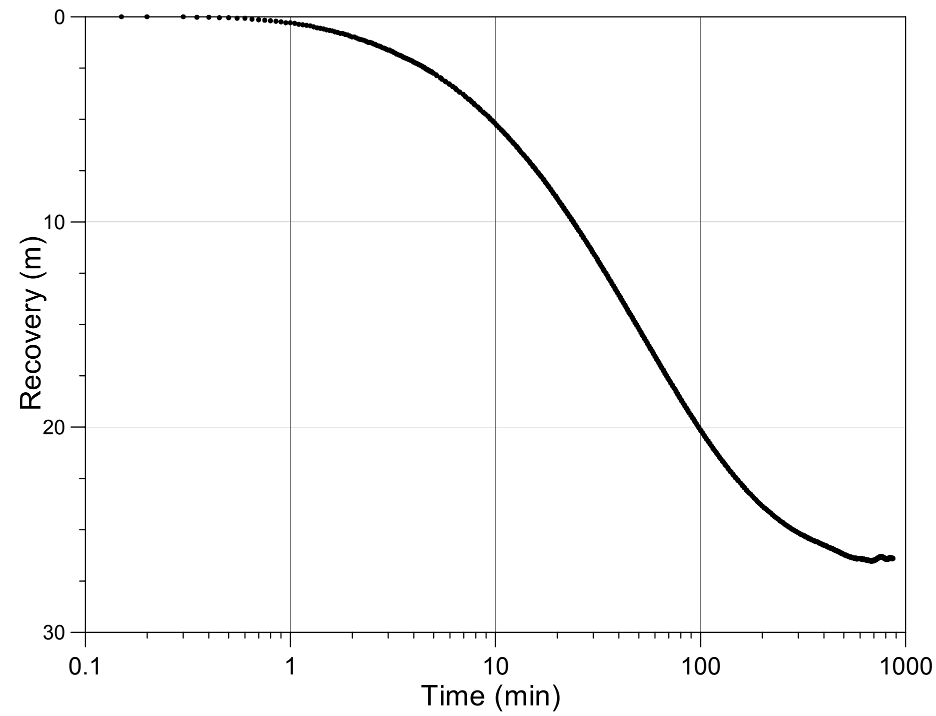
27_KA3539G_2.GRF 2005-06-15

KA3539G:4

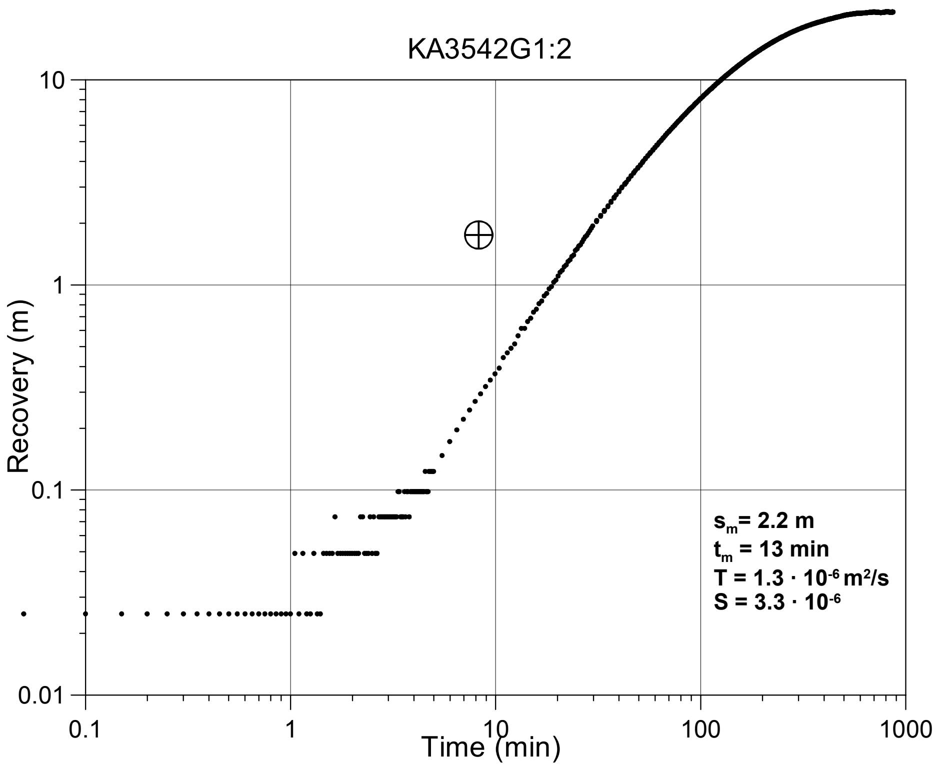


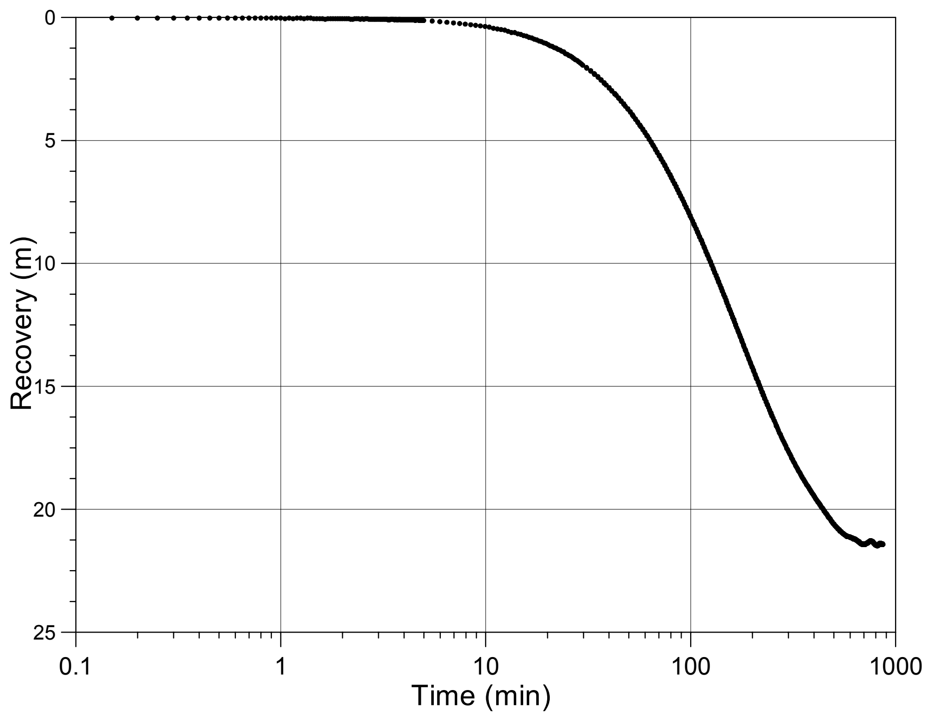
27_KA3539G_4.GRF 2005-06-15



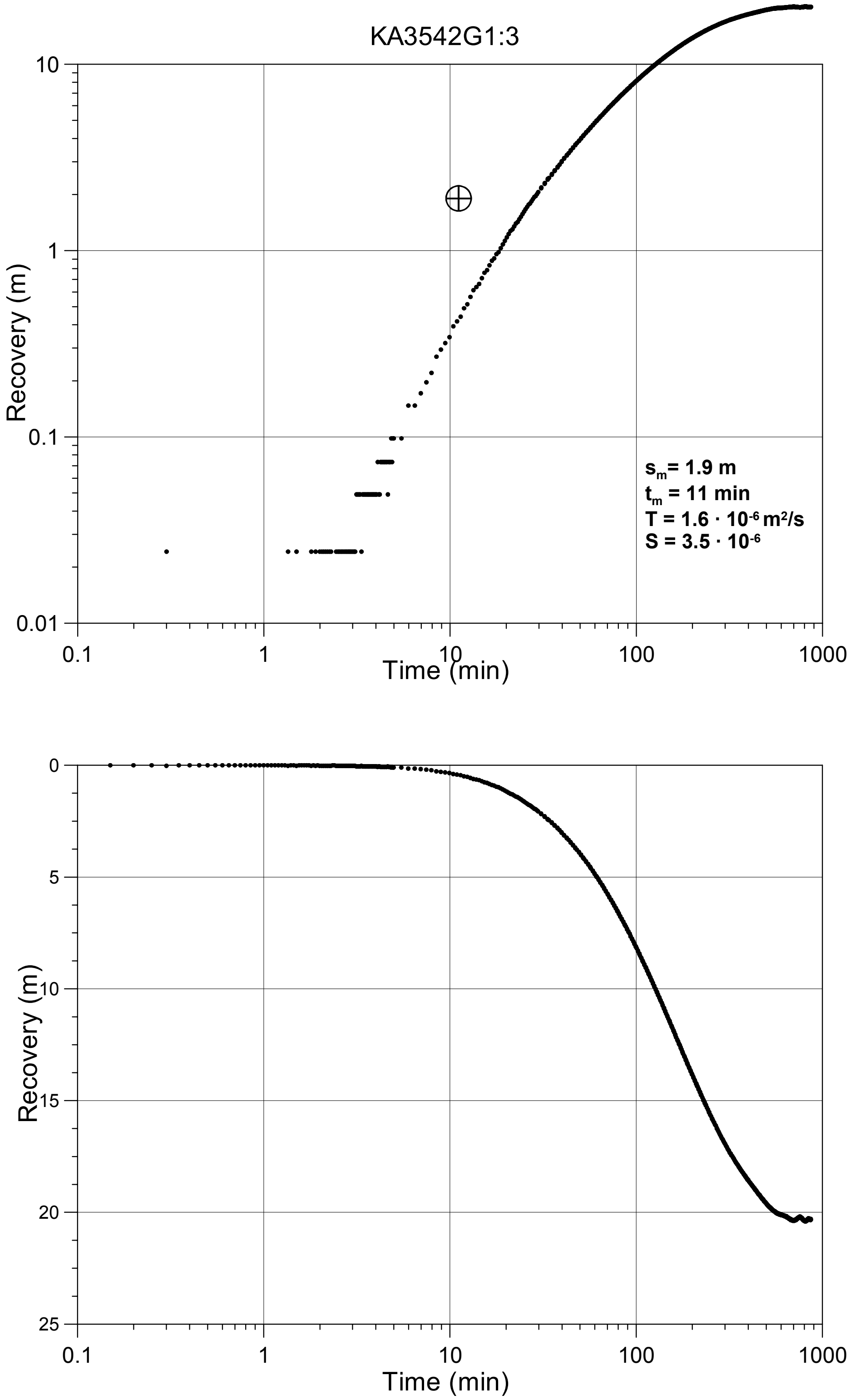


27_KA3542G1_1.GRF 2005-06-15



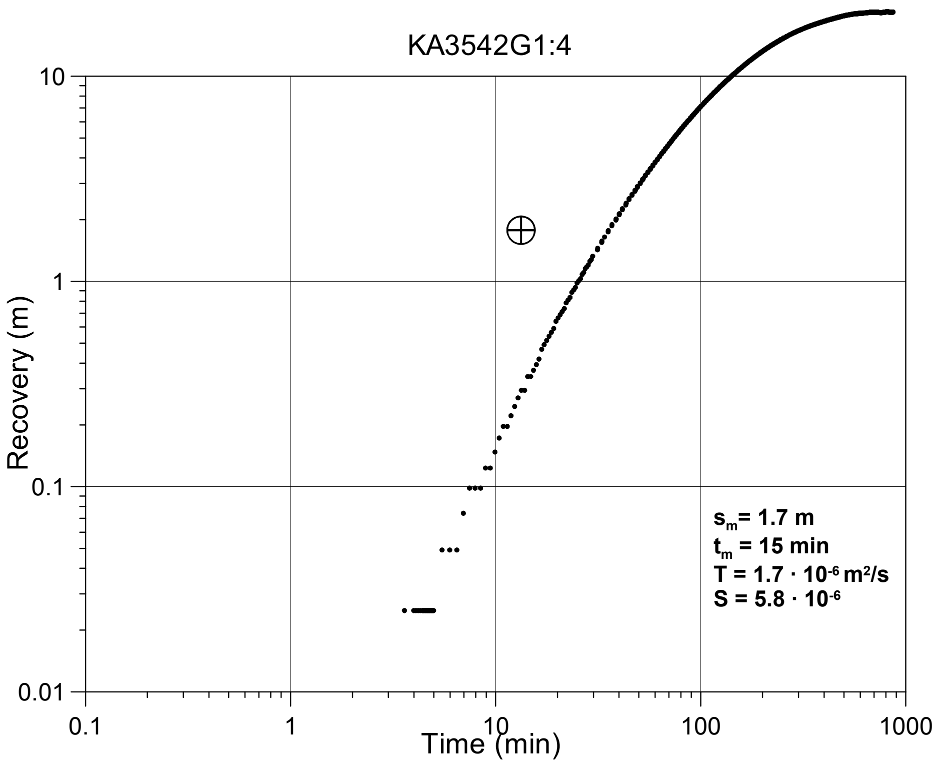


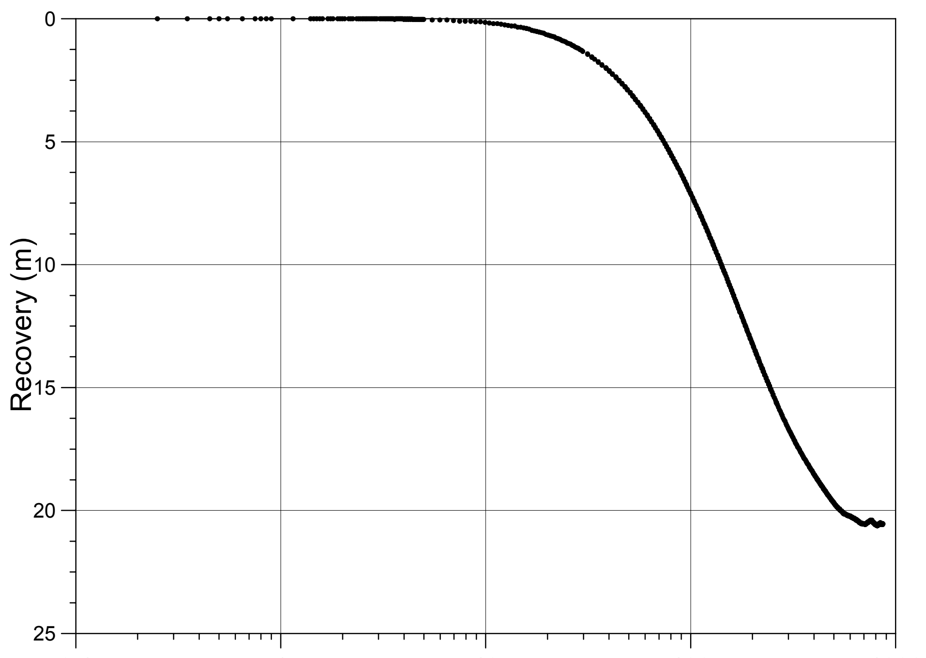
27_KA3542G1_2.GRF 2005-06-15



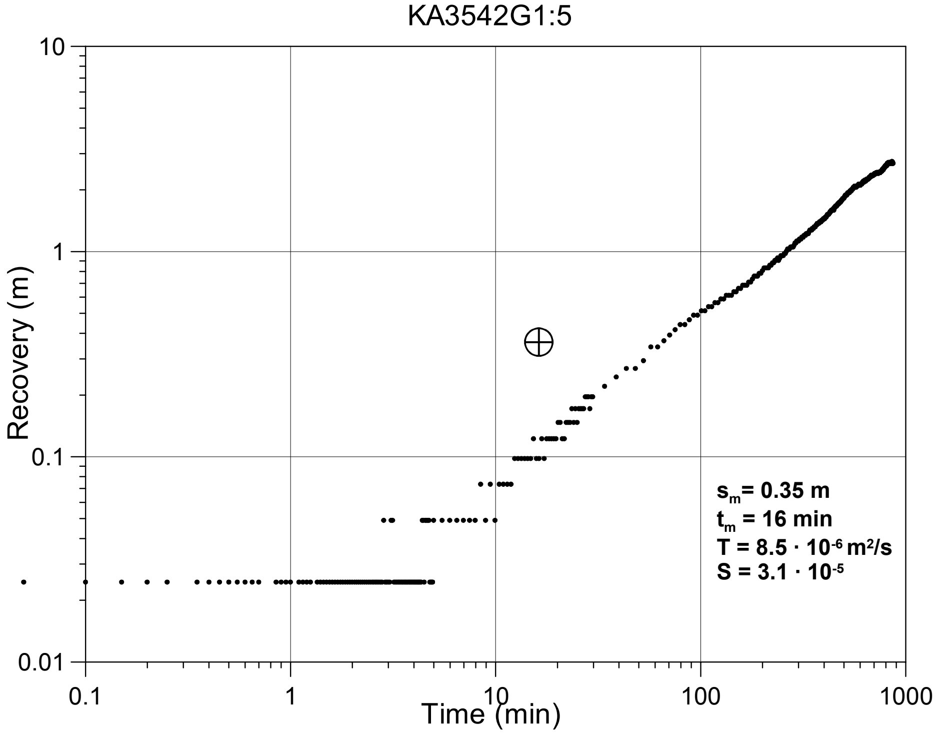
27_KA3542G1_3.GRF 2005-06-15

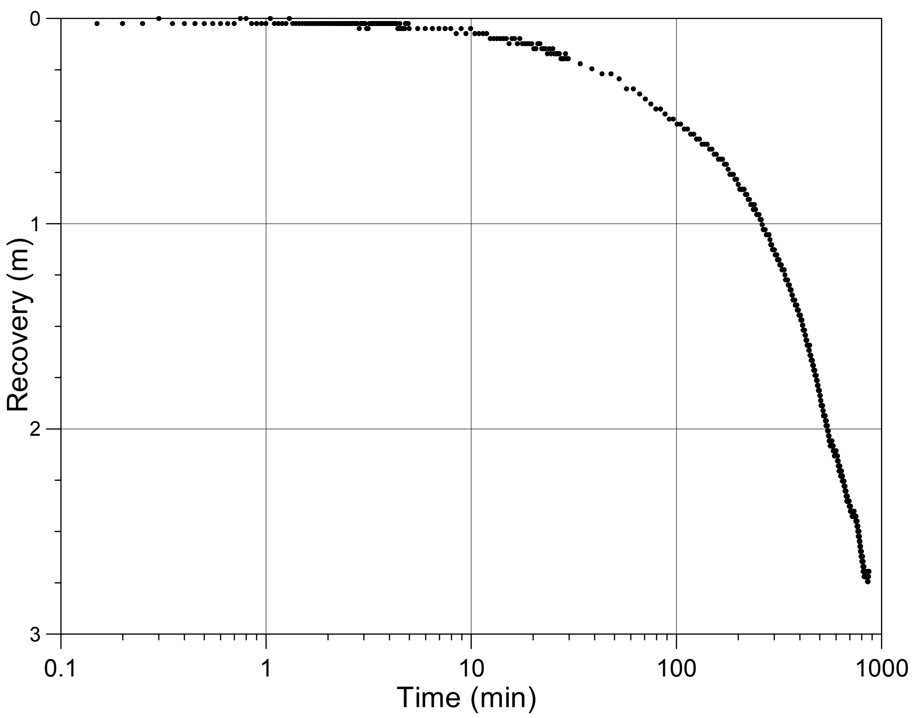
