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Hydraulic testing of borehole K03009F01

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Abstract

Hydraulic tests in borehole K03009F01 were conducted in the framework of the project DETUM-1 Stora sprickor subproject as one component in a whole suite of characterisation methods for assessing the potential of identifying and characterizing large fractures. The tested borehole is situated at 400 m depth in sparsely fractured granitic rock at the Äspö HRL. The seven hydraulic tests were performed with the specific objective to characterize the rock volume in terms of flow regimes, aquifer parameters (transmissivity and skin) and hydraulic connectivity. The test showed linear and radial flow regimes and transmissivities ranged from 5E−7 m^2/s to 4E−5 m^2/s while the encountered skin values were very high of up to 800 raising suspicion of the presence of turbulent flow.

Sammanfattning

Hydrauliska tester utfördes i borrhål K03009F01 inom ramen för delprojekt Stora sprickor inom DETUM-1projektet. Dessa tester utgjorde en av flera komponenter i ett undersökningsprogram som syftade till att värdera möjligheter för att identifiera och karakterisera stora sprickor. Borrhålet är beläget på 400 m djup i Äspölaboratoriet . Sju tester utfördes i borrhålet med det specifika syftet att karakterisera bergvolymen med avseende på flödesregim, transmissivitet, skin faktor och hydraulisk konnektivitet. Tester visade på linjära och radiella flödesregimer med transmissivitet i intervallet 5E−7 m^2/s till 4E−5 m^2/s och mycket höga skin faktorer upp 800 som högst vilket misstänks orsakas av turbulent flöde.

Contents

1 Introduction

Hydraulic tests in borehole K03009F01 were conducted in the framework of the project DETUM-1 Stora sprickor subproject as one component in a whole suite of characterisation methods for assessing the potential of identifying and characterizing large fractures. The tested borehole is situated at 400 m depth in the Äspö HRL, Figure 1-1.

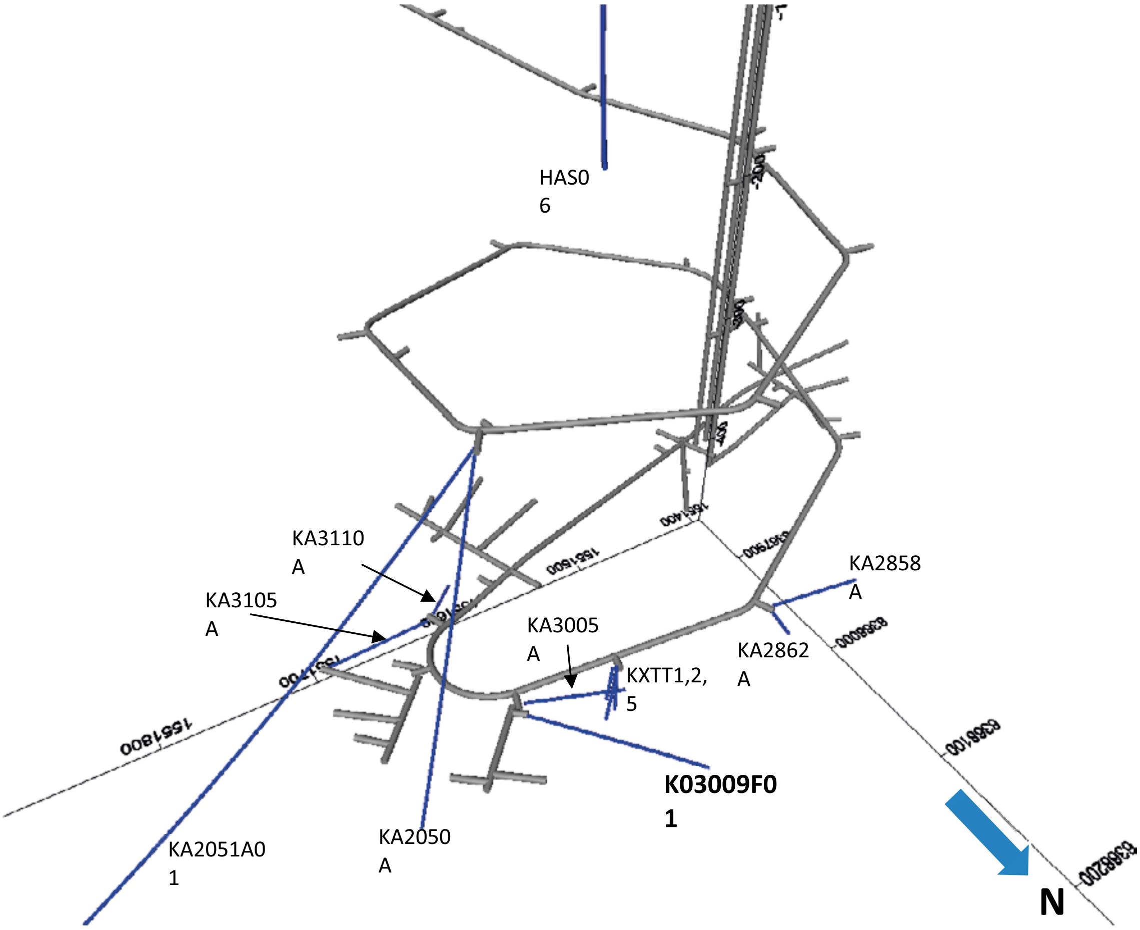

Figure 1-1. *Geometric layout of tunnels and borehole in the tested rock volume. Borehole where pressure responses were detected (observation holes) when flowing the different part of K03009F01 are also shown. Perspective view from the northeast.*

2 Objectives and scope

2.1 Objectives

The tests were performed with the objective to characterize the rock volume in terms of flow regimes, aquifer parameters (transmissivity and skin) and hydraulic connectivity (in terms of dp_p and response index).

The aim of this report is to present the tests performed and their associated results.

2.2 Scope

Test were performed first during drilling of a high yielding part of the borehole prior to grouting it and then upon drilling completion with customized interference tests comprising outflow and pressure build-up phases, Table 2-1. For the purpose of analysing flow regimes as well as well- and aquifer parameters the transient evaluation was performed on the recovery phase. Observation sections are given in Table 5-3 and are also shown in the response matrix presented in the Appendix 1 through 7.

Tabell 2-1. Flowing sections of performed tests in K03009F01, cf. Chapter 4 for definition of test types.

Test no	Start flowing	Test type[1]	Secup (m)	Seclow (m)	Location of inflow (m)	Test flow rate (L/min)	Flow duration (h)	Recovery duration (h)	Inflow during drilling (L/min)
1	2013-11-27 16:08	R	2.44	10.80	10.50	283	0.5	22	280
2	2013-11-29 09:22	I	2.44	15.50	10.5–10.8	204	6	65	204
3	2014-02-19 07:58	I	2.44	100.92		10.8	8	25	10
4	2014-03-03 08:20	I	14.20	17.19		0.7	8	16	1
5	2014-02-27 08:05	I	17.20	20.19		7	8	16	8
6	2014-02-25 08:05	I	25.20	28.19		0.55	8	17	2
7	2014-04-15 07:52	I	30.00	33.99	32[2]	0.8	8	17	?

[1)] R: Response test, I: Interference test.

[2)] There was no actual inflow observed at 32 m, but anomalies in temperature and salinity when logging the borehole with geophysics.

The core drilling of borehole K03009F01 started on 2013-11-26 and was completed on 2013-12-11.

3 Equipment

The tests were conducted with three basic test system units:

a) The Äspö Hydro Monitoring System (HMS) of the observations holes.

b) Down-hole equipment in the tested/flowing borehole.

c) Collar connected equipment to the tested/flowing borehole.

The down-hole equipment (b) consists of a pipe-string to which three Petrometalic packers are mounted allowing defining three measurement sections, Figure 3-1. The middle section is utilised for flowing the test section where flow and pressure are monitored, while the adjacent guard sections above and below are utilised for pressure monitoring, see Figure 3-1. The sealing-length of the packers is 1 m.

The collar equipment consists of the following components:

- Pressure gauge mounted on the casing.
- Valves, pipes and hoses as well as gauges for pressure, flow and electrical conductivity measurements.
- Pressure vessel with nitrogen gas for pressurising the water which inflates the individual packers.
- Data logger and signal transmission network connecting to the measurement server HMSB.

The system is schematically depicted in Figure 3-1 and 3-2.

Flow from the test section is regulated through a valve at the collar; the system is lacking an in situ valve in the test section. Range and accuracy of measurement gauges are specified in Table 3-2.

Table 3-2. Range and accuracy of measurement gauges.

Sensor	Range	Accuracy
Flow gauge test section, Qs, Krohne	0–83 L/min	± 0.5 % curr.value
Pressure gauge test section, Druck PTX7517-1	0–5 MPa	± 0.15 % full scale
Pressure gauge above and below, LevelTroll 700	0–703 m H_2O	± 0.05 % full scale
Pressure gauge observation holes Druck PTX7517-1	0–5 MPa	± 0.15 % full scale

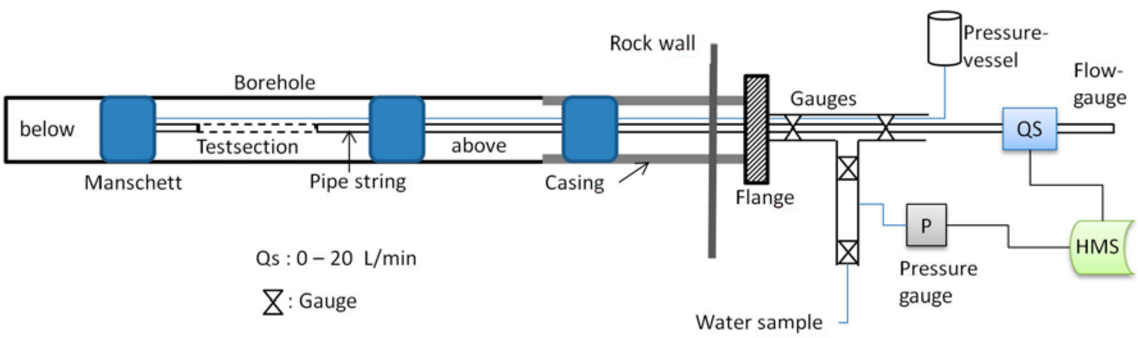

Figure 3-1. Schematics of the test system, down-hole and at the borehole collar.

Figure 3-2. *Measurement container (left) showing valves, gauges and logger and work at the borehole K03009F01 when changing test section position (right).*

4 Execution

A total of seven tests were performed of which six as interference tests and one as a response test, Table 5-1.

4.1 Interference test

Interference testing is an established methodology which SKB has used for many years. Its execution from underground boreholes is governed by a SKB specific method description while the analysis methodology of the tests is performed according a SKB specific instruction.

It shall be noted that the rock system contained pressure transients during the tests. It was not feasible to wait until the system had stabilised in all sections before undertaking the tests. The transients were instead accounted for through trend corrections of the pressure.

Outflow tests in the active test section were performed with fully open valve in order to maximize the diffusion of the pressure signal in the aquifer. This also maximises the outflow from the test section.

The sections adjacent to the test section were always defined by the borehole bottom at one end and by the casing which housed the uppermost packer.

4.2 Response test

A response test is very similar to an interference test except that the perturbation is not performed under controlled conditions. The test is primarily a spin-off from other activities which happen to induce pressure perturbations into the system, usually drilling activities.

The limitation of the response test relative the interference test is that fundamental test pre-requisites are not fulfilled:

a) The pressure situation in the aquifer prior to the test is not stable.

b) The induced response may contain superimposed disturbances from several different activities.

c) The perturbation is not controlled and its coupling to the response must be inferred e.g. from cumulative inflow measurements during borehole drilling.

Above all, this methodology is qualitative in its nature but still powerful and cost-efficient in order to understand the hydraulic connectivity of the system and to quickly provide information during the initial stage of a characterization campaign.

These measurements were useful for initial estimates in relation to grouting design; see also Fransson et al. (2016).