KA3542G1:4



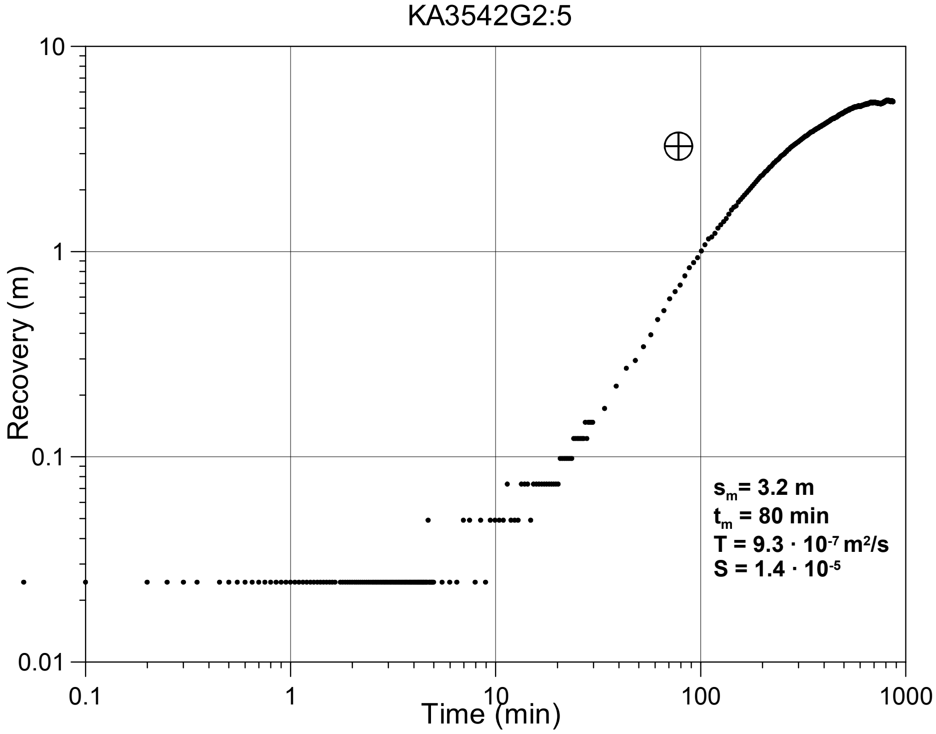


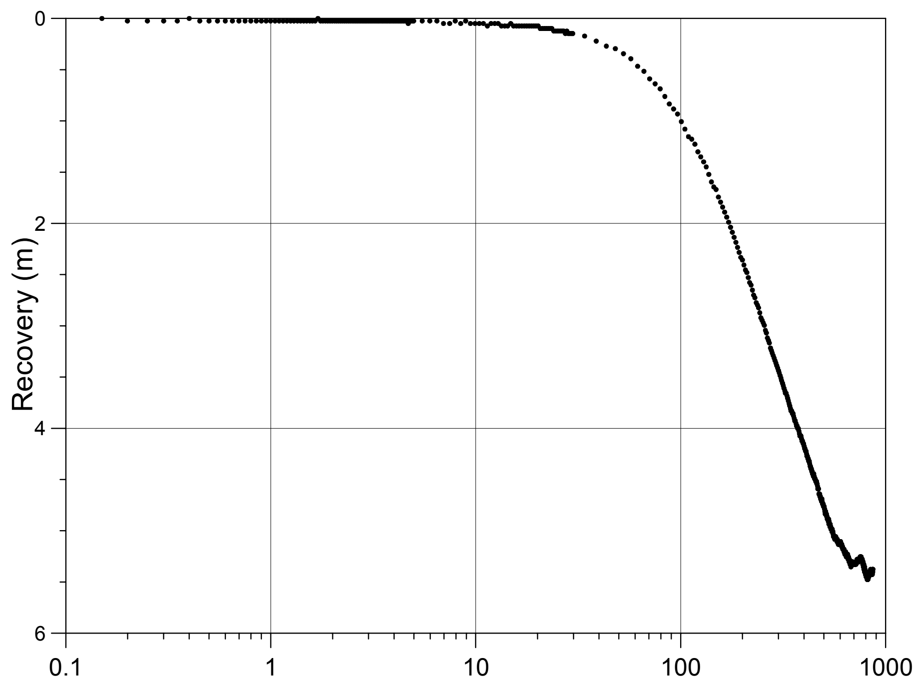
27_KA3542G1_4.GRF 2005-06-15



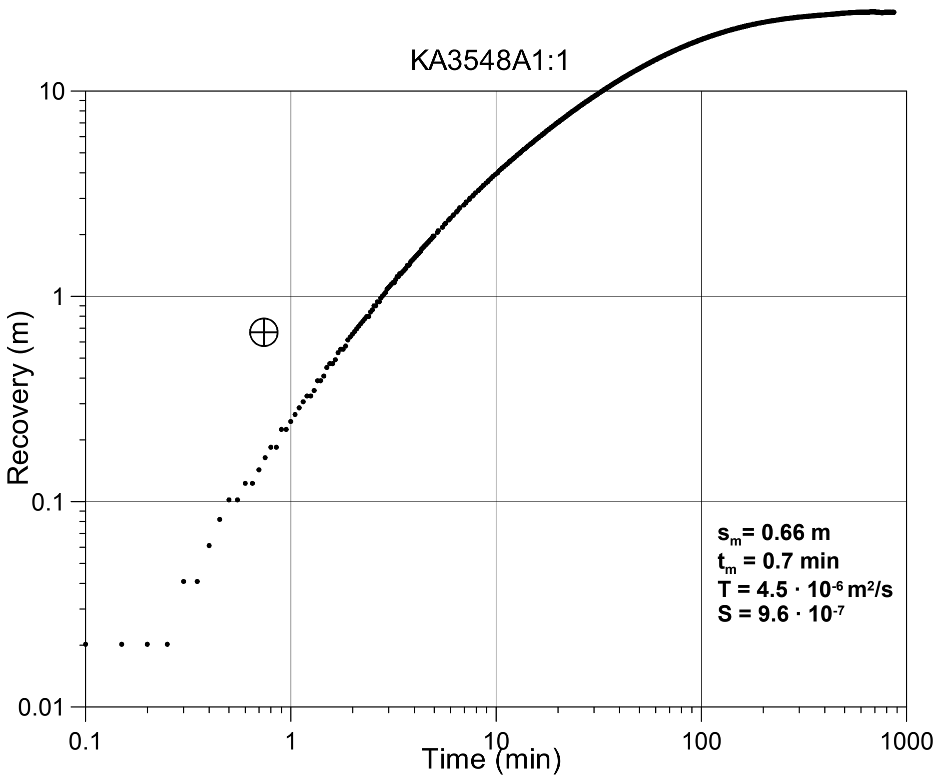


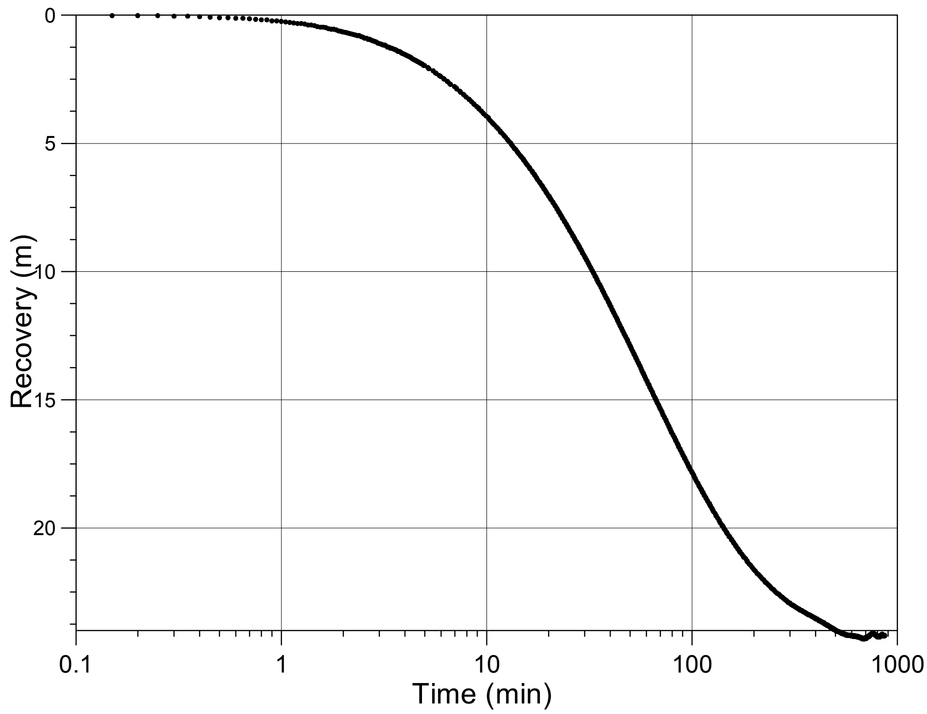
27_KA3542G1_5.GRF 2005-06-15





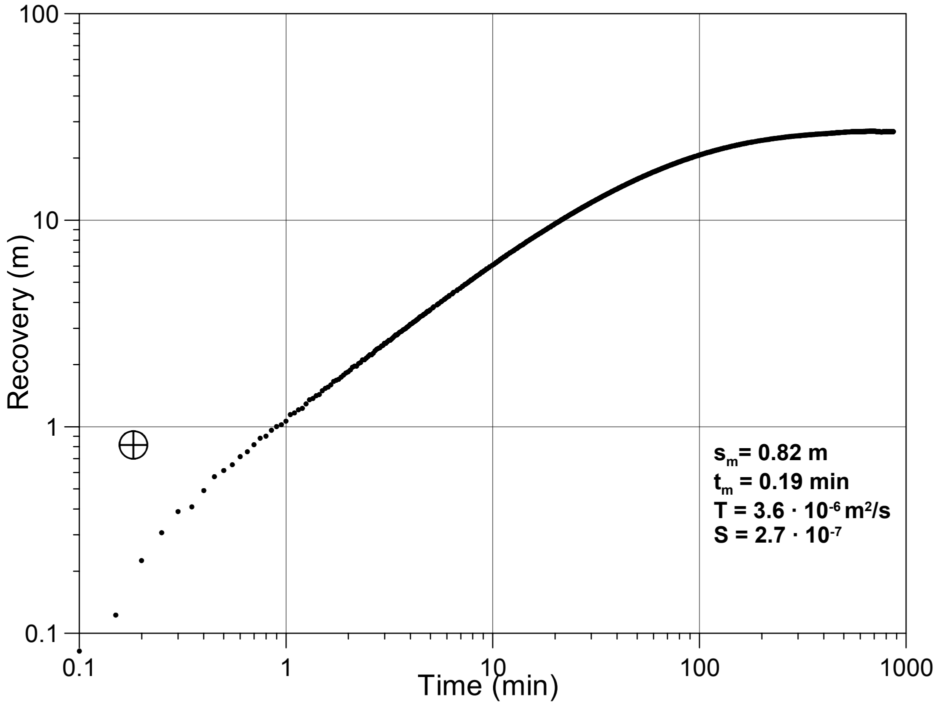
27_KA3542G2_5.GRF 2005-06-15

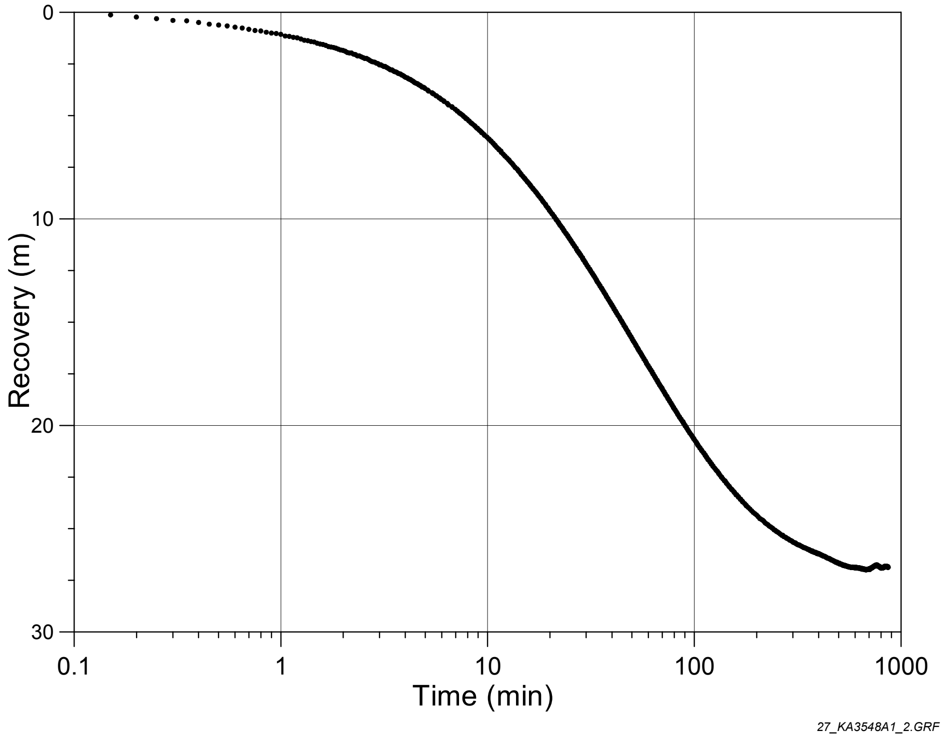




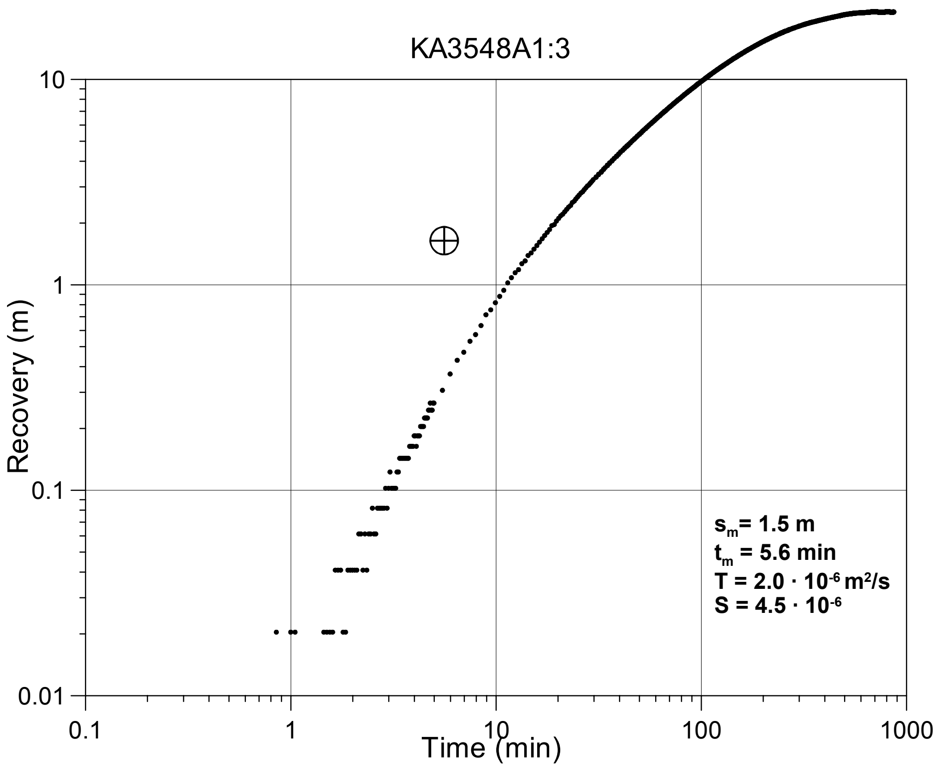
27_KA3548A1_1.GRF 2005-06-15

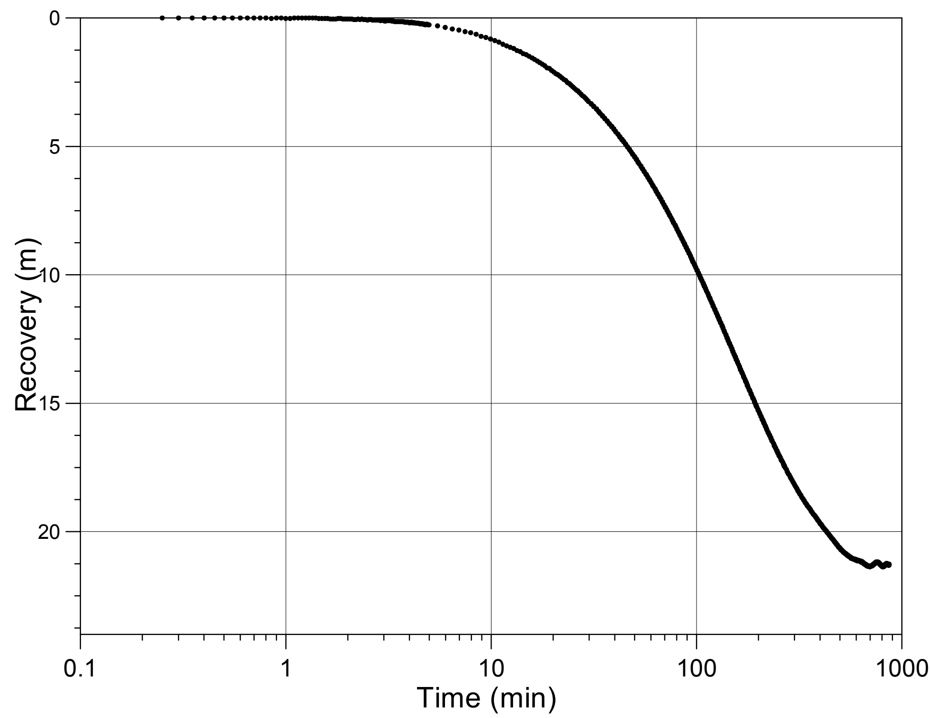
KA3548A1:2



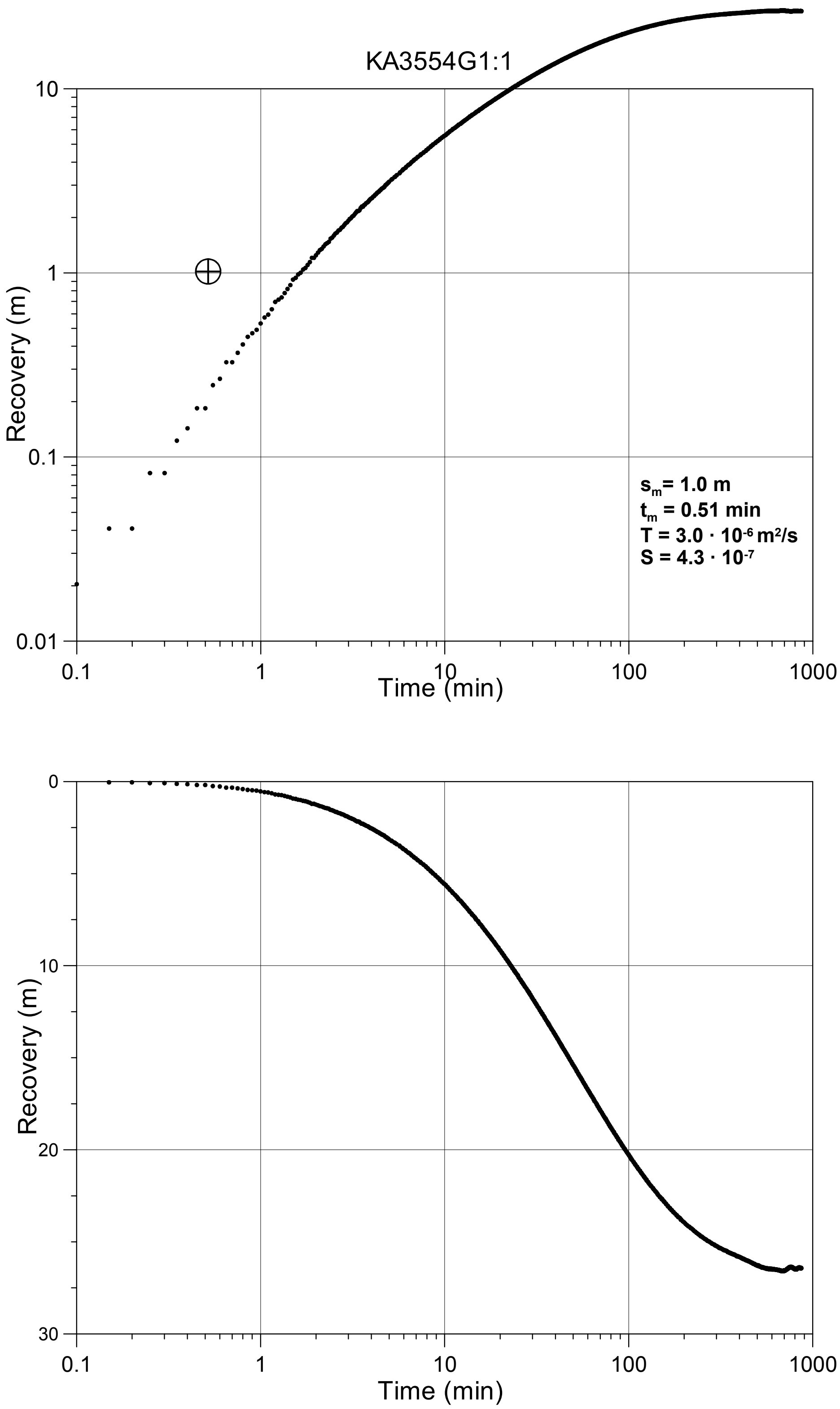


27_KA3548A1_2.GRF 2005-06-15

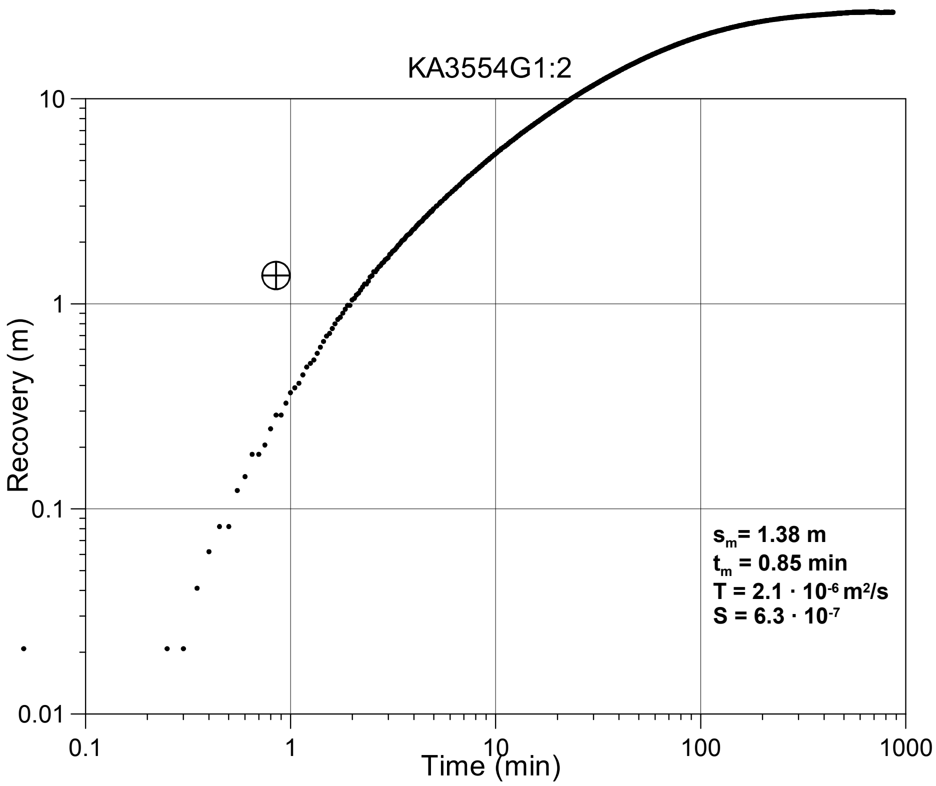


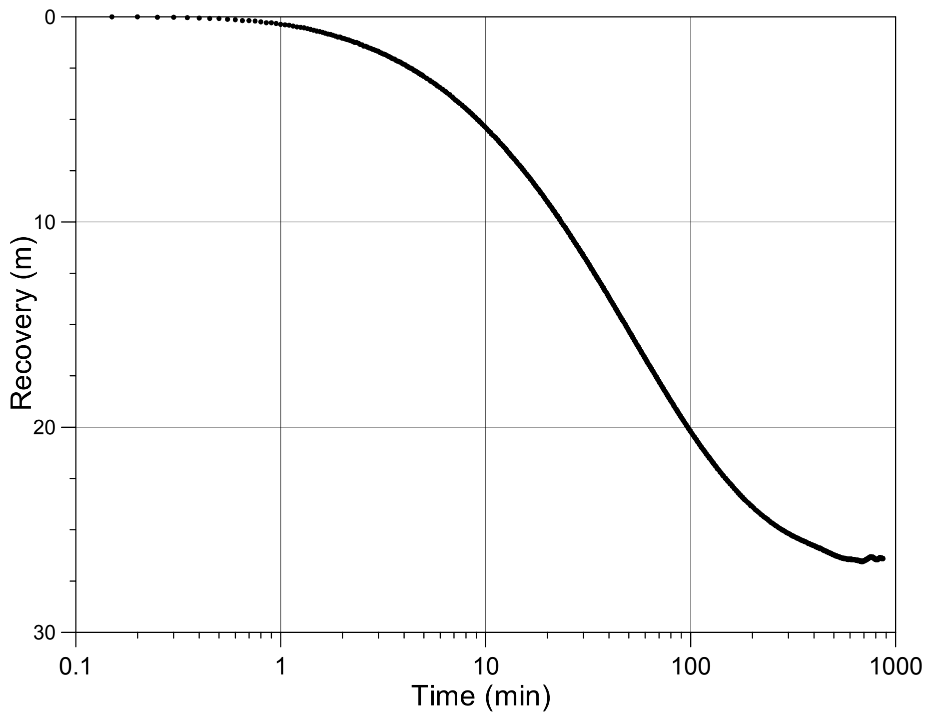


27_KA3548A1_3.GRF 2005-06-15

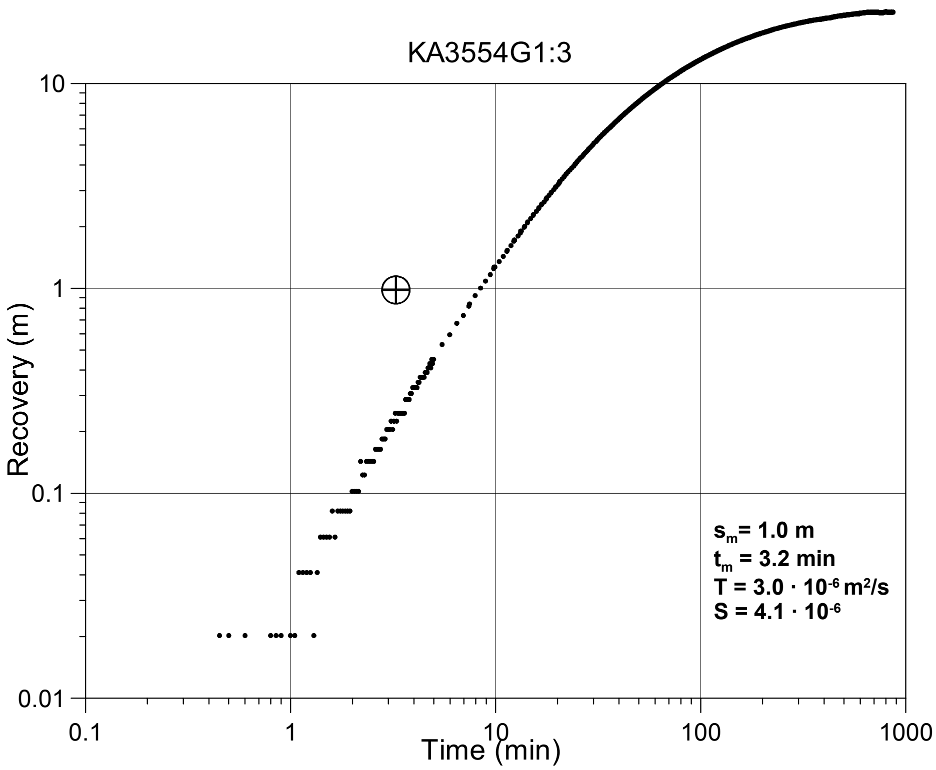


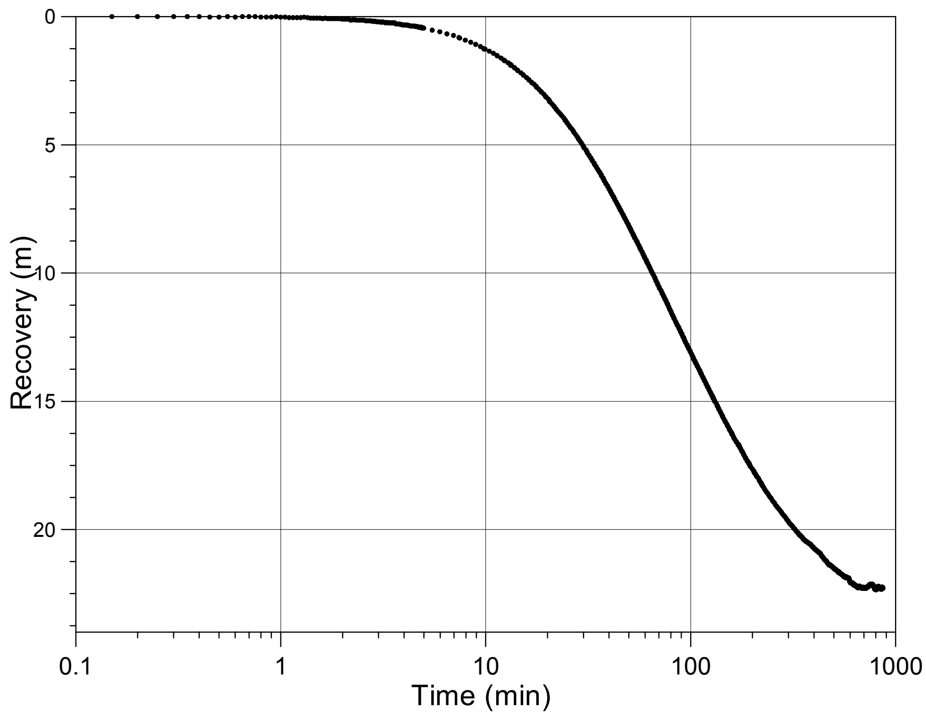
27_KA3554G1_1.GRF 2005-06-15



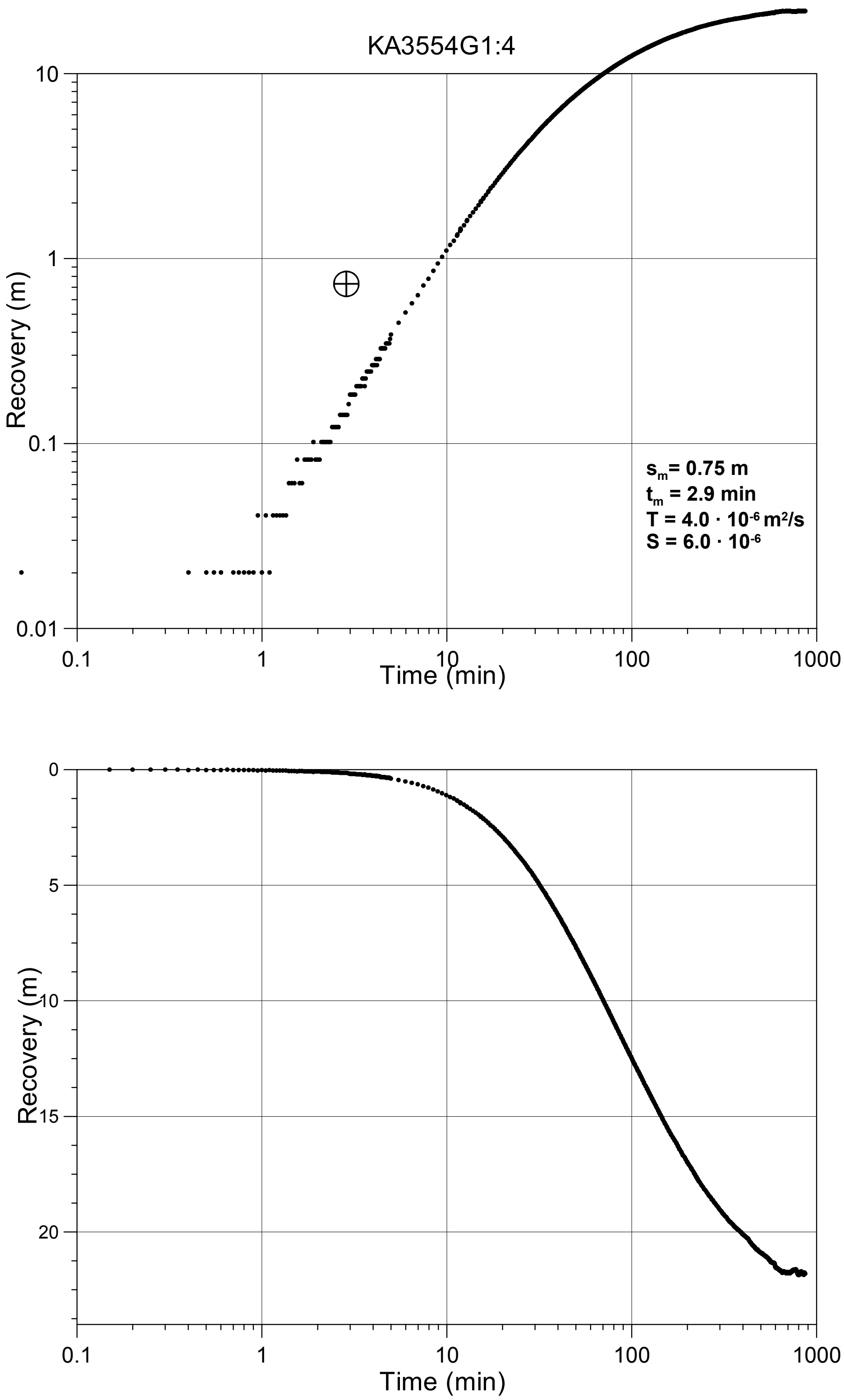


27_KA3554G1_2.GRF 2005-06-15

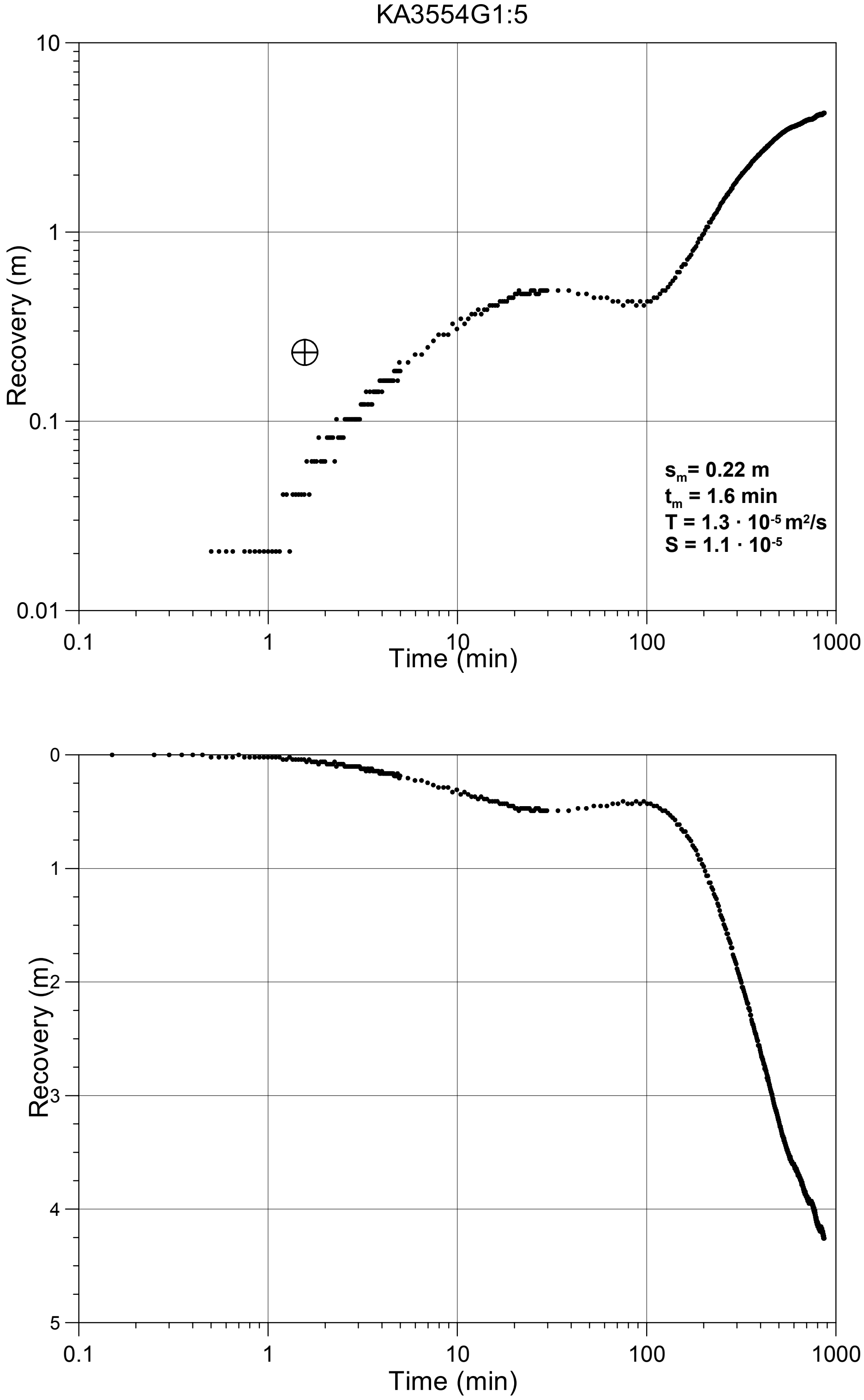




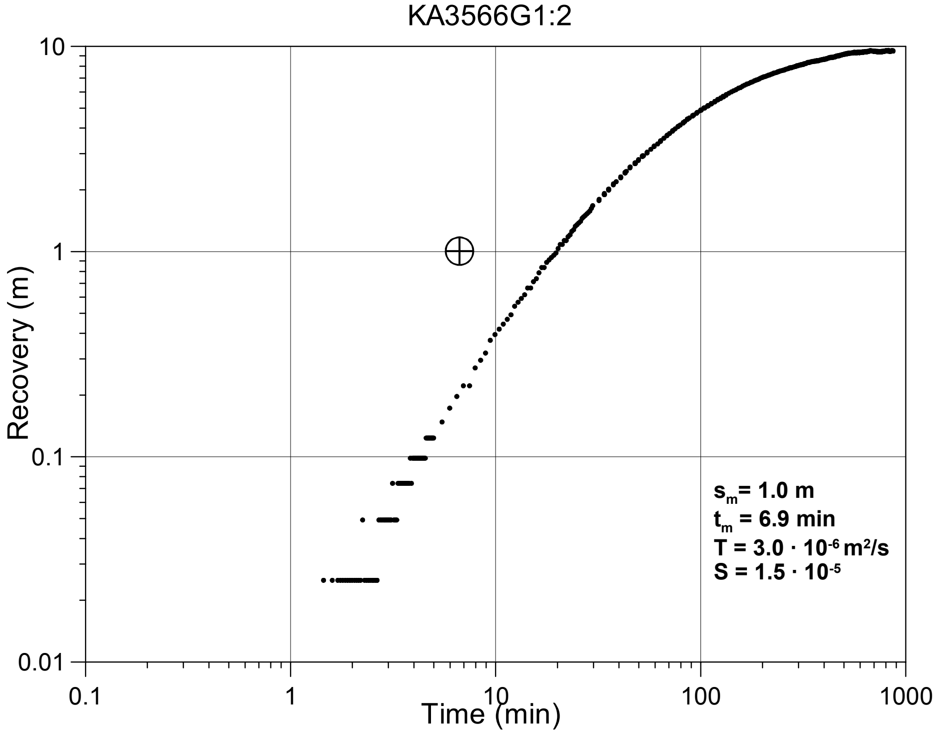