5 Results

The methodology of the evaluation of the tests follows the principles outlined in a SKB specific instruction utilising the software Saphir v4.3 (Kappa Engineering 2015).

The tests were evaluated with a storativity of S = 5E−6, the latter derived from calculated storativities from several previously conducted interference tests in the same rock volume (Morosini et.al. 2018).

5.1 Flow regimes and parameters

The tests presented in the following were analysed for the build-up phase since this phase displayed a much better defined pressure derivative which is instrumental for understanding the flow regimes and selection of appropriate evaluation model. A summary of test results from the flowing test sections is presented in Table 5-1. Full results are attached in the respective Appendix 1 through 7 for each test, including:

a) Test report with metadata, variables and parameters.

b) Measured and modelled history plot.

c) Measured and modelled diagnostic log-log plot.

d) Measured and modelled diagnostic semi-log plot.

e) Response matrix with dp_p, lag time and response index 2 = $\frac{dp_p}{Q_p} \cdot ln\left[\frac{r_s}{r_0}\right]$.

f) Response plot with Log(Index 2-new), only for interference tests.

It may be observed the sometime considerable difference between the specific capacity (Q/dp) and the transmissivity (T). Ideally these should be in the same ballpark. The difference is due to the different assumption underlying their calculations, where the evaluated transmissivity is based on flow geometries, honouring boundaries and considers different causes for the drawdown, while the calculated specific capacity does not make any such consideration but simply represents a lumped value which at times includes effects which are not strictly representative for the formation. A major contribution to this difference is the presumed presence of non-Darcy flow, see Section 6.3 for more about this issue. The evaluated transmissivity is considered more representative of the true formation value than the specific capacity.

It shall be noted that tests 1 and 2 (Table 5-1) are essentially testing the same flowing feature, namely the deformation zone encountered at 10.5 m borehole length, prior to it being grouted. Its inflow of 283L/min (after drilling) totally dominates relative to the inflow from the remaining part of the borehole. In Test 3 the deformation zone has been grouted.

The investigation volume is experiencing a general trend of decreasing groundwater head (Figure 5-1), partly due to the tunnel drainage at large but above all it is believed that this is enhanced by the leaking grout/rock around borehole K03009F01. This affected the recovery of the whole hole test 2.44–100.92 m (Test 3) which shows a decreasing pressure during the recovery phase, cf. Figure 5-2. It was confirmed that the rock around the borehole collar/mouth is leaking about 5.5L/min when hole is closed. This constitutes 32% of the overall drainage from TASU and side tunnels of about 17L/min. The leak was sealed off from the inner part of the borehole by installation of a packer.

Table 5-1. Summary of results from evaluation of the recovery phase of the flowing sections of K03009F01.

Test no	Secup	Seclow	Flow rate, Q	Applied pressure disturbance, dp	Formation flow regime	Transmissivity	Skin	Q/dp	Flow boundary	p_i[1]	R_i[2]	Comment
Unit:	**m**	**m**	**L/min**	**m**		**m^2/s**	**–**	**m^2/s**		**kPa**	**m**	**See respective appendix.**
1	2.44	10.8	283	321	1D−>2D	9E–6	3	1.5E–5	"Constant pressure fault"	3270 est.		Evaluated drilling inflow 283 L/min at 10.50 m, open hole 2.44–10.8 m. The flow boundary which is evident in the diagnostic log-log plot does not reflect a true fault. It is an "artefact" simply due to the recovery being completed.
2	2.44	15.50	204	318	1D−>2D−>2D	4E–5	4	1.1E–5	–	3220	592	Test between packer and 14.99 m (EOH), prior to grouting.
3	2.44	100.92	10.8	214	2D	4E–5	296	8.4E–7	–	2200	416	Testing the complete borehole from casing to end of hole. Lower pi due to leak around the casing. Very high skin due to grouting!?
4	14.20	17.19	0.7	324	WBS−>2D	3E–6	538	3.6E–8	–	3349	529	Extremely high skin. Clear evidence of changing WBS presumed to be due to gas in the system. This might be trapped air or degassing of the groundwater, yet unresolved. Borehole inclination calculations indicate the borehole should be water saturated from 11.77 m to EOH which would imply a degassing effect. 14.20–15.50 m is grouted.
5	17.20	20.19	7	329	WBS−>2D	2E–5	51	3.5E–7	Leaky fault	3339		Some evidence of changing WBS.
6	25.20	28.19	0.55	330	WBS−>2D −> Double porosity	5E–7	108	2.8E–8	–	3292	225	Clear evidence of changing WBS presumed to be due to gas in the system. This might be trapped air or degassing of the groundwater, yet unresolved. Borehole inclination calculations indicate the borehole should be water Unsaturated from 11.77 m to EOH which would imply a degassing effect.
7	30.00	33.99	0.8	324	WBS−>2D	5E–6	800	4.1E–8	–	3273	606	Extremely high skin!

[1] p_i is the initial formation pressure in the test section prior to flowing.

[2] R_i is the radius of influence defined as $R_i = 1.5\ 1.5\ \sqrt{Tt/S}$ (de Marsily 1986), assuming S = 5E−6 (Morosini et al. 2018).

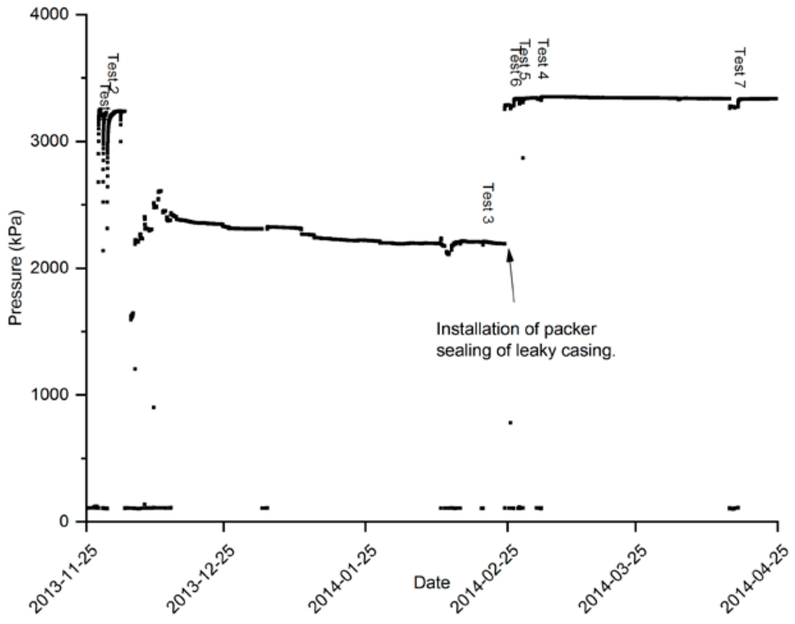

Figure 5-1. *Pressure in K03009F01 since it was drilled, including periods for the hydraulic tests. The borehole was drilled 26/11–11/12 2013.*

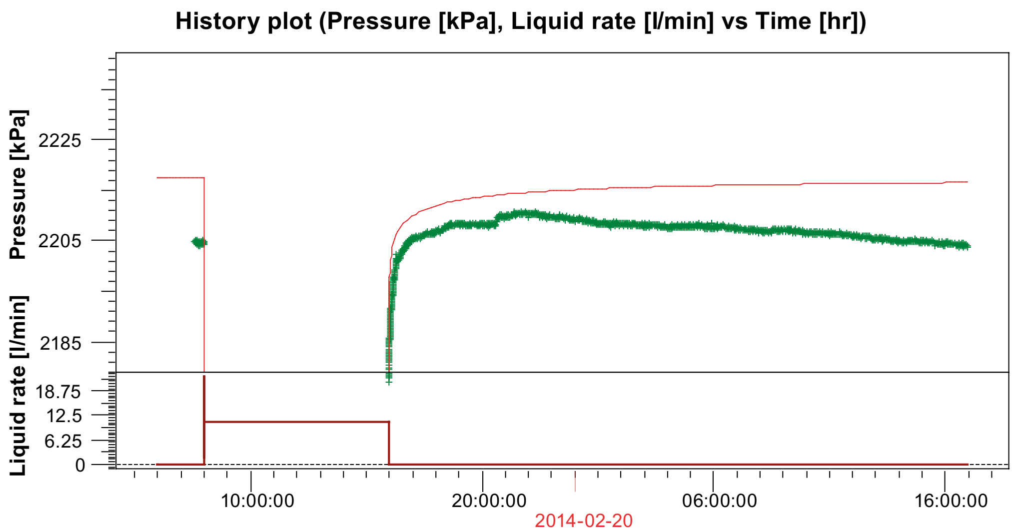

Figure 5-2. *Measured and modelled pressure recovery phase in whole borehole for test no.3: 2.44–100.92 m showing decreasing pressure.*

5.2 Observation hole data

Data from the observation boreholes were only analysed for the hydraulic responses presented in Section 5.3, and not for aquifer parameter calculations.

5.3 Hydraulic connectivity

Hydraulic connectivity calculations were performed following /SKB MD 320.005/ utilising Index 2-new as the main indicator, which is a normalised pressure response with distance for equal times, here after 1 h of flowing,

$$\text{Index 2-new} = \frac{dp_{1h}}{Q_p} * ln\left\{\frac{r_s}{r_0}\right\}, \text{(s/m}^2\text{)}$$

dp_{1h} : drawdown in observation section after 1 h of flowing (m)

Q_p : flow rate (L/min)

r_s : distance between flowing section and observation section (m)

r_0 : fictitious borehole radius which is set to 1 for all boreholes

A relative response strength classification according to Table 5-2 is utilised.

Table 5-2. Classification of response index 2-new (excerpt from SKB MD 320.005).

Index 2-new: $(s_p/Q_p) \cdot Ln(r_s/r_0)$ (s/m²)	**Log (Index 2-new)**			
$(s_p/Q_p)*Ln(r_s/r_0) > 3 \times 10^6$	> 6.5	Excellent	E	
$3 \times 10^5 < (s_p/Q_p)*Ln(r_s/r_0) \leq 3 \times 10^6$	5.5–6.5	High	H	
$3 \times 10^4 < (s_p/Q_p)*Ln(r_s/r_0) \leq 3 \times 10^5$	4.5–5.5	Medium	M	
$3 \times 10^3 < (s_p/Q_p)*Ln(r_s/r_0) \leq 3 \times 10^4$	3.5–4.5	Low	L	
$(s_p/Q_p)*Ln(r_s/r_0) \leq 3 \times 10^3$	< 3.5	Very Low	VL	
$s_p < 0.1$ m		No response	N	

The results of the connectivity calculations are presented in detail for each test in the appendix. This includes a full response matrix and a 3D spatial visualisation of Index 2-new. A graphical summary of all responses according to Index 2-new are shown in Table 5-3.

Table 5-3. Graphical summary of response index 2-new for all interference tests, Tests 2-7. Test 1 is omitted since it was a response test where the disturbance was not performed under controlled conditions where Test 2 is testing the same feature under controlled conditions. Locations of observation boreholes are shown in Figure 1-1.