27_KA3554G1_3.GRF 2005-06-15

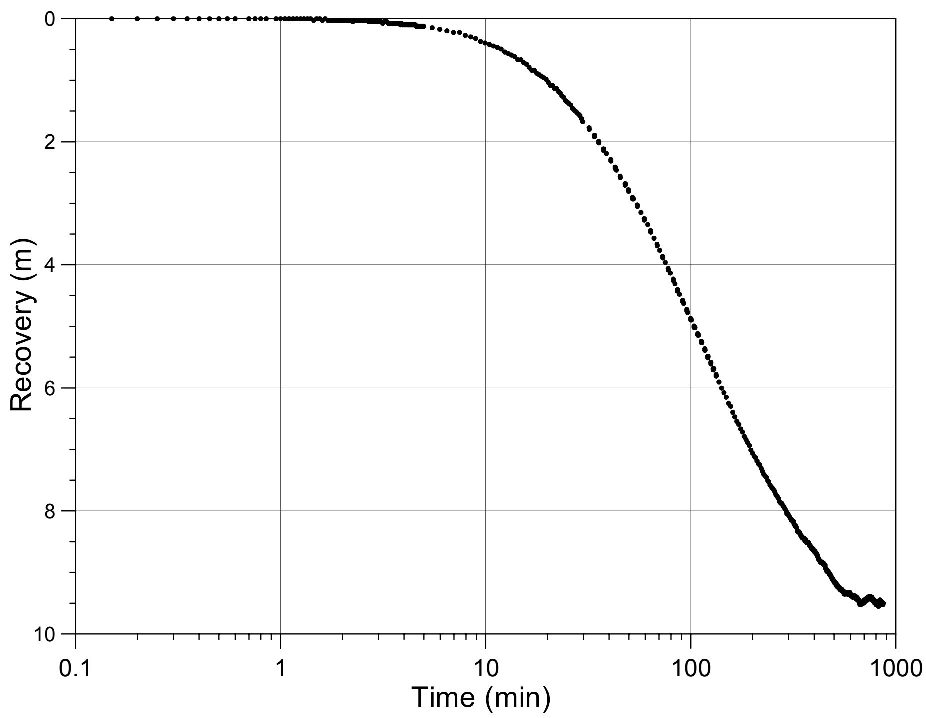


27_KA3554G1_4.GRF 2005-06-15

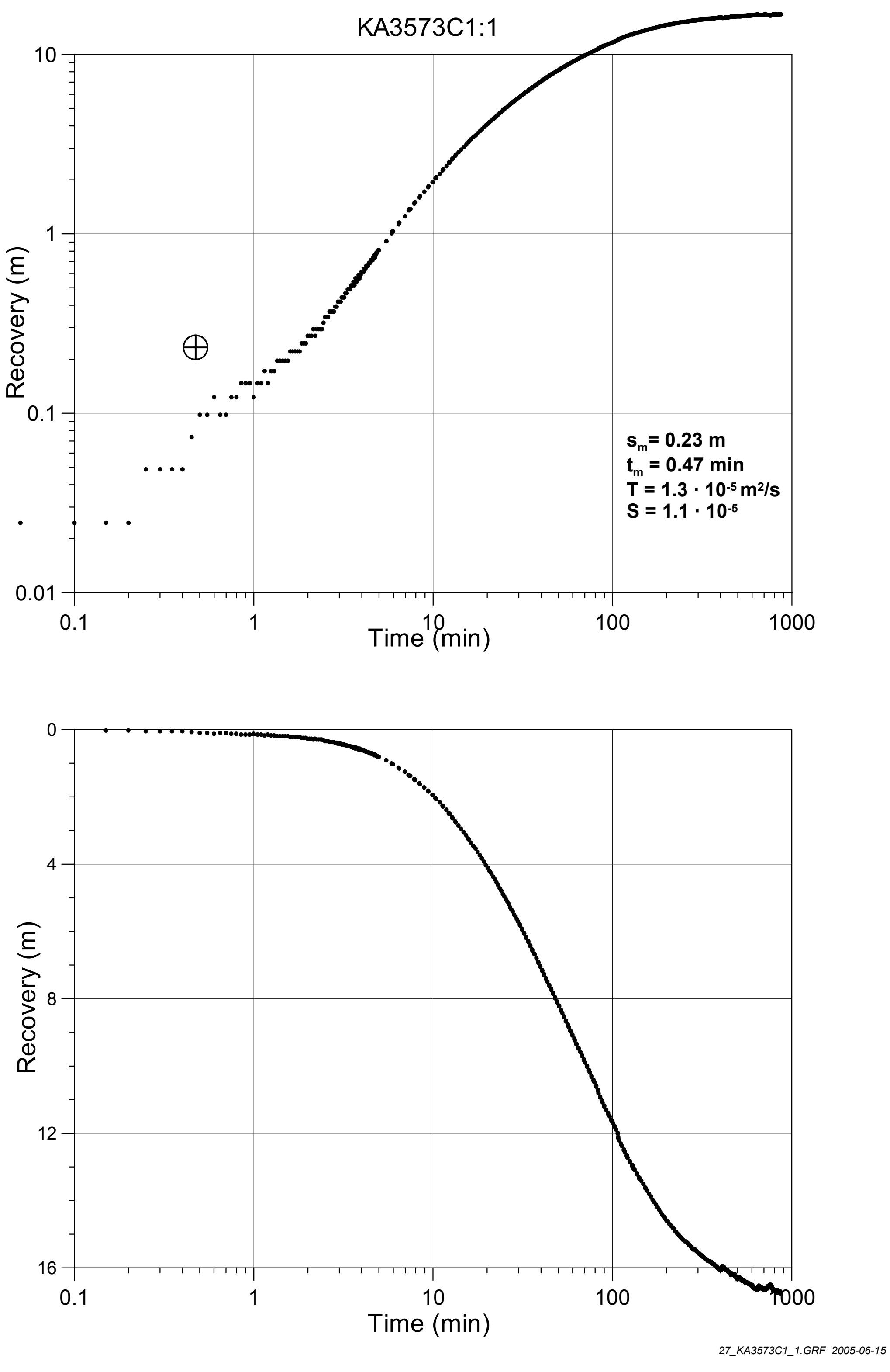


27_KA3554G1_5.GRF 2005-06-15

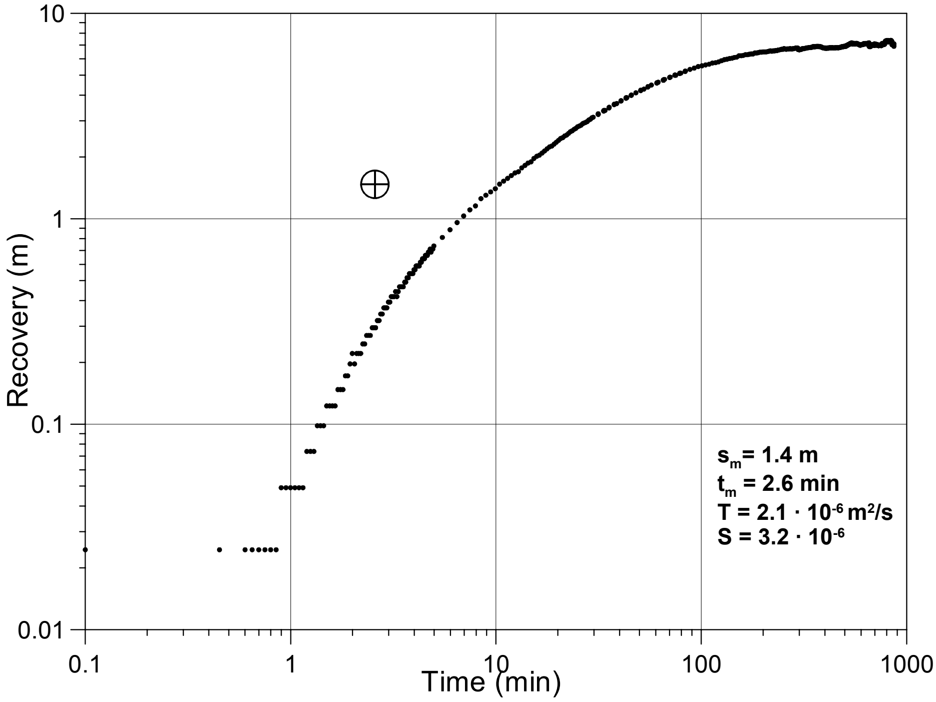


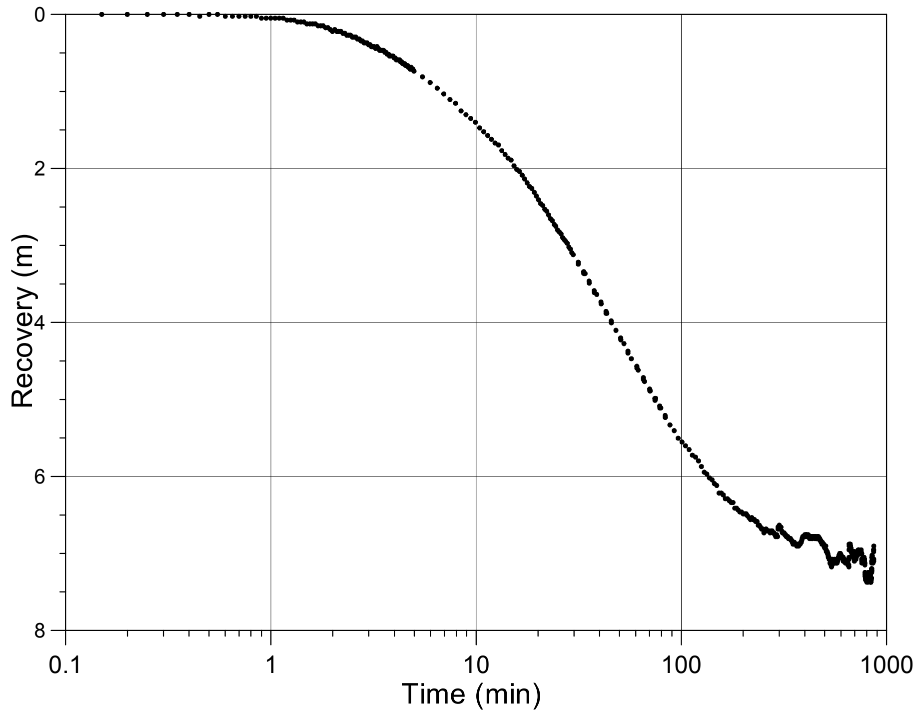


27_KA3566G1_2.GRF 2005-06-15

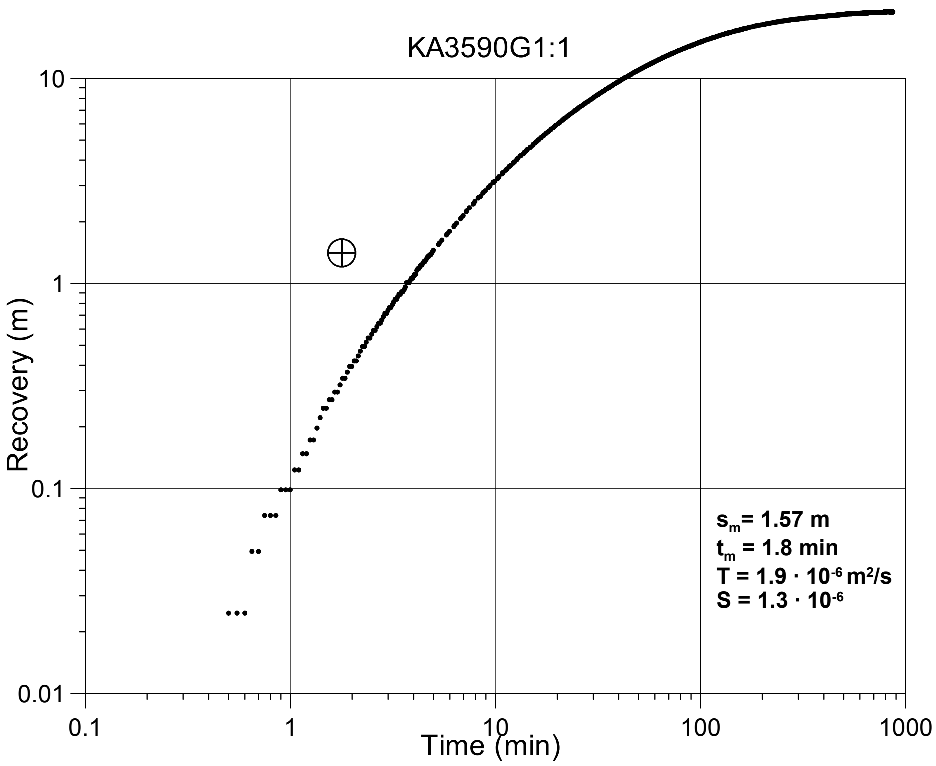

KA3573C1:1
Recovery (m)
Time (min)
s_m= 0.23 m
t_m = 0.47 min
T = 1.3 · 10^{-5} m^2/s
S = 1.1 · 10^{-5}
Recovery (m)
Time (min)
27_KA3573C1_1.GRF 2005-06-15

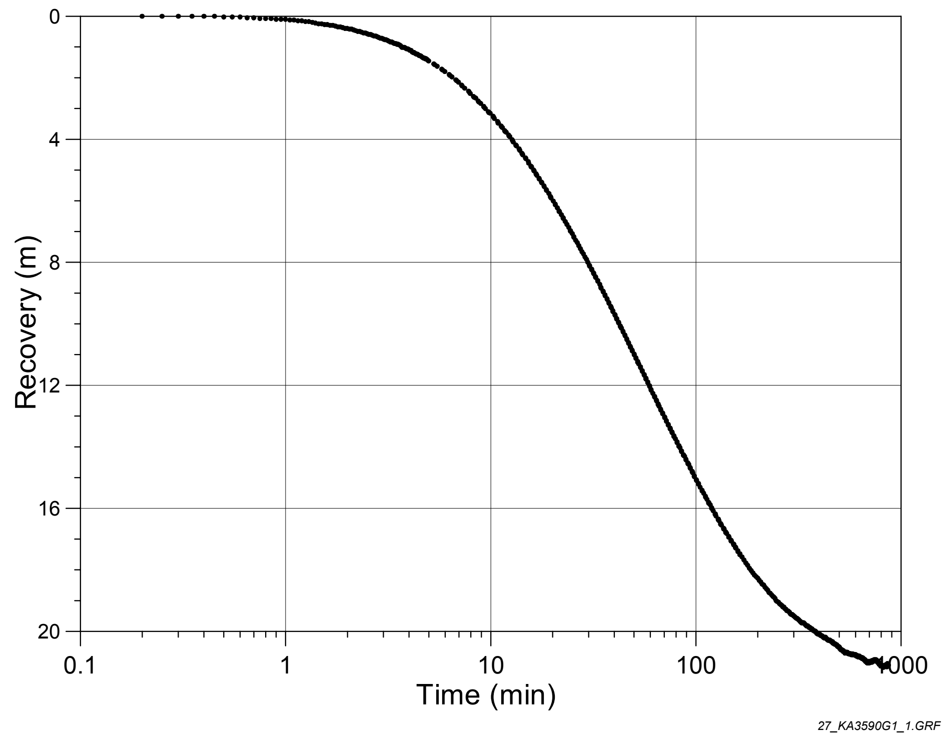
KA3588C1:1



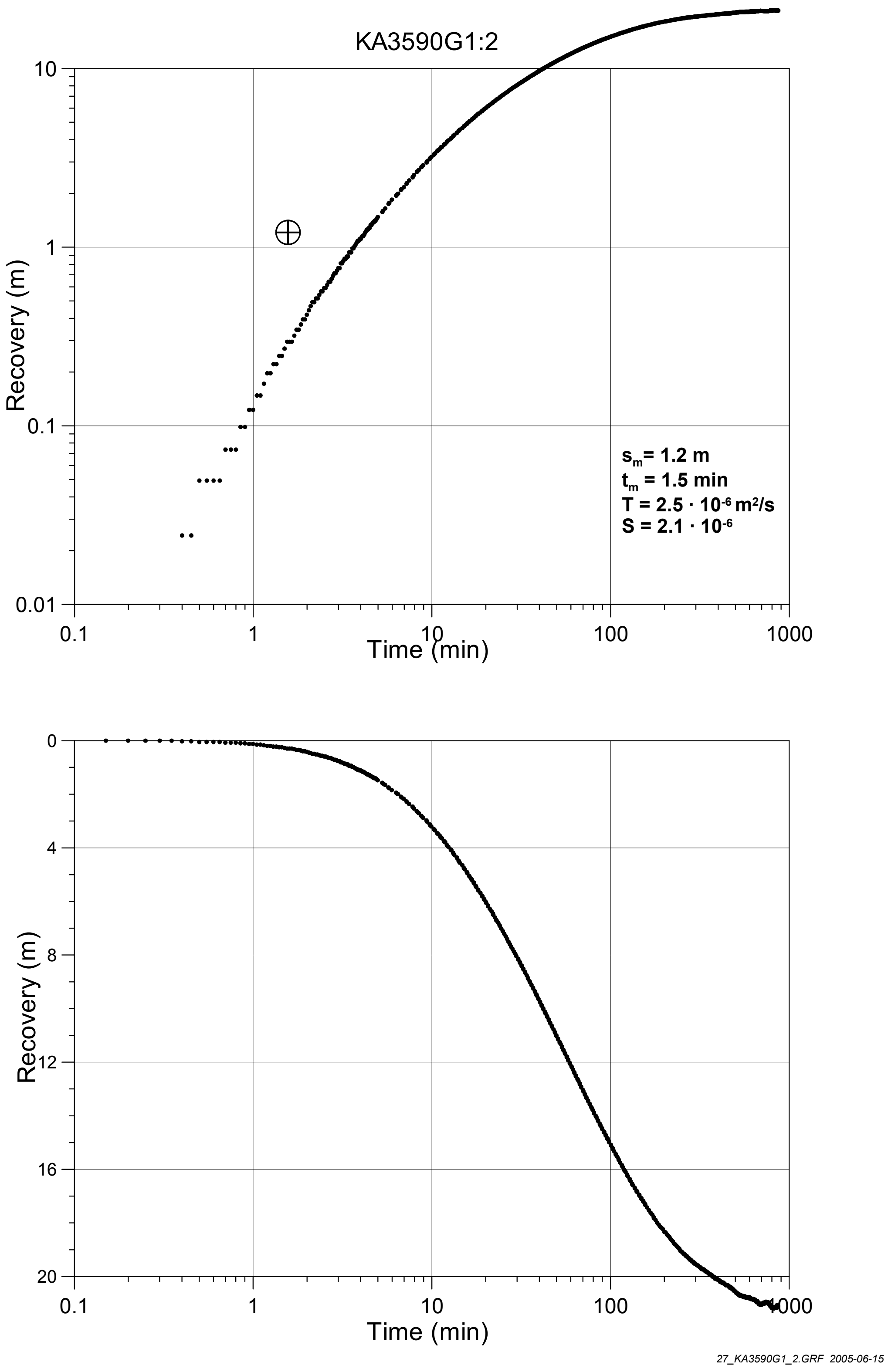


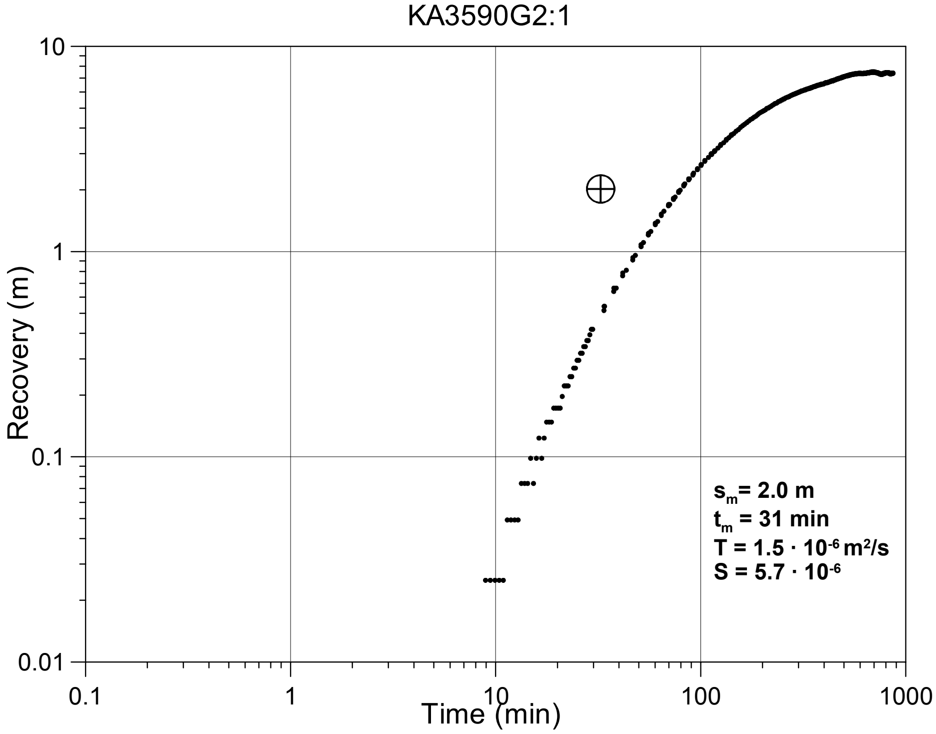
27_KA3588C1_1.GRF 2005-06-15

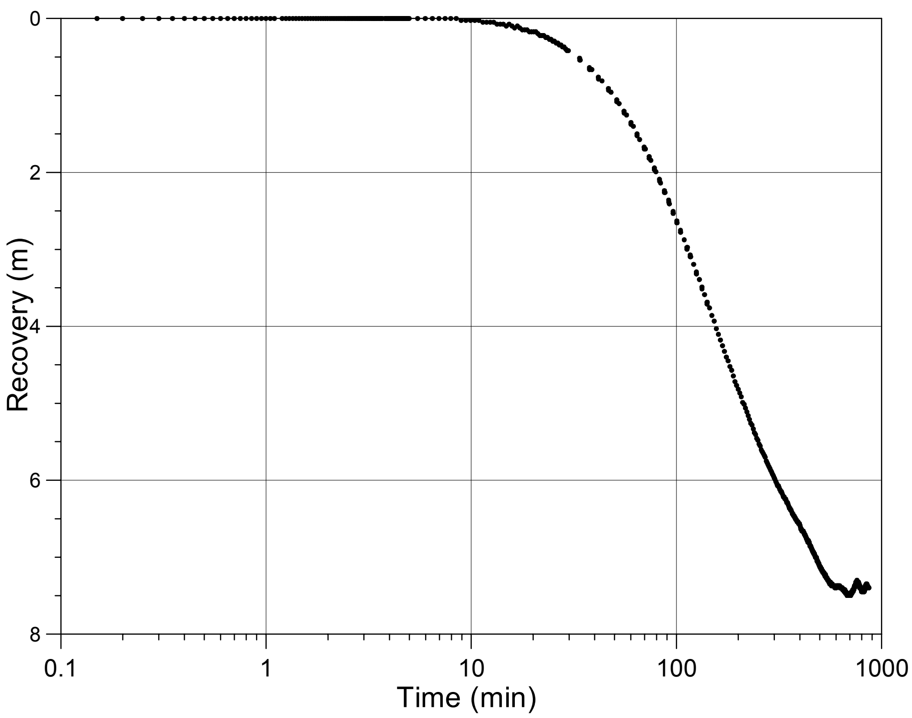




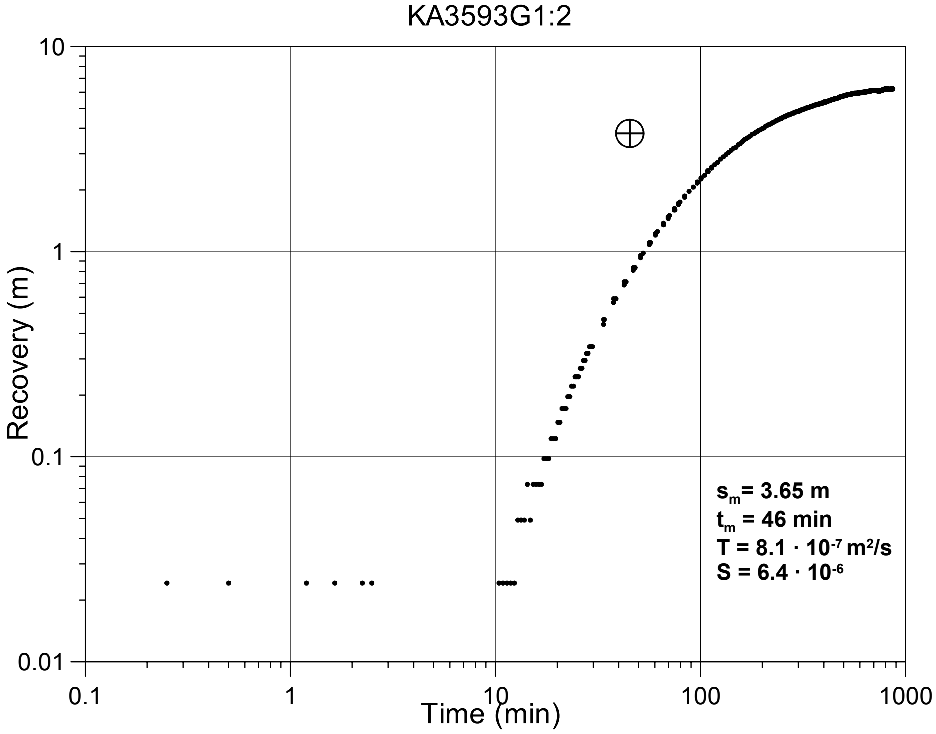
27_KA3590G1_1.GRF 2005-06-15

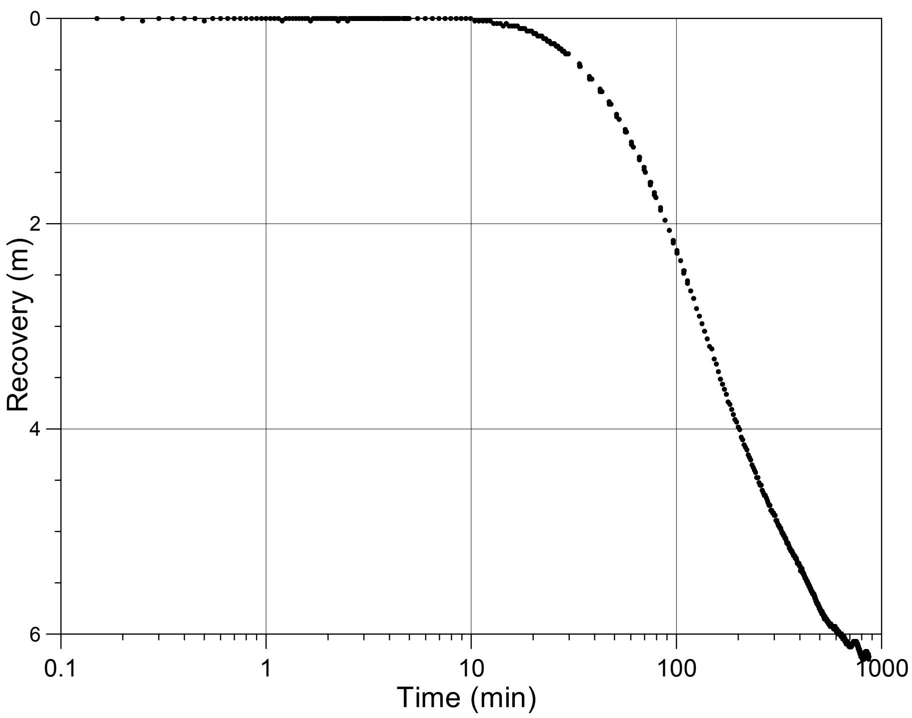

KA3590G1:2
Recovery (m)
Time (min)
10
1
0.1
0.01
0.1
1
10
100
1000
s_m= 1.2 m
t_m = 1.5 min
T = 2.5 · 10^-6 m²/s
S = 2.1 · 10^-6
Recovery (m)
0
4
8
12
16
20
0.1
1
10
100
1000
Time (min)
27_KA3590G1_2.GRF 2005-06-15