Responsmatris Index 2-new				2	3	4	5	6	7			
BOREHOLE	Sec no	Secup (m)	Seclow (m)	Response, dp1h	Response, dp1h	Response, dp1h	Response, dp1h	Response, dp1h	Response, dp1h	Test no in K03009F01	Section (m)	Flow (L/min)
KA2050A	1	155.00	211.57	H	M	M	M	M	M	1	2.44–10.80	283
KA2050A	2	102.00	154.00	H	M	M	M	M	M	2	2.44–15.50	204
KA2050A	3	6.00	101.00	M	L	M	L	M	M	3	2.44–100.92	10.8
KA2051A01	1	278	319.84	L	N	N	N	N	L	4	14.20–17.19	0.7
KA2051A01	2	235	277	L	VL	N	N	N	L	5	17.20–20.19	7
KA2051A01	3	204	234	L	N	N	N	N	M	6	25.20–28.19	0.55
KA2051A01	4	136	203	L	VL	N	N	N	M	7	30.00–33.99	0.8
KA2051A01	5	120	135	L	VL	N	N	N	M			
KA2051A01	6	96	119	M	L	N	L	N	M			
KA2051A01	7	76	95	M	L	N	L	N	M			
KA2051A01	8	68	75	M	L	N	L	N	M			
KA2051A01	9	51	67	M	VL	N	N	N	M			
KA2051A01	10	7	50	M	VL	N	N	N	L			
KA2858A	2	39.77	40.77	L	VL	N	N	N	N			
KA2862A	1	0	15.98	L	VL	N	N	N	N			
KA3005A		0.00	50.03	M	L	N	L	M	M			
KA3105A	1	53.01	68.95	M	L	N	L	N	N			
KA3105A	2	25.51	52.01	L	VL	N	L	N	N			
KA3105A	3	22.51	24.51	L	VL	N	L	N	N			
KA3105A	4	17.01	19.51	L	VL	N	L	N	N			
KA3105A	5	6.51	16.01	L	VL	N	N	N	N			
KA3110A	1	20.05	26.83	L	VL	N	N	N	N			
KA3110A	2	6.55	19.05	L	VL	N	N	N	N			
KXTT1	1	17.00	28.76	H	L	M	M	M	M			
KXTT1	2	15.00	16.00	H	L	L	L	M	M			
KXTT1	3	7.50	11.50	M	L	N	L	N	L			
KXTT1	4	3.00	6.50	N	N	N	N	N	N			
KXTT2	1	16.55	18.30	H	L	L	L	M	N			
KXTT2	2	14.55	15.55	H	L	M	L	M	N			
KXTT2	3	11.55	13.55	M	L	N	L	N	N			
KXTT2	4	7.55	10.55	M	L	N	L	N	N			
KXTT2	5	3.05	6.55	M	L	N	L	N	N			
KXTT5	1	10.81	25.85	H	L	L	L	M	M			
KXTT5	2	9.61	9.81	H	L	L	L	M	M			
KXTT5	3	6.11	8.61	M	L	N	L	N	M			
KXTT5	4	3.11	5.11	M	L	N	L	N	L			
HAS06		0.00	100.00	N	N	N	L	N	N			

6 Discussion

The selection of borehole sections to be tested was for the most part based on the observed inflow during drilling. Test 1 is actually the major water strike of 283L/min encountered at 10.5 m, presumably from a high yielding singular feature. It was decided to grout it, but first a controlled hydraulic test of longer duration was performed, Test 2. The effect of the grouting (see e.g. Fransson et al. 2016) reduced the inflow to 0.62 L/min, a reduction of 456 times. Upon borehole completion three low to moderately yielding inflows were identified from the cumulative inflow measurements during drilling which were made at every uptake of drillcore i. e. every 3 m. These were targeted with customized interference tests, Test 4, 5 and 6. Additionally, a test of the whole borehole was also performed, Test 3.

Test 7 was warranted to investigate an abrupt change, an anomaly, in borehole water temperature and salinity encountered during the geophysical borehole logging, Figure 6-1. Water samples were taken from the borehole section for chemical analysis revealed that its temperature and salinity was similar the water taken from the other test sections. Hence, this anomaly is reflecting the situation in the borehole and not necessarily in the aquifer.

6.1 Flow regimes

All tests over time develop 2D radial flow regimes and Test 6 also a double porosity regime, cf. Table 5-1. Tests 1, 2 and 3 are essentially testing the feature of dominant inflow and yield similar transmissivities, with the difference that Test 3 is showing a very high skin which is consistent with the effect of the grouting done. Tests 1 and 2 both show an initial linear flow (1D) regime which would be consistent with flow in a “single” feature fracture/channel, the effect is not evident in Test 3, presumably being concealed due to the previous grouting of the feature. Test 5 also shows a very high transmissivity similar to Tests 1-3. This may suggest that the fracturing of this section is somehow connected to the high yielding feature. It should be noted that Test 2 is the most adequate for characterizing the high yielding linear feature since it was performed under controlled conditions, prior to grouting it and with long duration of the flow- and recovery phase.

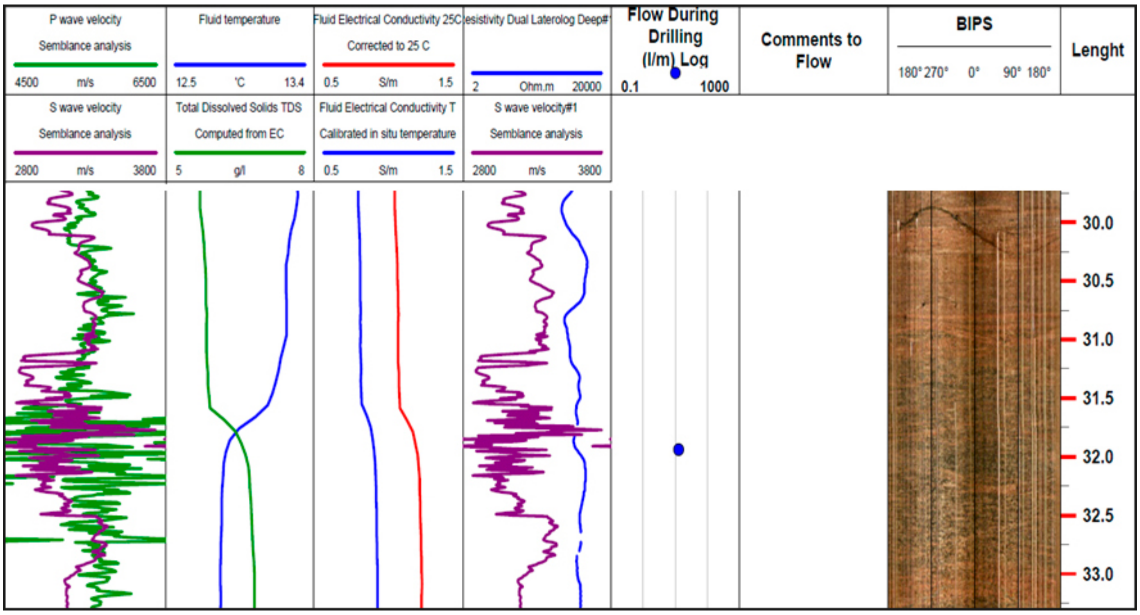

__Figure 6-1.__ Geophysical borehole anomaly at 32 m in K03009F01.

6.2 Wellbore storage

Tests 4 through 6 show typical evidences of an initial changing of wellbore storage (WBS) (Kabir 2009) which is particularly pronounced for the two most low yielding test sections, i.e. Tests 4 and 6. It is presumed to be due to gas in the system, either trapped air or degassing of the groundwater. Borehole inclination calculations indicates the borehole should be water saturated from 11.77 m to EOH (end of hole) which would imply a degassing effect since these test sections are situated in this saturated part.

The degassing effect seem more pronounced in low conductivity rock since the gas there a higher presence relative to the advective flow, assuming partial pressures of gases is originally equal in the groundwater system.

6.3 Interpreted skin values

For tests 3 through 7 the abnormally high transmissivities are evaluated in relation to the flow from the formation, given the high formation pressure. Although the match between data and model is excellent such extremely high skin, of several hundred up to 1 000, are not seen in the literature. In the petroleum industry Raghavan (1993) state that skin up to 500 are not uncommon in highly permeable formations but do not elaborate further. In the groundwater industry such high skin values have not been reported to the best of my knowledge. Through the equivalence between skin and equivalent borehole radius ($r_e = r \cdot e^{-\xi}$), a skin of $\xi = 100$ gives extremely small r_e which are practically inconceivable.

Tests 1 and 2 do not display this behaviour, they have in common that they both test a very conductive fracture zone and are testing the complete open hole without packers and without flow gauge, with the flow being measured manually at the well head.

It is tentatively suspected that the high skins are due to turbulent flow which would imply that the calculated transmissivities are not necessarily representative and should be treated with caution. To quantify the effect due to turbulence the tests should have been performed differently, with multiple rates. In the present situation this potential source of error cannot be accounted for correctly.

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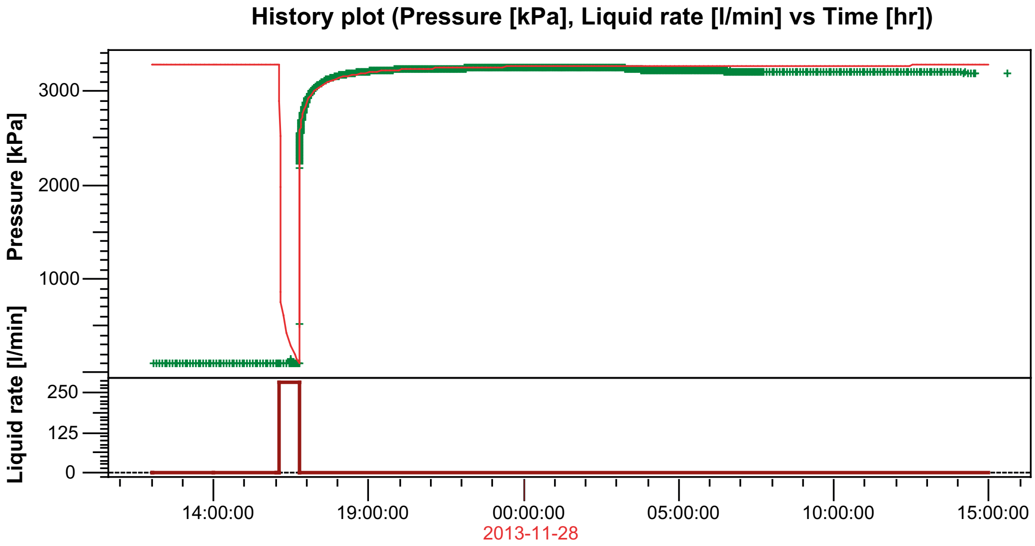
Response test K03009F01 10.50 m

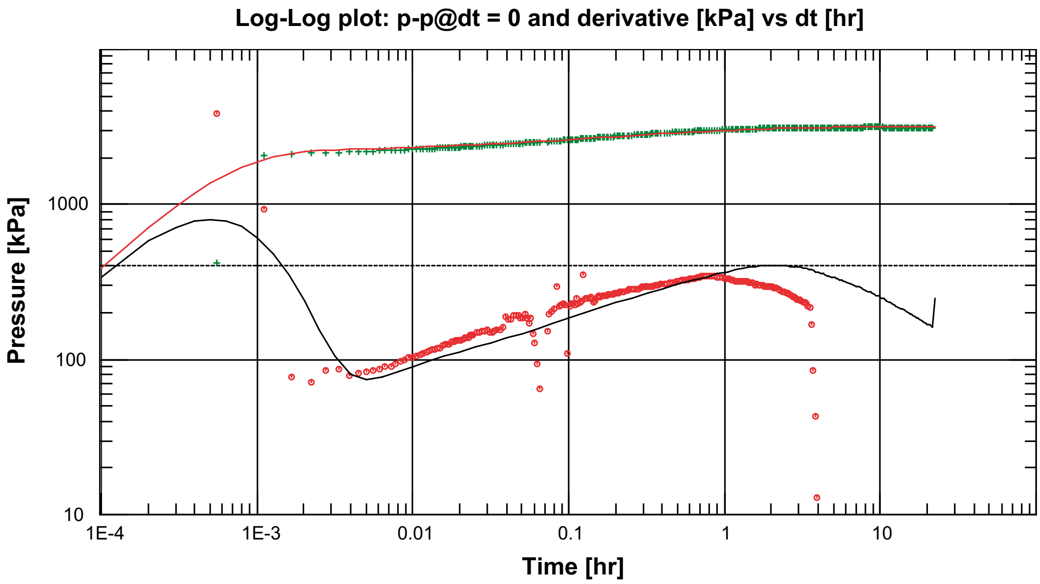
Test report

Main results		Response test build-up	
Company	Svensk Kärnbränslehantering AB	Field	Äspö HRL
Well	K03009F01	Test Name / #	Inflöde under borrning

Test date / time	2013-11-27 16:08
Formation interval	2.44-10.8
Perforated interval	10.5-10.8
Gauge type / #	Druck PTX7517-1, 0-5MPa, accur:+-0.15%
Gauge depth	-399.226m RHB70
Analyzed by	Mansueto Morosini
Analysis date / time	2013-11-28
Filed Crew	Göran Nilsson and drilling contractors
TEST TYPE	Standard
Porosity Phi (%)	5
Well Radius rw	0.038 m
Pay Zone h	0.3 m
Form. compr.	8.70226E-10 Pa-1
Reservoir T	14 °C
Reservoir P	3500 kPa
Fluid type	Water
Volume Factor B	0.99827 m3/stm3
Viscosity	0.00127436 Pa.sec
Total Compr. ct	4E-8 Pa-1
Selected Model	
Model Option	Standard Model
Well	Fracture - Infinite conductivity
Reservoir	Homogeneous
Boundary	One fault
Main Model Parameters	
TMatch	1.83 [hr]-1
PMatch	0.00124 [kPa]-1
C	3.96E-9 m3/Pa
Total Skin	-5.78
T	9.15E-6 m2/s
K	3.05E-5 m/s
Pi	3277.72 kPa
Model Parameters	
Well & Wellbore parameters (K03009F01)	
C	3.96E-9 m3/Pa
Skin	2.67
Geometrical Skin	-8.46
Xf	361 m
Theta	1.5708 Radians
Reservoir & Boundary parameters	
Pi	3277.72 kPa
T	9.15E-6 m2/s
K	3.05E-5 m/s
L - Constant P.	1120 m
Derived & Secondary Parameters	
P @ dt=0	106.813 kPa
Delta P (Total Skin)	-4668.11 kPa
Delta P (Skin)	2159.05 kPa
Delta P Ratio (Total Skin)	-1.47329 Fraction

Ecrin v4.30.04 Inflöde K03009F01 10,5m 2014-04-17 Page 1/1


History plot (Pressure [kPa], Liquid rate [l/min] vs Time [hr])
Pressure [kPa]
Liquid rate [l/min]
3000
2000
1000
250
125
0
14:00:00
19:00:00
00:00:00
2013-11-28
05:00:00
10:00:00
15:00:00


Log-Log plot: p-p@dt = 0 and derivative [kPa] vs dt [hr]
Pressure [kPa]
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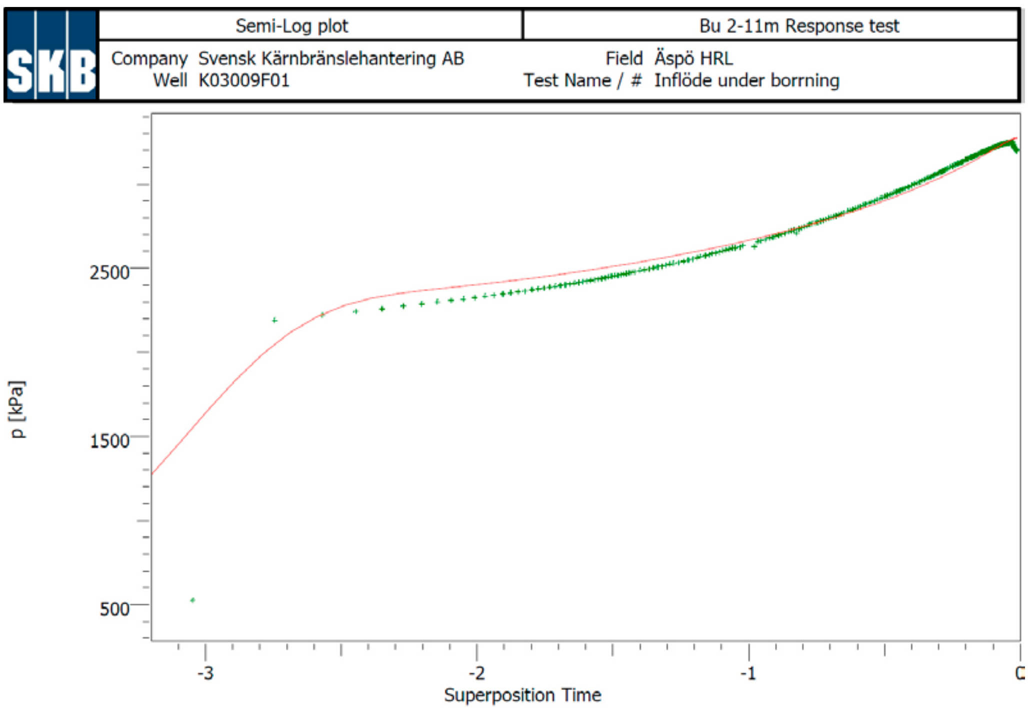
100
10
1E-4
1E-3
0.01
0.1
1
10
Time [hr]


Semi-Log plot
Bu 2-11m Response test
SKB
Company Svensk Kärnbränslehantering AB
Well K03009F01
Field Äspö HRL
Test Name / # Inflöde under borrning
p [kPa]
2500
1500
500
-3
-2
-1
0
Superposition Time

Response matrix

A1 Responsmatris hydrotest 2.44–10.8 m K03009F01											Index 2-new			
Borehole	Sec#	Secup	Seclow	PoA	Distance rs	dp_{1h}	dp_p		dp_{1h}	dp_p	I2n,dp1h = dp1h/Qp*Ln(rs/r0)	I2n,dpp = dpp/Qp*Ln(rs/r0)	Log[I2n,dpp	Response
		(m)	(m)	(m)	(m)	(kPa)	(kPa)	Kommentar	(m)	(m)				
K03009F01	Q = 283 l/min	2.44	10.80	10.50	2.72		3 150.0			321.21		6.81E+04	4.8	H
KA2050A	1	155.00	211.57	185	70.30		336.0			34.26		3.09E+04	4.5	H
KA2050A	2	102.00	154.00	125	60.70		448.0			45.68		3.98E+04	4.6	H
KA2050A	3	6.00	101.00	75	90.40		120.0			12.24		1.17E+04	4.1	M
KA2051A01	1	278	319.84	290	235.00		18.0			1.84		2.12E+03	3.3	M
KA2051A01	2	235	277	270	217.60		34.0			3.47		3.96E+03	3.6	M
KA2051A01	3	204	234	214	172.40		28.0			2.86		3.12E+03	3.5	M
KA2051A01	4	136	203	178	147.90		35.0			3.57		3.78E+03	3.6	M
KA2051A01	5	120	135	130	125.20		50.0			5.10		5.22E+03	3.7	M
KA2051A01	6	96	119	105	119.90		60.0			6.12		6.21E+03	3.8	M
KA2051A01	7	76	95	83	119.70		80.0			8.16		8.28E+03	3.9	M
KA2051A01	8	68	75	71	121.30		107.0			10.91		1.11E+04	4.0	M
KA2051A01	9	51	67	60	123.80		45.0			4.59		4.69E+03	3.7	M
KA2051A01	10	7	50	41	130.30		24.0			2.45		2.53E+03	3.4	M
KA2858A	2	39.77	40.77	40	187.90		4.0			0.41		4.53E+02	2.7	L
KA2862A	1	0	15.98	7	145.30		12.0			1.22		1.29E+03	3.1	M
KA3005A		0.00	50.03	25.02	21.90		157.0			16.01		1.05E+04	4.0	M
KA3105A	1	53.01	68.95	60.98	136.90		91.0			9.28		9.68E+03	4.0	M
KA3105A	2	25.51	52.01	38.76	124.70		23.0			2.35		2.40E+03	3.4	M
KA3105A	3	22.51	24.51	23.51	118.10		21.0			2.14		2.17E+03	3.3	M
KA3105A	4	17.01	19.51	18.26	116.20		21.0			2.14		2.16E+03	3.3	M
KA3105A	5	6.51	16.01	11.26	114.10		4.0			0.41		4.10E+02	2.6	L
KA3110A	1	20.05	26.83	23.44	130.20		2.5			0.25		2.63E+02	2.4	L
KA3110A	2	6.55	19.05	12.80	122.70		3.0			0.31		3.12E+02	2.5	L
KXTT1	1	17.00	28.76	22.88	38.90		420.0			42.83		3.32E+04	4.5	H
KXTT1	2	15.00	16.00	15.50	41.70		248.0			25.29		2.00E+04	4.3	H
KXTT1	3	7.50	11.50	9.50	44.70		38.0			3.87		3.12E+03	3.5	M
KXTT1	4	3.00	6.50	4.75	47.40									
KXTT2	1	16.55	18.30	17.43	39.30		275.0			28.04		2.18E+04	4.3	H
KXTT2	2	14.55	15.55	15.05	40.40		192.0			19.58		1.54E+04	4.2	H
KXTT2	3	11.55	13.55	12.55	41.70		44.0			4.49		3.55E+03	3.6	M
KXTT2	4	7.55	10.55	9.05	43.60		35.0			3.57		2.86E+03	3.5	M
KXTT2	5	3.05	6.55	4.80	46.30		31.0			3.16		2.57E+03	3.4	M
KXTT5	1	10.81	25.85	18.33	40.30		253.0			25.80		2.02E+04	4.3	H
KXTT5	2	9.61	9.81	9.71	44.60		250.0			25.49		2.05E+04	4.3	H
KXTT5	3	6.11	8.61	7.36	46.00		71.0			7.24		5.88E+03	3.8	M
KXTT5	4	3.11	5.11	4.11	48.00		32.0			3.26		2.68E+03	3.4	M
HAS06		0.00	100.00		355.40		0.62 m			0.62		7.72E+02	2.9	VL

Appendix 2

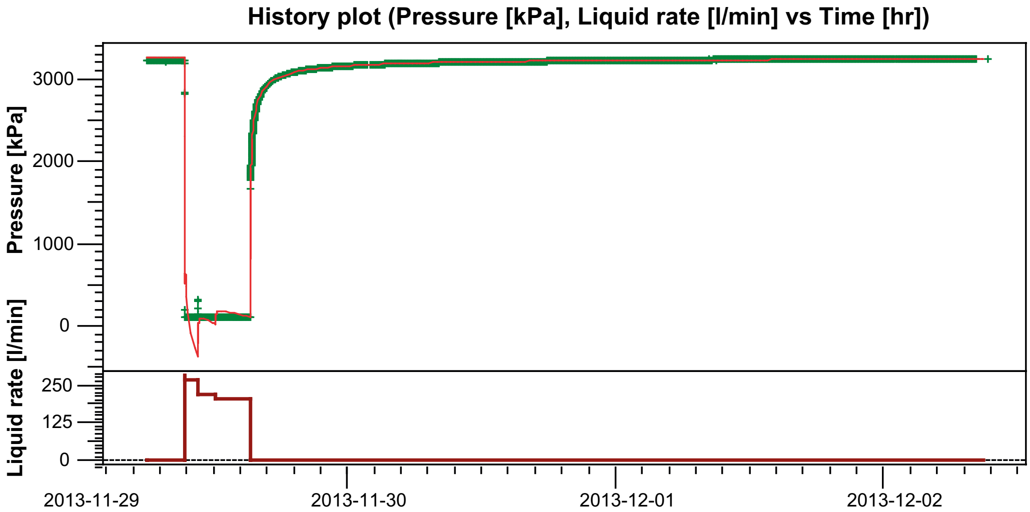
Interference test K03009F01 10.50–14.99 m