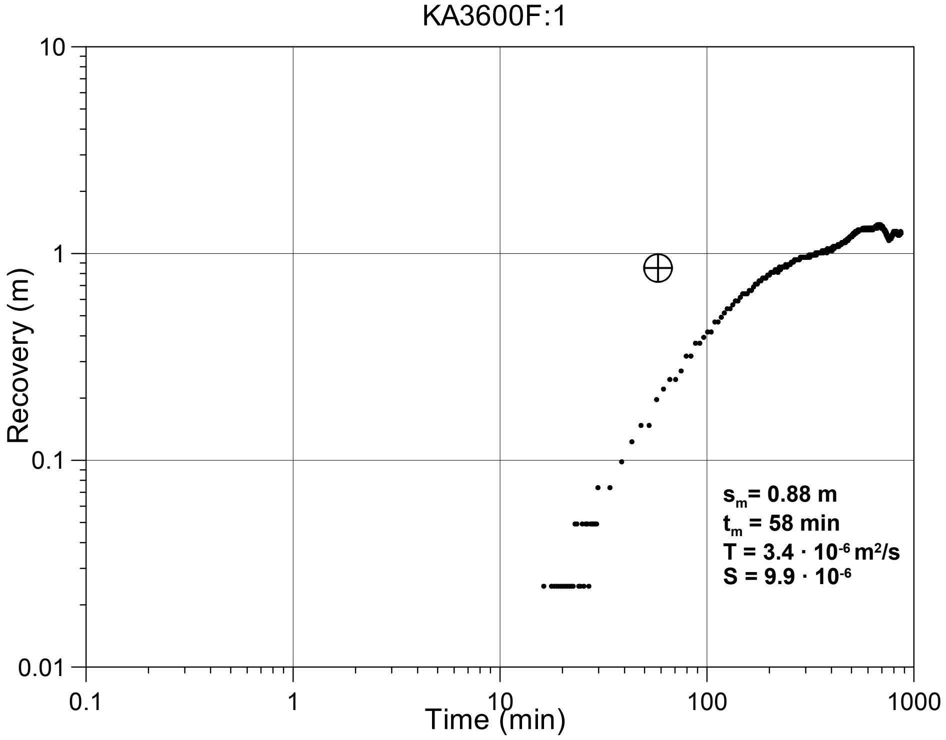


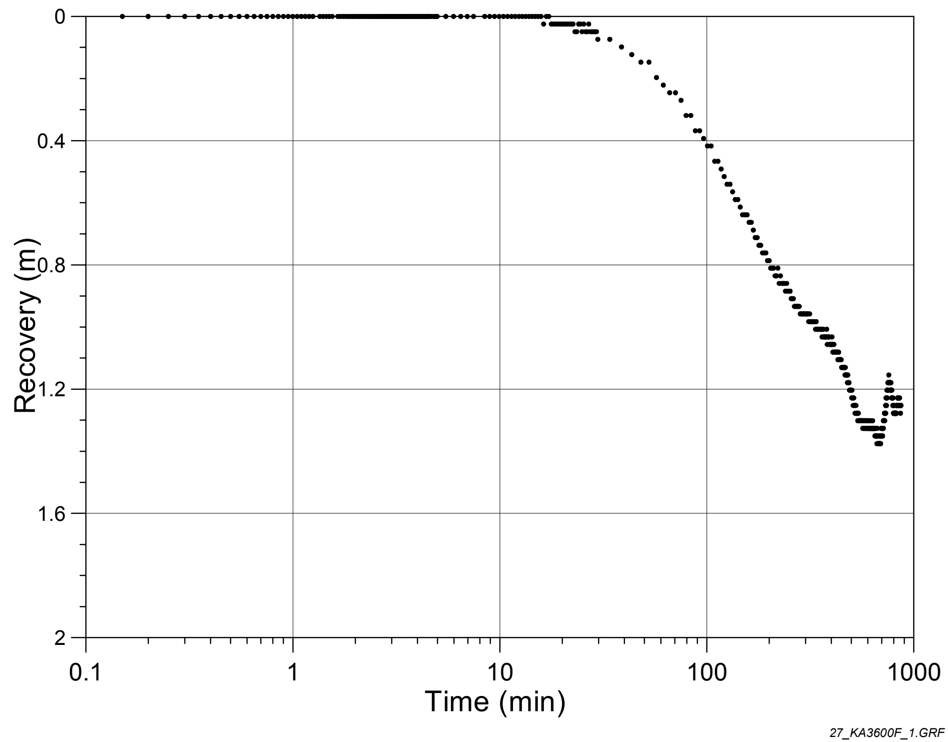
27_KA3590G2_1.GRF 2005-06-15



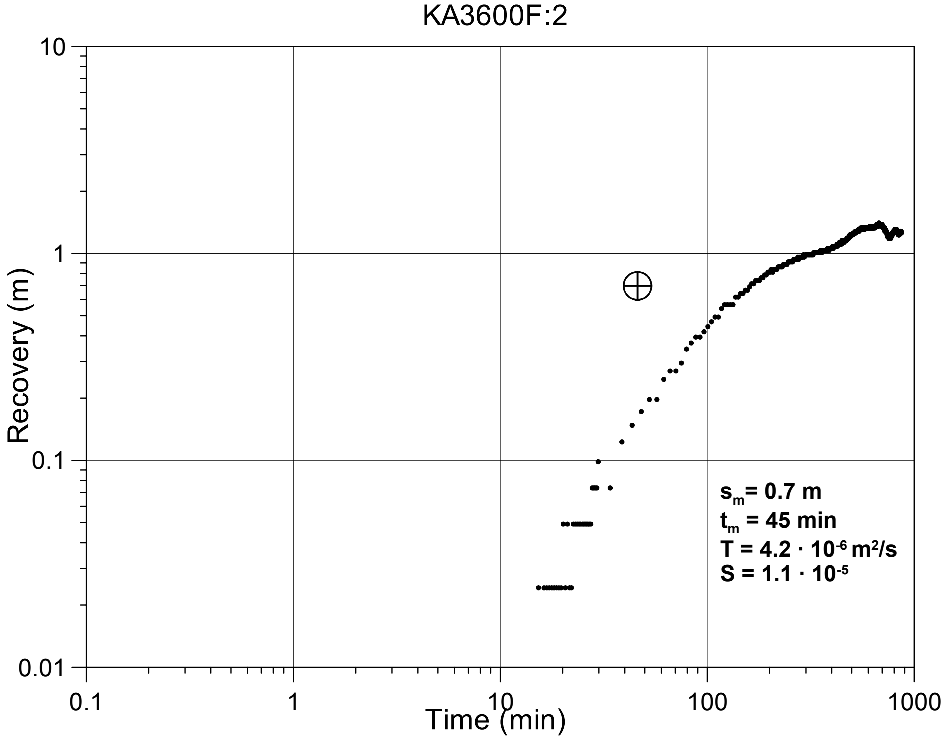


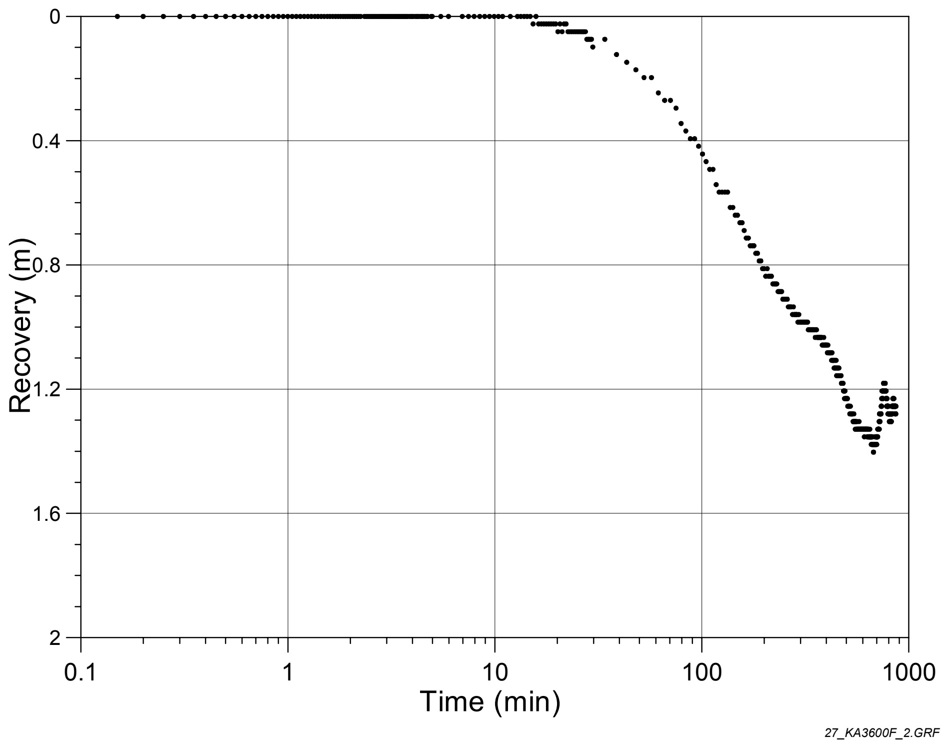
27_KA3593G1_2.GRF 2005-06-15



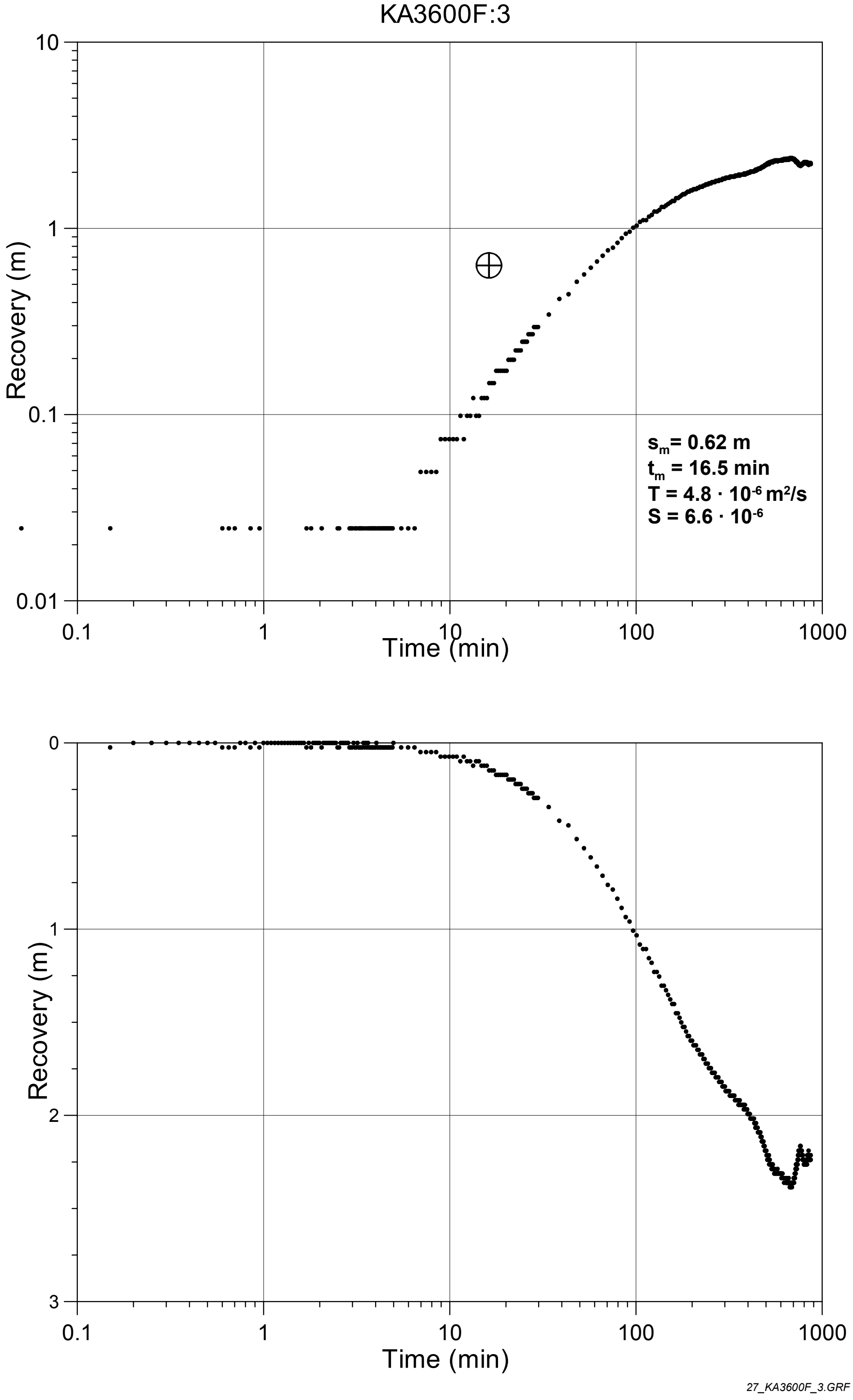


27_KA3600F_1.GRF 2005-06-15

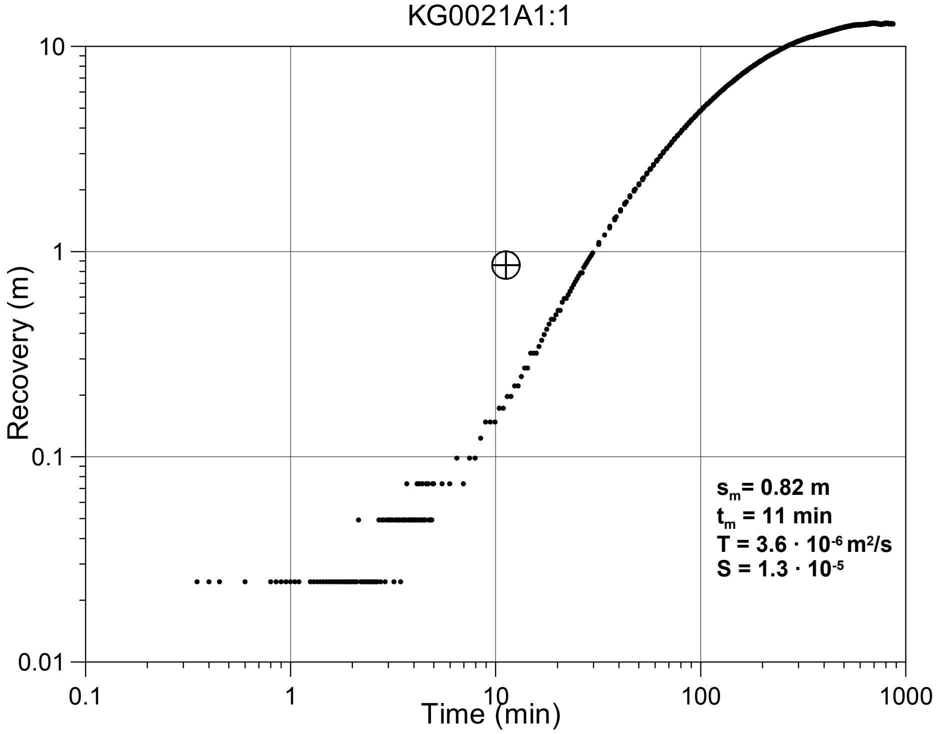


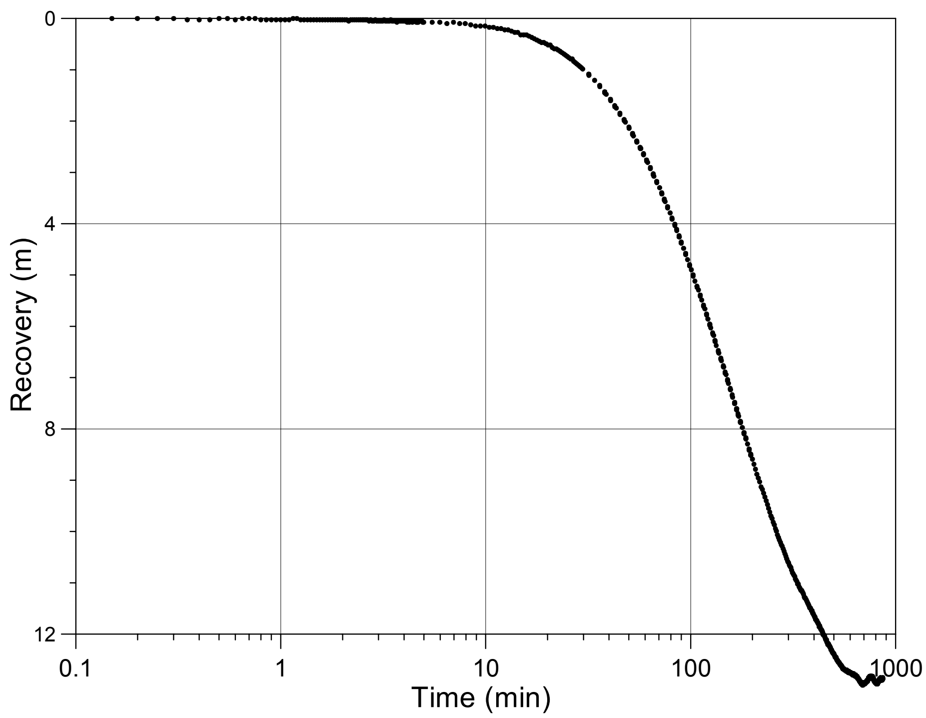


27_KA3600F_2.GRF 2005-06-15



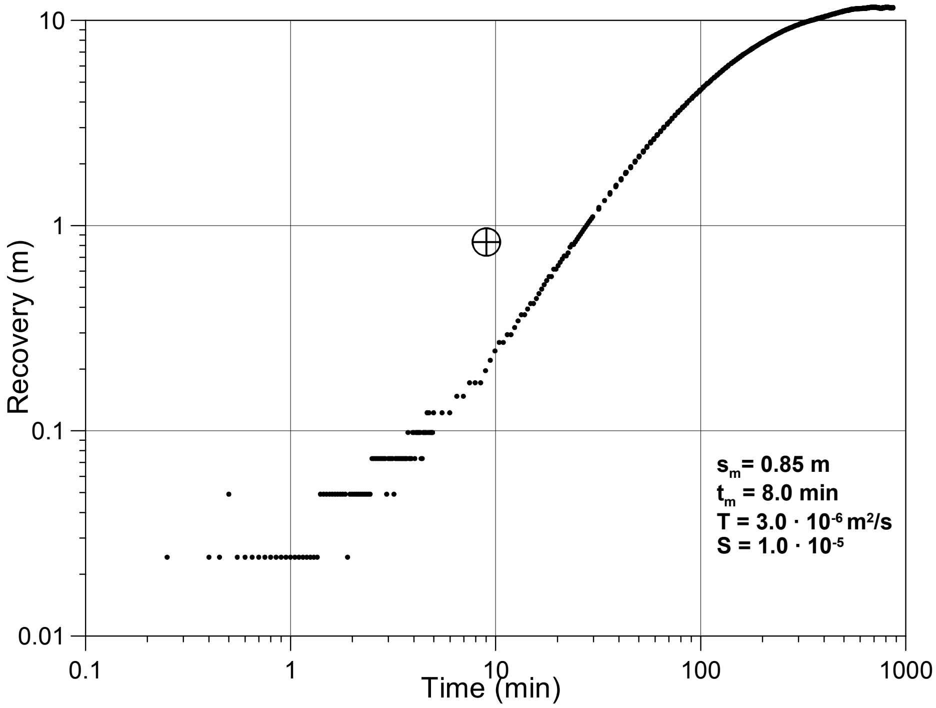