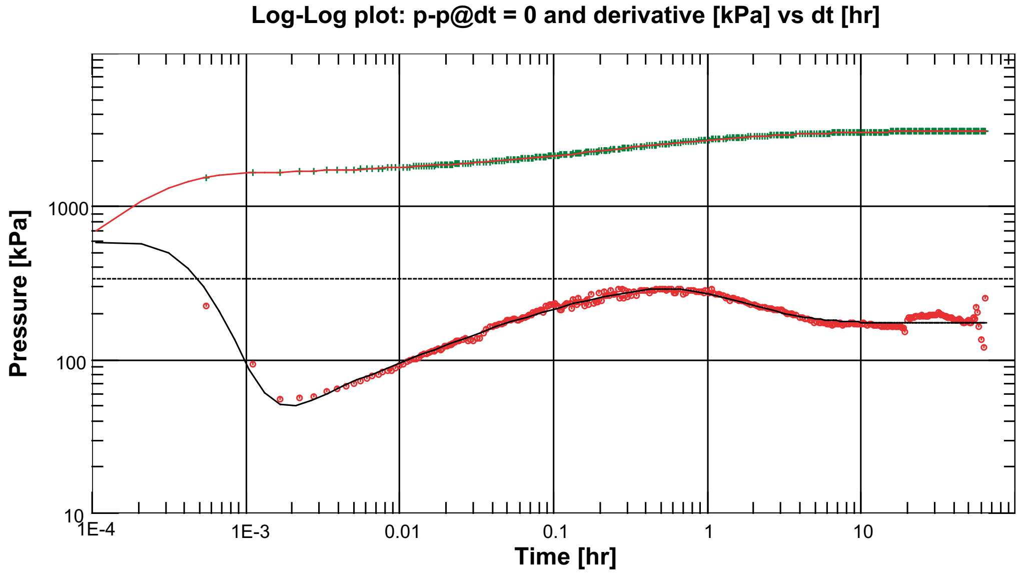
Test report

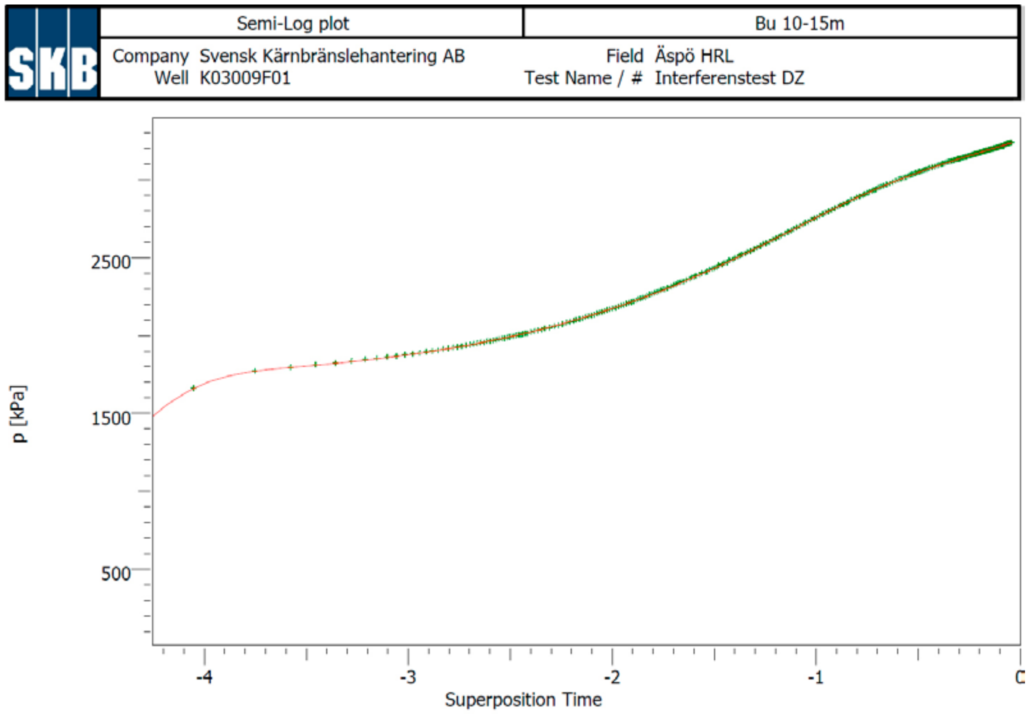
Main results	FinK-RadC
Company Svensk Kärnbränslehantering AB	Field Äspö HRL
Well K03009F01	Test Name / # Interferenstest DZ

Test date / time	2013-11-29 09:22:30
Formation interval	2.55-15.50m
Perforated interval	open hole, major inflow 10.50-14.5m (DZ)
Gauge type / #	Druck PTX 7517-1, 0-5MPa, accur:+-0.15%
Gauge depth	-399.226m RHB70
Analyzed by	Mansueto Morosini
Analysis date / time	2013-12-02
Field crew	Göran Nilsson and drilling contractor
TEST TYPE	Standard
Porosity Phi (%)	5
Well Radius rw	0.038 m
Pay Zone h	0.4 m
Form. compr.	8.70226E-10 Pa-1
Reservoir T	14 °C
Reservoir P	3500 kPa
Fluid type	Water
Volume Factor B	0.99827 m3/stm3
Viscosity	0.00127436 Pa.sec
Total Compr. ct	1E-8 Pa-1
Selected Model	
Model Option	Standard Model
Well	Fracture - Finite conductivity
Reservoir	Radial composite
Boundary	Infinite
Main Model Parameters	
TMatch	3.06 [hr]-1
PMatch	0.00148 [kPa]-1
C	1.42E-9 m3/Pa
Total Skin	-4.44
T	7.95E-6 m2/s
K	1.99E-5 m/s
Pi	3254.62 kPa
Model Parameters	
Well & Wellbore parameters (K03009F01)	
C	1.42E-9 m3/Pa
Skin	2.34
Geometrical Skin	-6.78
Xf	68.8 m
Fc	2.9E-8 m3
Reservoir & Boundary parameters	
Pi	3254.62 kPa
T	7.95E-6 m2/s
K	1.99E-5 m/s
Ri	181 m
M	0.521
D	0.726
Derived & Secondary Parameters	
P @ dt=0	110.987 kPa
Delta P (Total Skin)	-2998.1 kPa
Delta P (Skin)	1579.86 kPa
Delta P Ratio (Total Skin)	-0.958651 Fraction

Ecrin v4.30.04 Interferenstest K03009F01 10,5-15.5m 2014-04-17 Page 1/1


History plot (Pressure [kPa], Liquid rate [l/min] vs Time [hr])
Pressure [kPa]
3000
2000
1000
0
Liquid rate [l/min]
250
125
0
2013-11-29
2013-11-30
2013-12-01
2013-12-02

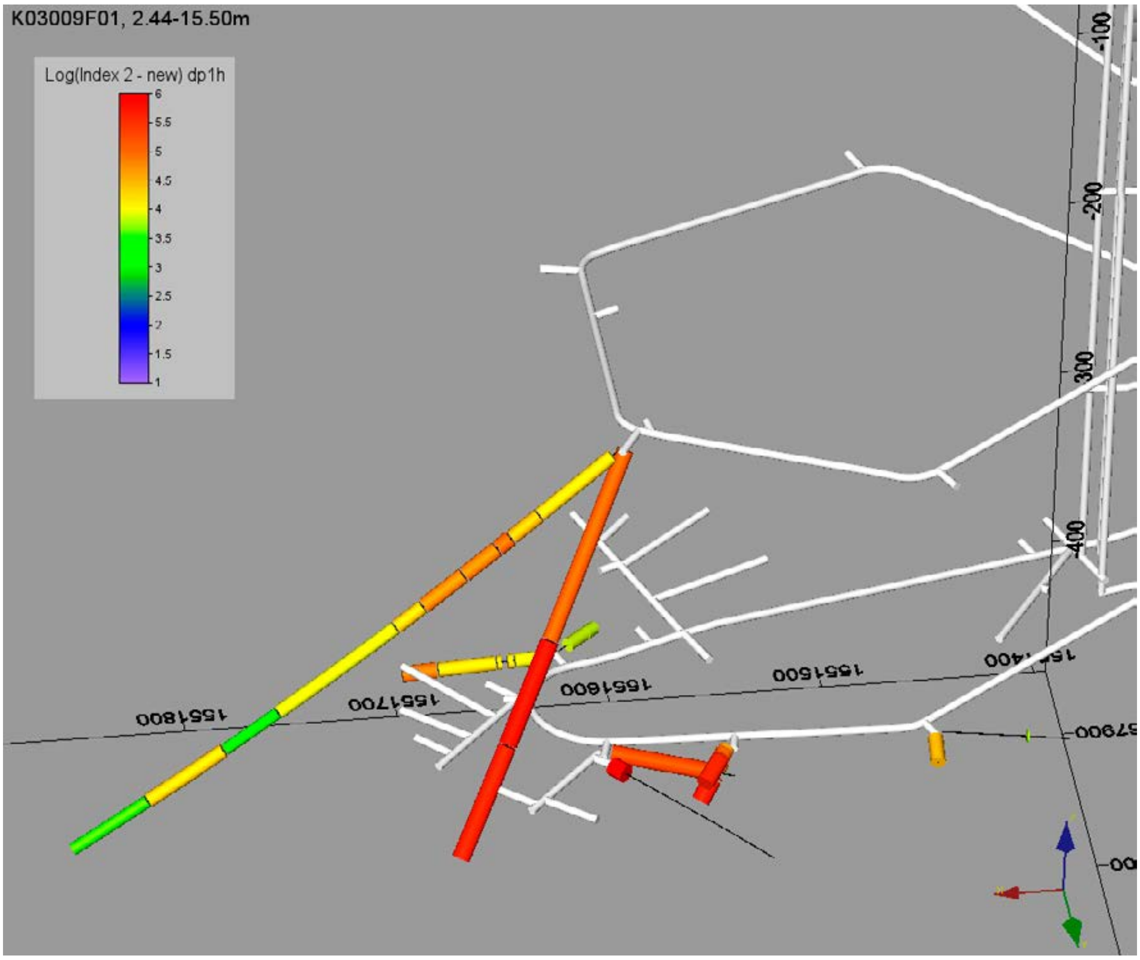

Log-Log plot: p-p@dt = 0 and derivative [kPa] vs dt [hr]
Pressure [kPa]
1000
100
10
1E-4
1E-3
0.01
0.1
1
10
Time [hr]


Semi-Log plot
Bu 10-15m
Company Svensk Kärnbränslehantering AB
Field Äspö HRL
Well K03009F01
Test Name / # Interferenstest DZ
p [kPa]
2500
1500
500
-4
-3
-2
-1
0
Superposition Time

Response matrix

A2 Responsmatris hydrotest 2.44 (10.5)–14.99 m K03009F01											Index 2-new					
Borehole	Sec#	Secup	Seclow	PoA	Dis-tance rs	dp_{1h}	dp_p		dp_{1h}	dp_p	I2n,dp1h = dp1 h/Qp*Ln(rs/r0)	Log[I2n,dp1h]	Response, dp1h	I2n,dpp = dpp/Qp*Ln(rs/r0)	Log[I2n,dpp]	Response, dpp
		(m)	(m)	(m)	(m)	(kPa)	(kPa)	Kommentar								
K03009F01	Q = 204 l/min	2.44 (10.5)	10.80	10.50	2.72	3 115.0	3 115.0		317.64	317.64	9.34E+05	6.0	H	9.34E+05	6.0	H
KA2050A	1	155.00	211.57	185	70.30	397.0	710.0		40.48	72.40	5.06E+05	5.7	H	9.06E+05	6.0	H
KA2050A	2	102.00	154.00	125	60.70	545.0	893.0		55.57	91.06	6.71E+05	5.8	H	1.10E+06	6.0	H
KA2050A	3	6.00	101.00	75	90.40	94.0	408.0	Lagg 15 min	9.59	41.60	1.27E+05	5.1	M	5.51E+05	5.7	H
KA2051A01	1	278	319.84	290	235.00	2.0	61.0	Lagg 60 min	0.20	6.22	3.27E+03	3.5	L	9.99E+04	5.0	M
KA2051A01	2	235	277	270	217.60	12.0	140.0	Lagg 20 min	1.22	14.28	1.94E+04	4.3	L	2.26E+05	5.4	M
KA2051A01	3	204	234	214	172.40	1.0	109.0	Lagg 40 min	0.10	11.11	1.54E+03	3.2	L	1.68E+05	5.2	M
KA2051A01	4	136	203	178	147.90	6.0	183.0	Lagg 30 min	0.61	18.66	8.99E+03	4.0	L	2.74E+05	5.4	M
KA2051A01	5	120	135	130	125.20	15.0	248.0	Lagg 25 min	1.53	25.29	2.17E+04	4.3	L	3.59E+05	5.6	H
KA2051A01	6	96	119	105	119.90	44.0	250.0	Lagg 7 min	4.49	25.49	6.32E+04	4.8	M	3.59E+05	5.6	H
KA2051A01	7	76	95	83	119.70	49.0	338.0	Lagg 15 min	5.00	34.47	7.03E+04	4.8	M	4.85E+05	5.7	H
KA2051A01	8	68	75	71	121.30	74.0	382.0	Lagg 10 min	7.55	38.95	1.06E+05	5.0	M	5.50E+05	5.7	H
KA2051A01	9	51	67	60	123.80	20.0	202.0	Lagg 10 min	2.04	20.60	2.89E+04	4.5	M	2.92E+05	5.5	H
KA2051A01	10	7	50	41	130.30	12.0	121.0	Lagg 10 min	1.22	12.34	1.75E+04	4.2	M	1.77E+05	5.2	M
KA2858A	2	39.77	40.77	40	187.90	3.0	24.0	Lagg 15 min	0.31	2.45	4.71E+03	3.7	L	3.77E+04	4.6	M
KA2862A	1	0	15.98	7	145.30	17.0	53.0	Lagg 15 min	1.73	5.40	2.54E+04	4.4	L	7.91E+04	4.9	M
KA3005A		0.00	50.03	25.02	21.90	234.0	428.0		23.86	43.64	2.17E+05	5.3	M	3.96E+05	5.6	H
KA3105A	1	53.01	68.95	60.98	136.90	54.0	362.0		5.51	36.91	7.97E+04	4.9	M	5.34E+05	5.7	H
KA3105A	2	25.51	52.01	38.76	124.70	12.0	118.0		1.22	12.03	1.74E+04	4.2	L	1.71E+05	5.2	M
KA3105A	3	22.51	24.51	23.51	118.10	11.0	92.0		1.12	9.38	1.57E+04	4.2	L	1.32E+05	5.1	M
KA3105A	4	17.01	19.51	18.26	116.20	11.0	93.0		1.12	9.48	1.57E+04	4.2	L	1.33E+05	5.1	M
KA3105A	5	6.51	16.01	11.26	114.10	7.0	22.0		0.71	2.24	9.95E+03	4.0	L	3.13E+04	4.5	M
KA3110A	1	20.05	26.83	23.44	130.20	4.5	12.5		0.46	1.27	6.57E+03	3.8	L	1.83E+04	4.3	M
KA3110A	2	6.55	19.05	12.80	122.70	5.0	16.0		0.51	1.63	7.21E+03	3.9	L	2.31E+04	4.4	M
KXTT1	1	17.00	28.76	22.88	38.90	512.0	739.0		52.21	75.36	5.62E+05	5.7	H	8.11E+05	5.9	H
KXTT1	2	15.00	16.00	15.50	41.70	315.0	498.0		32.12	50.78	3.52E+05	5.5	H	5.57E+05	5.7	H
KXTT1	3	7.50	11.50	9.50	44.70	52.0	154.0		5.30	15.70	5.93E+04	4.8	M	1.76E+05	5.2	M
KXTT1	4	3.00	6.50	4.75	47.40			Tryck ej akvi								
KXTT2	1	16.55	18.30	17.43	39.30	360.0	560.0		36.71	57.10	3.96E+05	5.6	H	6.17E+05	5.8	H
KXTT2	2	14.55	15.55	15.05	40.40	276.0	486.0		28.14	49.56	3.06E+05	5.5	H	5.39E+05	5.7	H
KXTT2	3	11.55	13.55	12.55	41.70	67.0	179.0		6.83	18.25	7.50E+04	4.9	M	2.00E+05	5.3	M
KXTT2	4	7.55	10.55	9.05	43.60	45.0	145.0		4.59	14.79	5.09E+04	4.7	M	1.64E+05	5.2	M
KXTT2	5	3.05	6.55	4.80	46.30	43.0	138.0		4.38	14.07	4.95E+04	4.7	M	1.59E+05	5.2	M
KXTT5	1	10.81	25.85	18.33	40.30	363.0	578.0		37.02	58.94	4.02E+05	5.6	H	6.41E+05	5.8	H
KXTT5	2	9.61	9.81	9.71	44.60	317.0	503.0		32.33	51.29	3.61E+05	5.6	H	5.73E+05	5.8	H
KXTT5	3	6.11	8.61	7.36	46.00	102.0	250.0		10.40	25.49	1.17E+05	5.1	M	2.87E+05	5.5	H
KXTT5	4	3.11	5.11	4.11	48.00	42.0	135.0		4.28	13.77	4.88E+04	4.7	M	1.57E+05	5.2	M
HAS06					355.40		1.66 m	Lagg 1.5 h. Tv	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N

Response plot



Interference test K03009F01 2.44–100.92 m

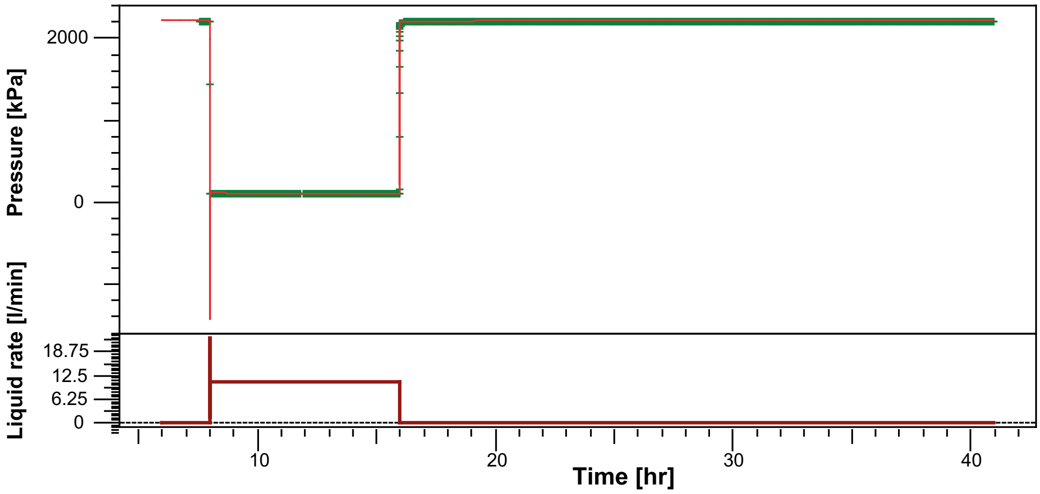
Test report

Main results		Analysis 1	
Company	Svensk Kärnbränslehantering AB	Field	Äspö HRL
Well	K03009F01	Test Name / #	DETUM1 - Stora sprickor

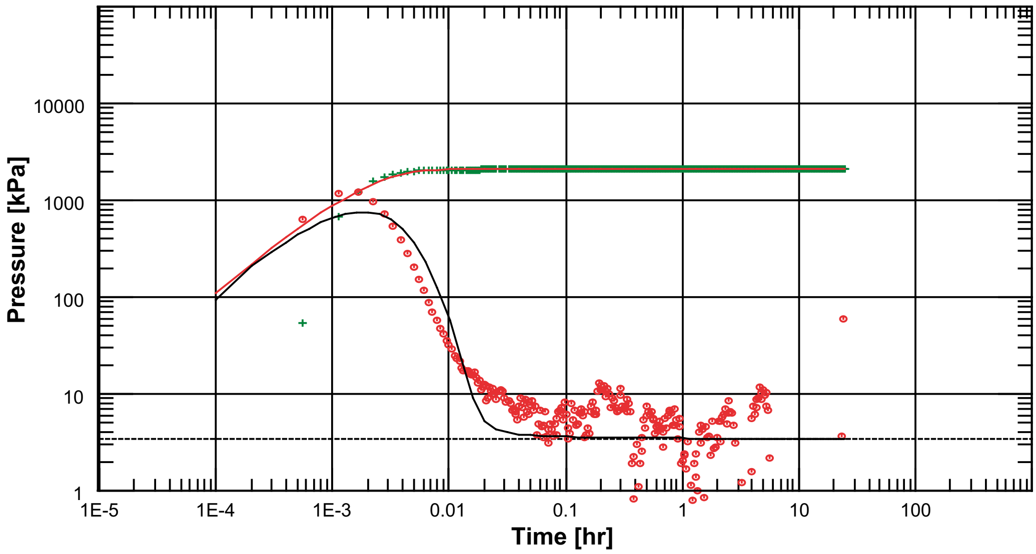
Test date / time	2014-02-19 08:00
Formation interval	2.44 - 100.92m (EOH)
Perforated interval	open hole
Gauge type / #	Druck PTX 7517-1, 0-5MPa a, accur: 0.15% MV
Gauge depth	-399.226m RHB70
Analyzed by	Mansueto Morosini, SKB
Analysis date / time	2014-02-21
Field crew	Lars Andersson (SKB)
Flow gauge	Krohne 0-20L/min, accur: 0.5% MV
TEST TYPE	Standard
Porosity Phi (%)	5
Well Radius rw	0.038 m
Pay Zone h	98.48 m
Form. compr.	8.70226E-10 Pa-1
Reservoir T	15 °C
Reservoir P	2200 kPa
Fluid type	Water
Volume Factor B	0.999037 m3/stm3
Viscosity	0.00124603 Pa.sec
Total Compr. ct	5E-10 Pa-1
Selected Model	
Model Option	Standard Model
Well	Vertical
Reservoir	Homogeneous
Boundary	Infinite
Main Model Parameters	
TMatch	1.65E+5 [hr]-1
PMatch	0.144 [kPa]-1
C	5.64E-10 m3/Pa
Total Skin	296
T	4.07E-5 m2/s
K	4.13E-7 m/s
Pi	2217.52 kPa
Model Parameters	
Well & Wellbore parameters (K03009F01)	
C	5.64E-10 m3/Pa
Skin	296
Reservoir & Boundary parameters	
Pi	2217.52 kPa
T	4.07E-5 m2/s
K	4.13E-7 m/s
Derived & Secondary Parameters	
P @ dt=0	104.406 kPa
Rinv	416 m
Test. Vol.	2.68348 MMm3
Delta P (Total Skin)	2053.67 kPa
Delta P Ratio (Total Skin)	0.972314 Fraction

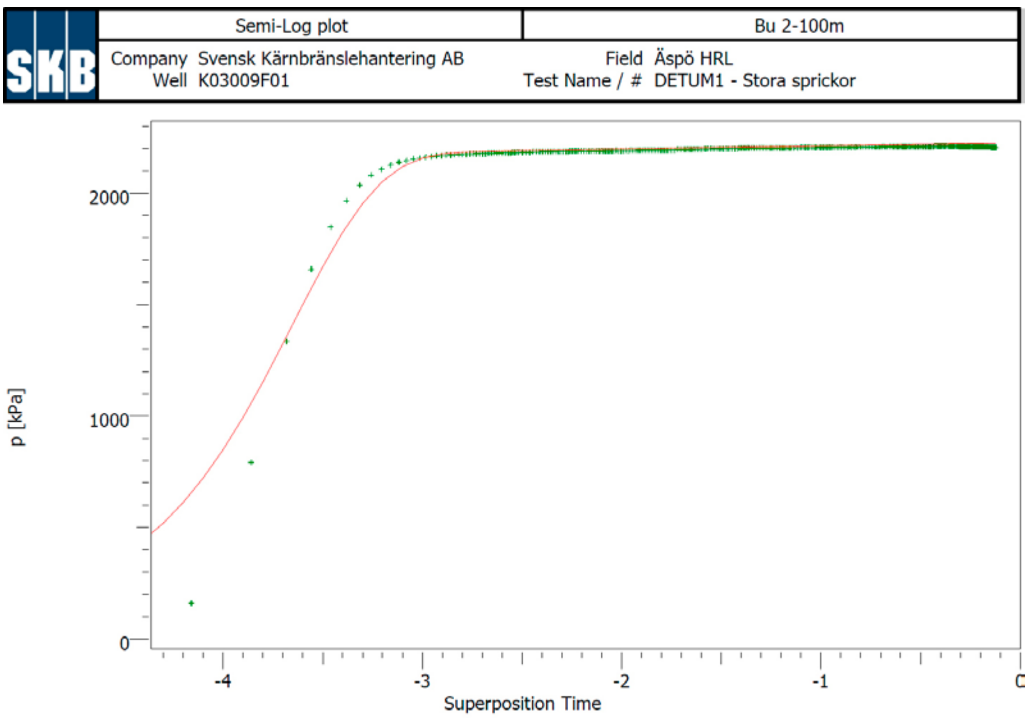
Ecrin v4.30.04 K03009F01 2-100m 2014-04-17 Page 1/1