27_KA3600F_3.GRF 2005-06-15

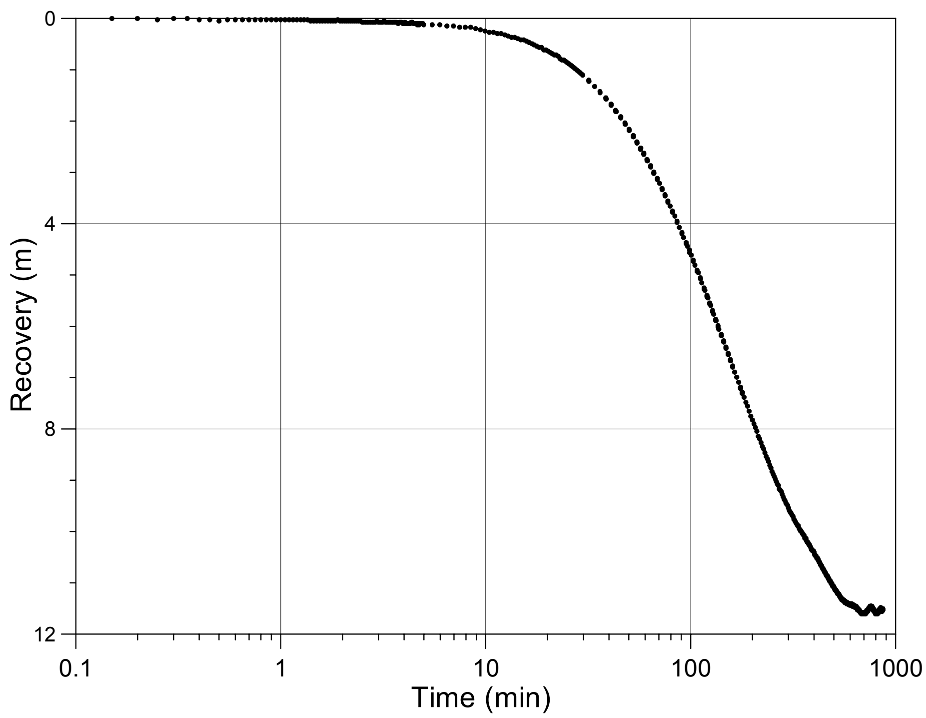




27_KG0021A1_1.GRF 2005-06-15

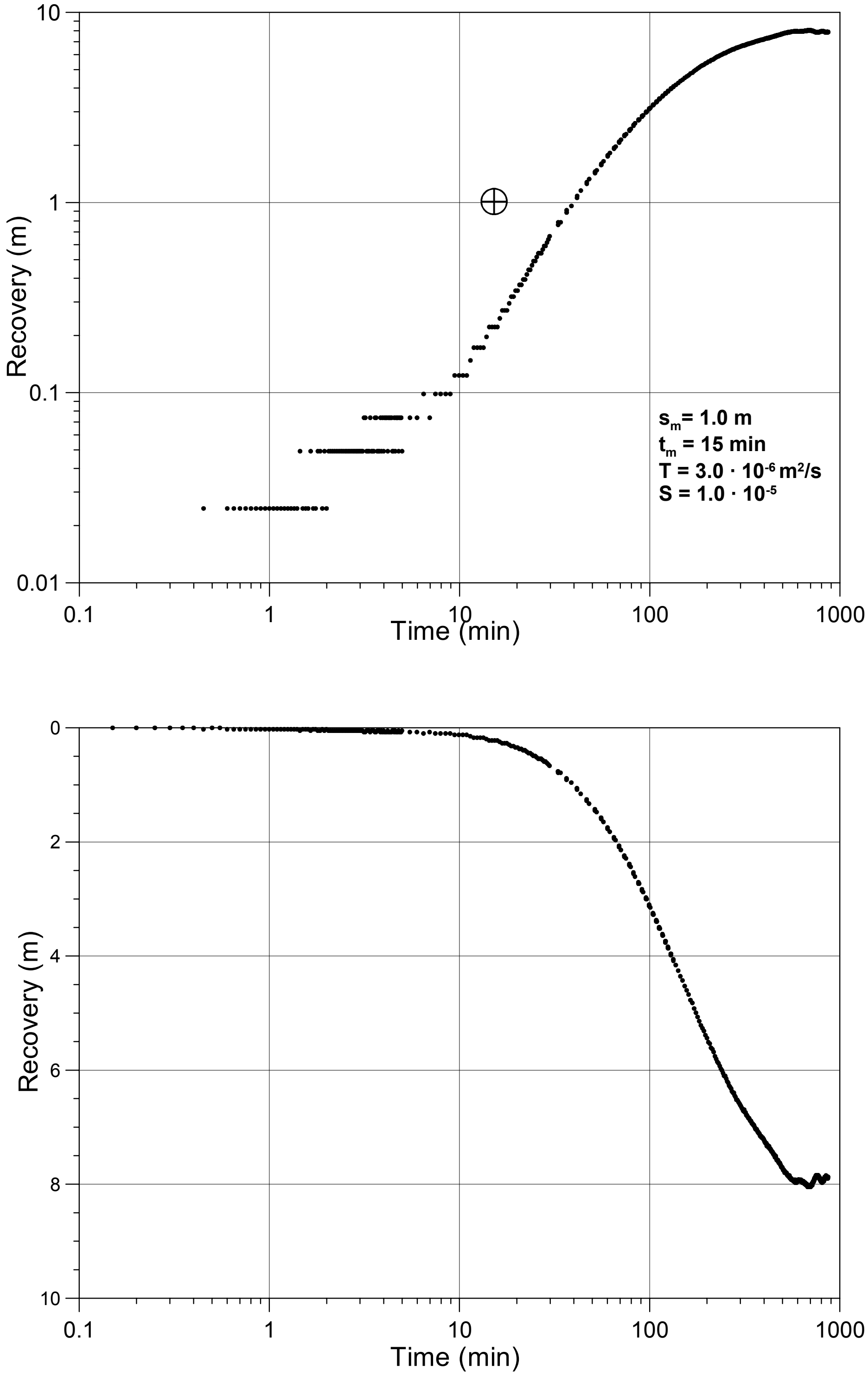
KG0021A1:2





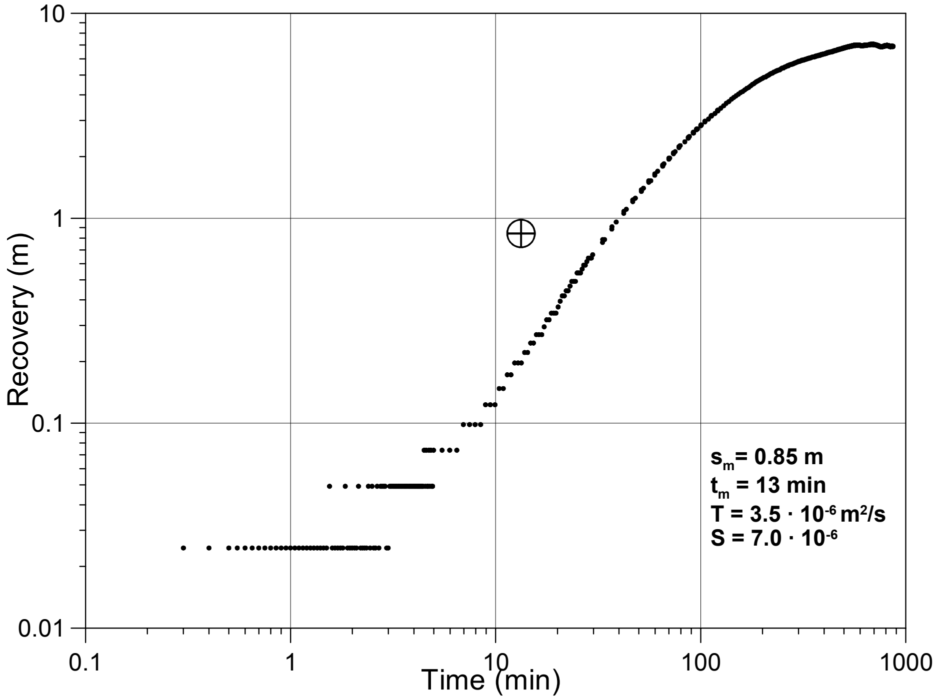
27_KG0021A1_2.GRF 2005-06-15

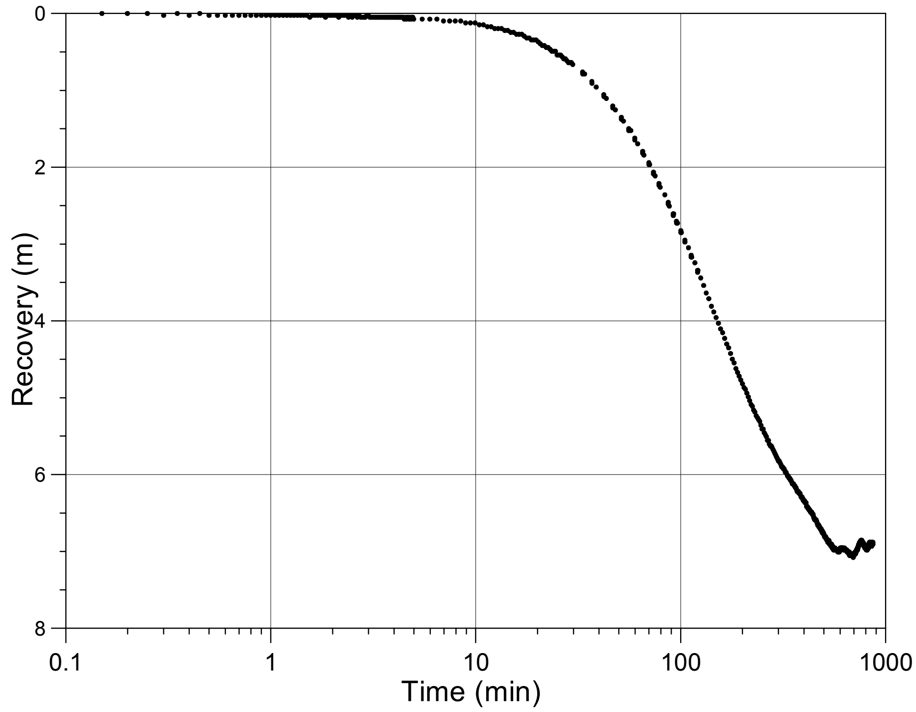
KG0021A1:3



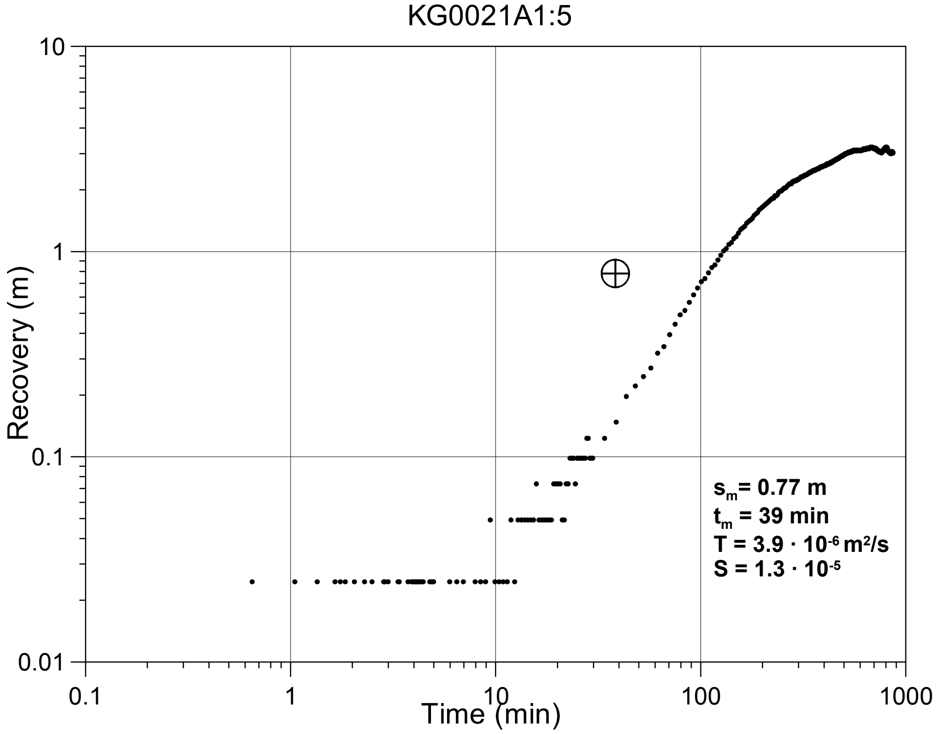
27_KG0021A1_3.GRF 2005-06-15

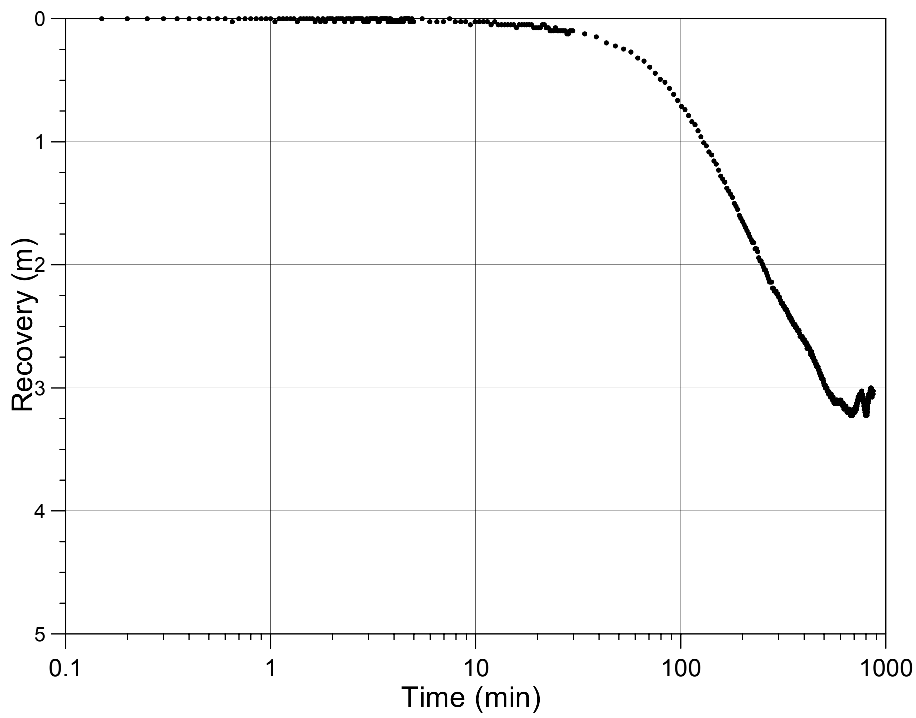
KG0021A1:4



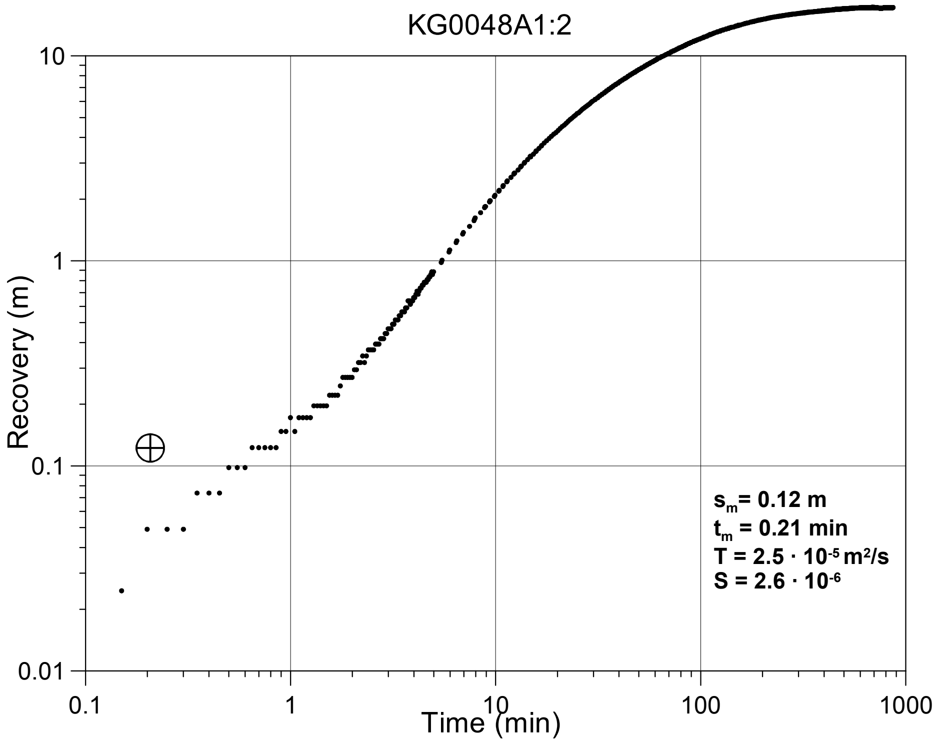