History plot (Pressure [kPa], Liquid rate [l/min] vs Time [hr])



Log-Log plot: p-p@dt = 0 and derivative [kPa] vs dt [hr]

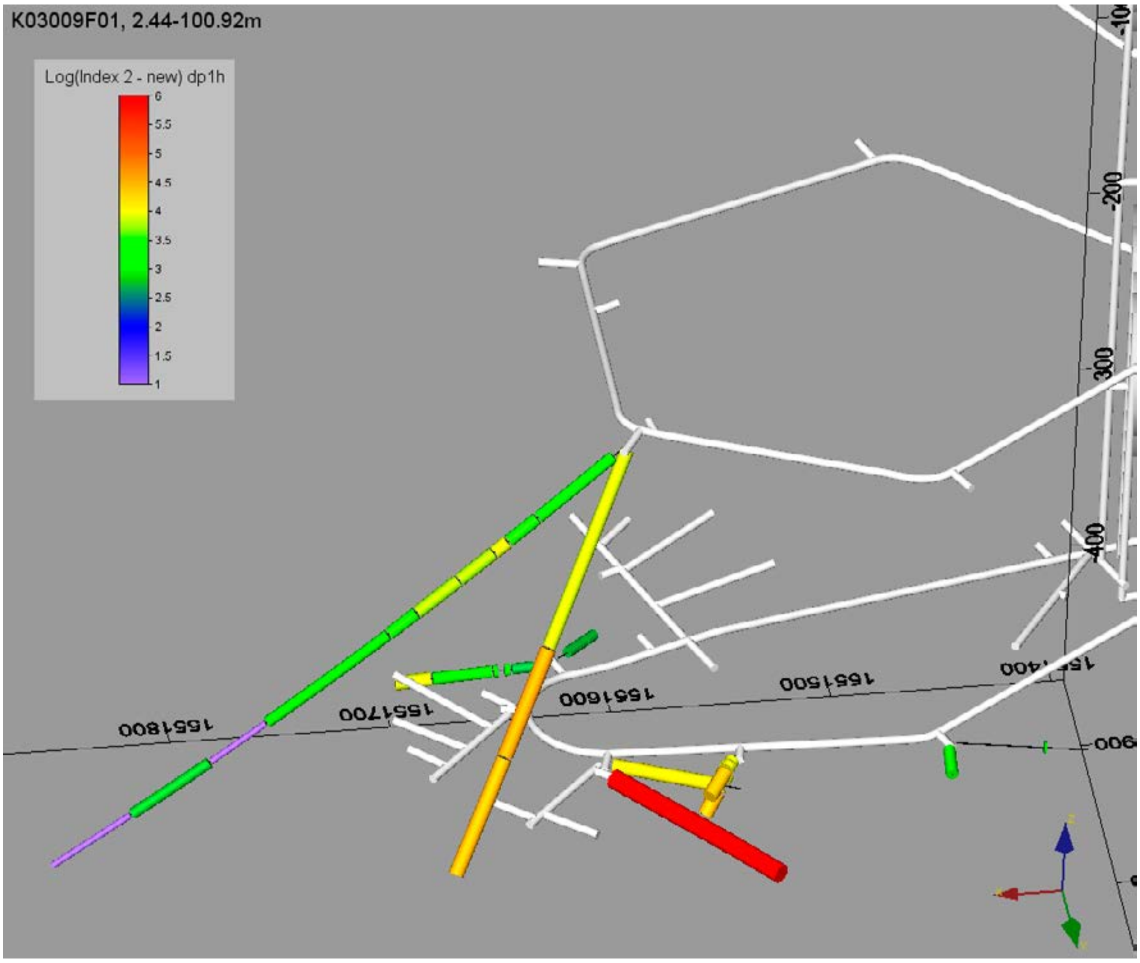




Response matrix K03009F01, 2.44–100.92 m

A3 Responsmatris 2.44–100.92 m K03009F01											Index 2-new					
Borehole	Sec-tion_N	Secup	Seclow	PoA	Dis-tance rs	dp_{1h}	dp_p		dp_{1h}	dp_p	I2n,dp1h = dp1h/Qp*Ln(rs/r0)	Log[I2n,dp1h]	Response, dp1h	I2n,dpp = dpp/Qp*Ln(rs/r0)	Log[I2n,dpp]	Response, dpp
		(m)	(m)	(m)	(m)	(kPa)	(kPa)	Kommentar	(m)	(m)						
K03009F01	Q = 11 l/mi	2.44	100.92	10.50	2.72	2 100.0	2 100.0	ej fullt formatio	214.14	214.14	1.19E+06	6.1	H	1.19E+06	6.1	H
KA2050A	1	155.00	211.57	185	70.30	12.0	26.0		1.22	2.65	2.89E+04	4.5	M	6.26E+04	4.8	M
KA2050A	2	102.00	154.00	125	60.70	16.0	33.0		1.63	3.37	3.72E+04	4.6	M	7.68E+04	4.9	M
KA2050A	3	6.00	101.00	75	90.40	3.0	18.0		0.31	1.84	7.66E+03	3.9	L	4.59E+04	4.7	M
KA2051A01	1	278	319.84	290	235.00	0.0	3.0	Lagg ca 60 min	0.00	0.31	0.00E+00	1.0	N	9.28E+03	4.0	L
KA2051A01	2	235	277	270	217.60	0.2	6.0	Lagg ca 30 min	0.02	0.61	6.10E+02	2.8	VL	1.83E+04	4.3	L
KA2051A01	3	204	234	214	172.40	0.0	5.0	Lagg ca 60 min	0.00	0.51	0.00E+00	1.0	N	1.46E+04	4.2	L
KA2051A01	4	136	203	178	147.90	0.3	8.0	Lagg ca 30 min	0.03	0.82	8.49E+02	2.9	VL	2.26E+04	4.4	L
KA2051A01	5	120	135	130	125.20	1.0	9.0	Lagg ca 20 min	0.10	0.92	2.74E+03	3.4	VL	2.46E+04	4.4	L
KA2051A01	6	96	119	105	119.90	2.0	14.0	Lagg ca 20 min	0.20	1.43	5.42E+03	3.7	L	3.80E+04	4.6	M
KA2051A01	7	76	95	83	119.70	2.0	15.0	Lagg ca 20 min	0.20	1.53	5.42E+03	3.7	L	4.07E+04	4.6	M
KA2051A01	8	68	75	71	121.30	3.0	16.0	Lagg ca 20 min	0.31	1.63	8.15E+03	3.9	L	4.35E+04	4.6	M
KA2051A01	9	51	67	60	123.80	1.0	11.0	Lagg ca 20 min	0.10	1.12	2.73E+03	3.4	VL	3.00E+04	4.5	M
KA2051A01	10	7	50	41	130.30	0.5	6.0	Lagg ca 20 min	0.05	0.61	1.38E+03	3.1	VL	1.66E+04	4.2	L
KA2858A	2	39.77	40.77	40	187.90	0.3	1.5	Lagg ca 70 min	0.03	0.15	8.90E+02	2.9	VL	4.45E+03	3.6	L
KA2862A	1	0	15.98	7	145.30	0.5	2.5	Lagg ca 15 min	0.05	0.25	1.41E+03	3.1	VL	7.05E+03	3.8	L
KA3005A		0.00	50.03	25.02	21.90	6.0	16.0		0.61	1.63	1.05E+04	4.0	L	2.80E+04	4.4	L
KA3105A	1	53.01	68.95	60.98	136.90	3.0	16.0	Lagg ca 20 min	0.31	1.63	8.36E+03	3.9	L	4.46E+04	4.6	M
KA3105A	2	25.51	52.01	38.76	124.70	0.5	6.0	Lagg ca 20 min	0.05	0.61	1.37E+03	3.1	VL	1.64E+04	4.2	L
KA3105A	3	22.51	24.51	23.51	118.10	0.5	5.0	Lagg ca 20 min	0.05	0.51	1.35E+03	3.1	VL	1.35E+04	4.1	L
KA3105A	4	17.01	19.51	18.26	116.20	0.5	5.0	Lagg ca 20 min	0.05	0.51	1.35E+03	3.1	VL	1.35E+04	4.1	L
KA3105A	5	6.51	16.01	11.26	114.10	0.2	1.8	Lagg ca 20 min	0.02	0.18	5.37E+02	2.7	VL	4.83E+03	3.7	L
KA3110A	1	20.05	26.83	23.44	130.20	0.2	1.0	Lagg ca 20 min	0.02	0.10	5.52E+02	2.7	VL	2.76E+03	3.4	L
KA3110A	2	6.55	19.05	12.80	122.70	0.2	1.2	Lagg ca 20 min	0.02	0.12	5.45E+02	2.7	VL	3.27E+03	3.5	L
KXTT1	1	17.00	28.76	22.88	38.90	13.0	26.0		1.33	2.65	2.70E+04	4.4	L	5.39E+04	4.7	M
KXTT1	2	15.00	16.00	15.50	41.70	9.0	19.0		0.92	1.94	1.90E+04	4.3	L	4.02E+04	4.6	M
KXTT1	3	7.50	11.50	9.50	44.70	4.0	10.0		0.41	1.02	8.61E+03	3.9	L	2.15E+04	4.3	L
KXTT1	4	3.00	6.50	4.75	47.40	0.0	0.0	Tryck ej akvifärlikt								
KXTT2	1	16.55	18.30	17.43	39.30	9.0	22.0		0.92	2.24	1.87E+04	4.3	L	4.58E+04	4.7	M
KXTT2	2	14.55	15.55	15.05	40.40	8.0	18.0		0.82	1.84	1.68E+04	4.2	L	3.77E+04	4.6	M
KXTT2	3	11.55	13.55	12.55	41.70	4.0	11.0		0.41	1.12	8.45E+03	3.9	L	2.32E+04	4.4	L
KXTT2	4	7.55	10.55	9.05	43.60	4.0	10.0		0.41	1.02	8.55E+03	3.9	L	2.14E+04	4.3	L
KXTT2	5	3.05	6.55	4.80	46.30	4.0	9.0		0.41	0.92	8.69E+03	3.9	L	1.96E+04	4.3	L
KXTT5	1	10.81	25.85	18.33	40.30	10.0	23.0		1.02	2.35	2.09E+04	4.3	L	4.82E+04	4.7	M
KXTT5	2	9.61	9.81	9.71	44.60	8.0	20.0		0.82	2.04	1.72E+04	4.2	L	4.30E+04	4.6	M
KXTT5	3	6.11	8.61	7.36	46.00	4.0	10.0		0.41	1.02	8.68E+03	3.9	L	2.17E+04	4.3	L
KXTT5	4	3.11	5.11	4.11	48.00	4.0	9.0		0.41	0.92	8.77E+03	3.9	L	1.97E+04	4.3	L
HAS06		0.00	100.00		355.40	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N