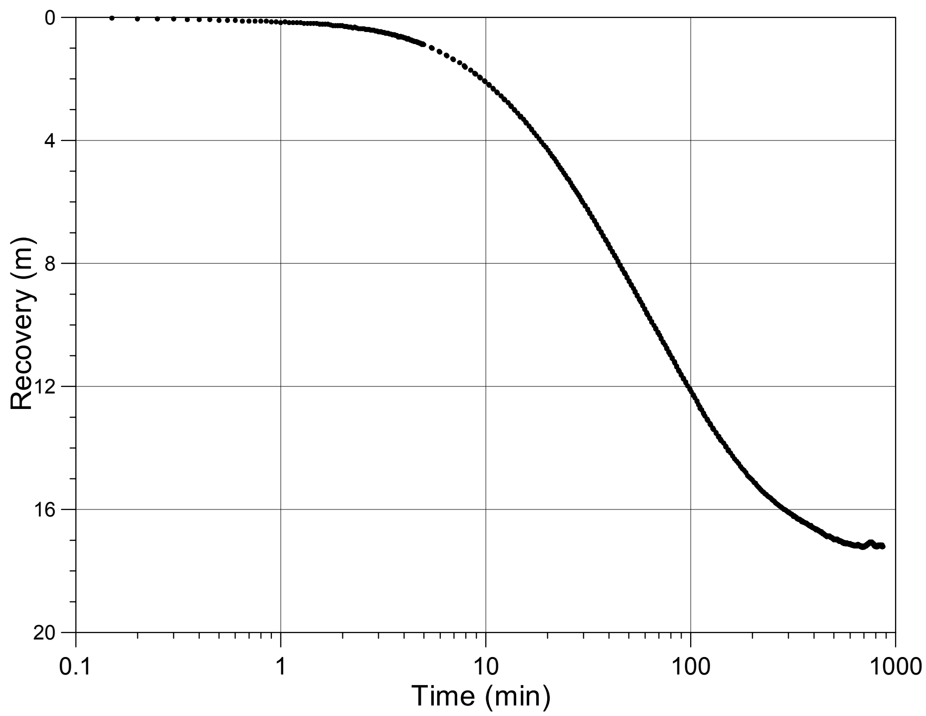
27_KG0021A1_4.GRF 2005-06-15



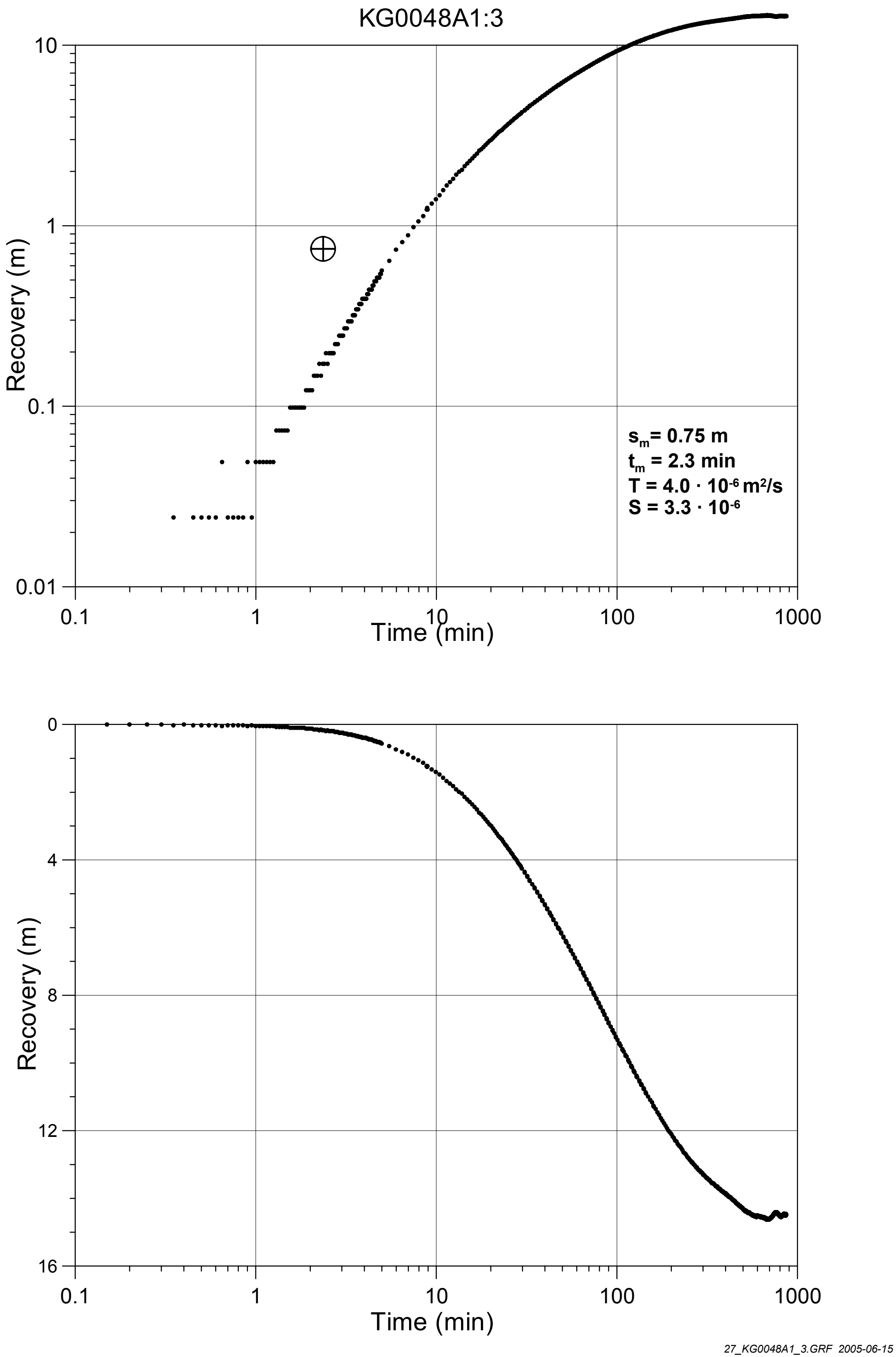


27_KG0021A1_5.GRF 2005-06-15

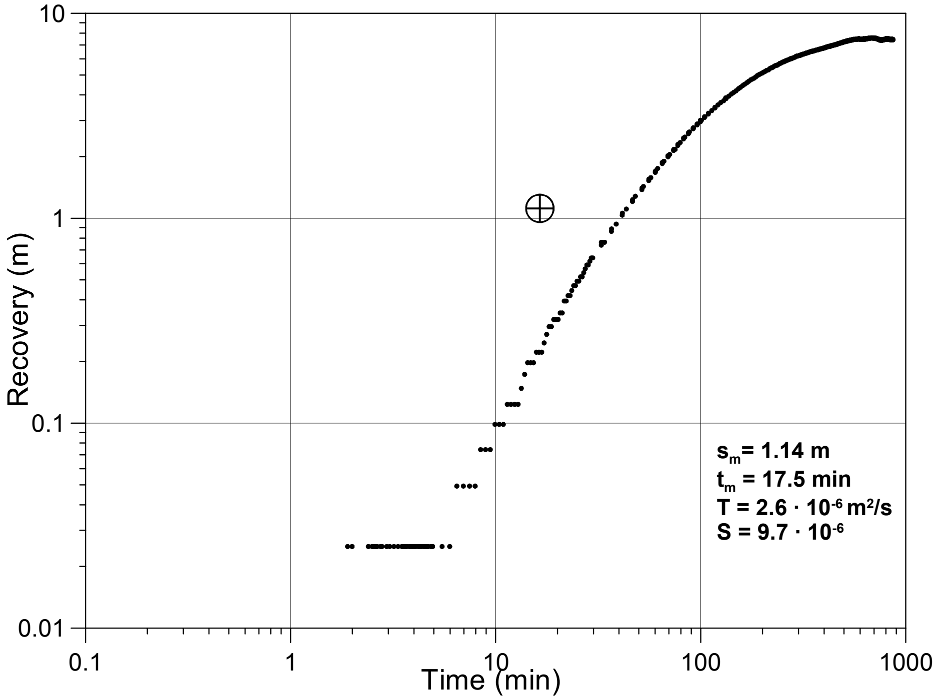


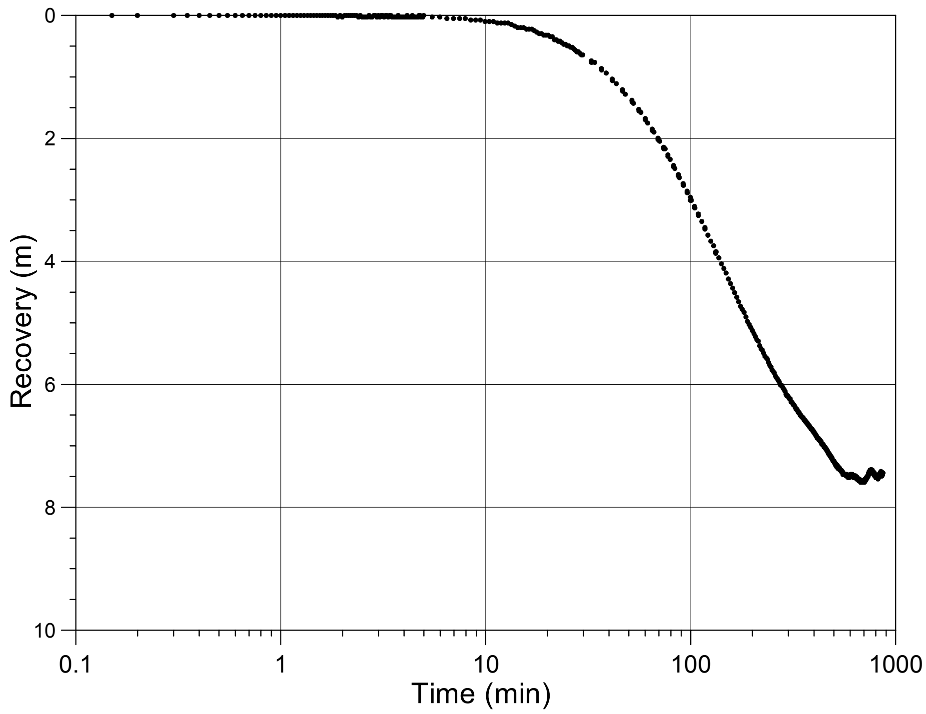


27_KG0048A1_2.GRF 2005-06-15


KG0048A1:3
Recovery (m)
Time (min)
s_m= 0.75 m
t_m = 2.3 min
T = 4.0 · 10^{-6} m²/s
S = 3.3 · 10^{-6}
Recovery (m)
Time (min)
27_KG0048A1_3.GRF 2005-06-15

KG0048A1:4





27_KG0048A1_4.GRF 2005-06-15