Response plot



Interference test K03009F01 25.20–28.19 m

Test report

Main results	Bu 25-28m
Company Svensk Kärnbränslehantering AB Well K03009F01	Field Äspö HRL Test Name / # DETUM1 - Stora sprickor

Test date / time 2014-02-25 08:05
Formation interval 25.20 - 28.20 m
Perforated interval open hole
Gauge type / # PTX 7517-10-5MPa a, Accur. +-0.15%
Gauge depth -399.226 m RHB70
Analyzed by Mansueto Morosini, SKB
Analysis date / time
Field crew Lars Andersson (SKB) & Pierre Nilsson (TEQ)

TEST TYPE Standard

Porosity Phi (%) 5
Well Radius rw 0.038 m
Pay Zone h 3 m

Form. compr. 8.70226E-10 Pa-1
Reservoir T 15 °C
Reservoir P 2200 kPa

Fluid type Water

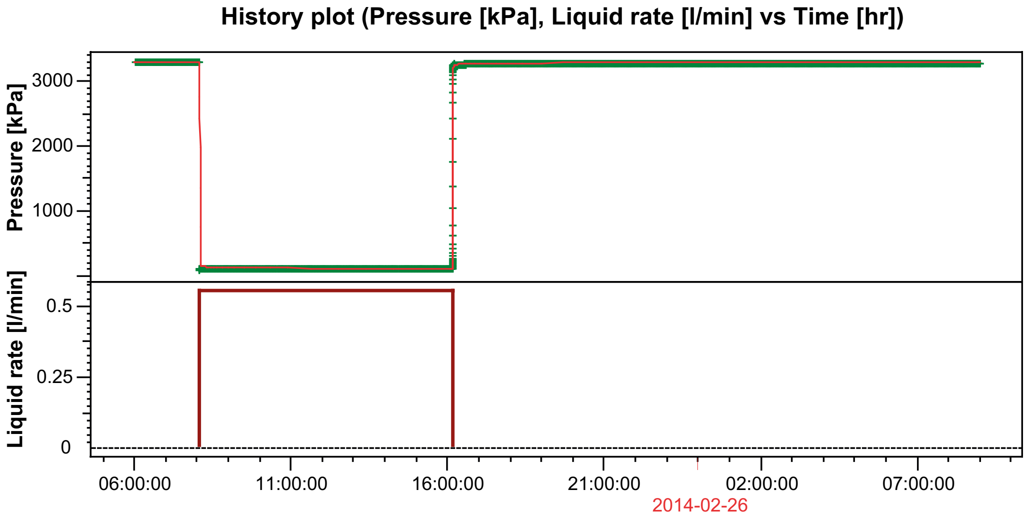
Volume Factor B 0.999037 m3/stm3
Viscosity 0.00124603 Pa.sec
Total Compr. ct 1E-10 Pa-1

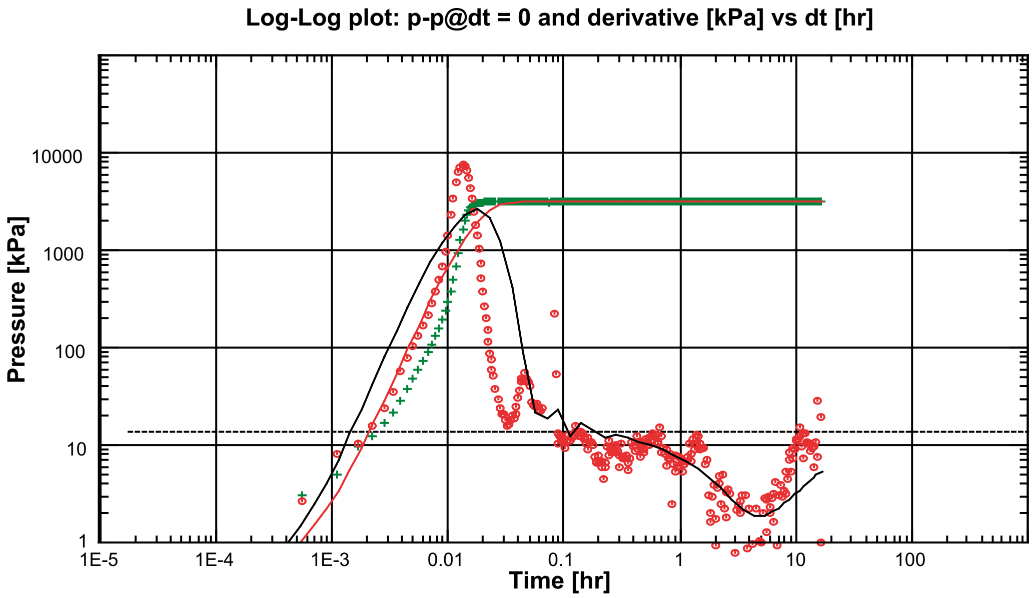
Selected Model
Model Option Standard Model
Well Vertical, Changing Storage (Hegeman)
Reservoir Two porosity PSS
Boundary Infinite

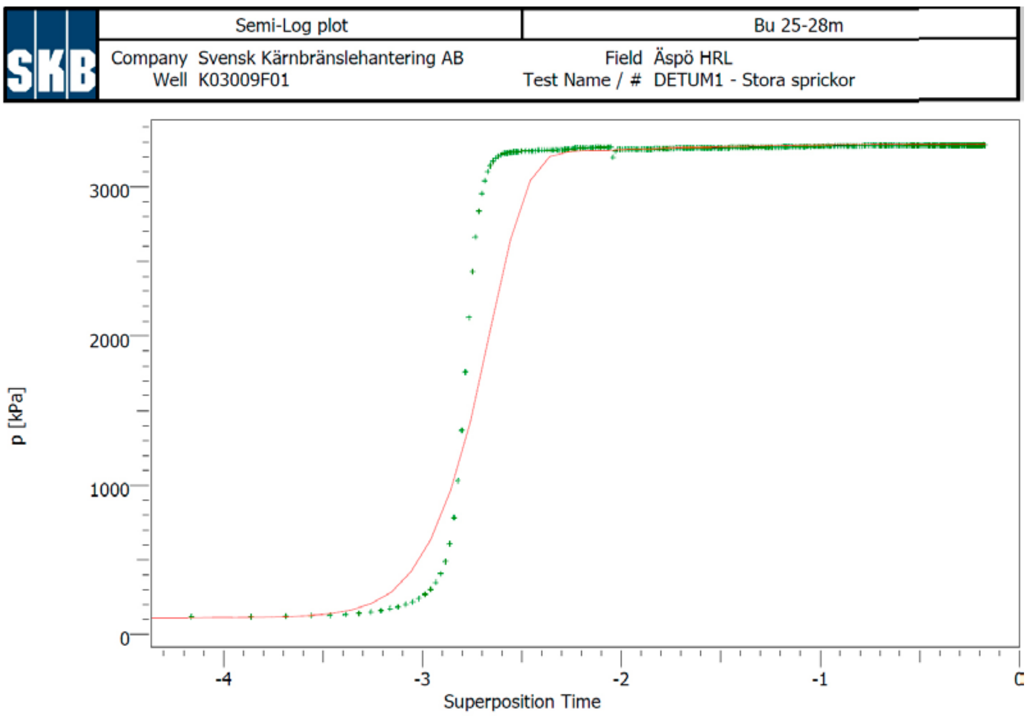
Main Model Parameters
TMatch 28800 [hr]-1
PMatch 0.0365 [kPa]-1
C 4.24E-11 m3/Pa
Total Skin 108
T 5.33E-7 m2/s
K 1.78E-7 m/s
Pi 3292.1 kPa

Model Parameters
Well & Wellbore parameters (K03009F01)
C 4.24E-11 m3/Pa
Ci/Cf 484
delta_t 0.0459 hr
Skin 108
Reservoir & Boundary parameters
Pi 3292.1 kPa
T 5.33E-7 m2/s
K 1.78E-7 m/s
Omega 0.0856
Lambda 9.5E-8

Derived & Secondary Parameters
Delta P (Total Skin) 2951.14 kPa
Delta P Ratio (Total Skin) 0.92894 Fraction


History plot (Pressure [kPa], Liquid rate [l/min] vs Time [hr])
Pressure [kPa]
3000
2000
1000
Liquid rate [l/min]
0.5
0.25
0
06:00:00
11:00:00
16:00:00
21:00:00
02:00:00
07:00:00
2014-02-26

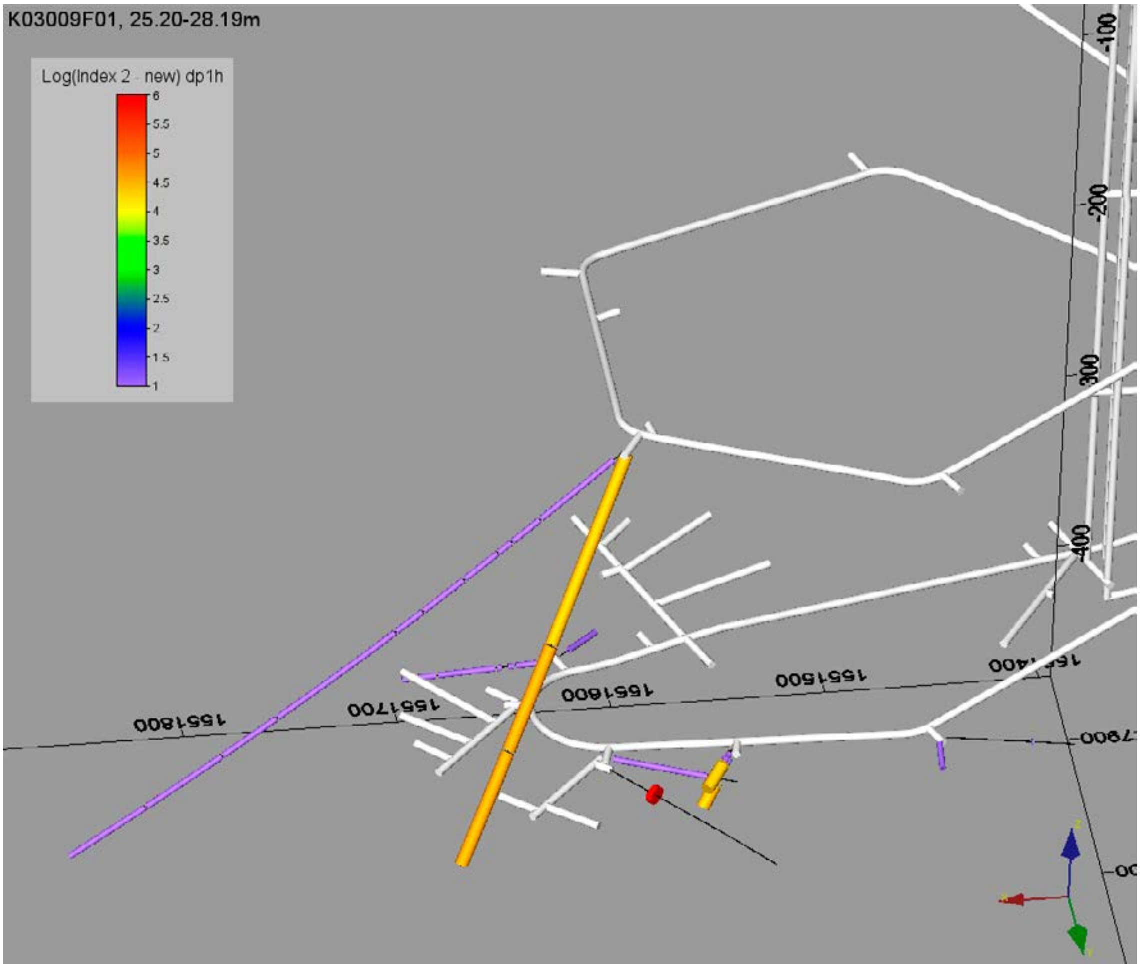

Log-Log plot: p-p@dt = 0 and derivative [kPa] vs dt [hr]
Pressure [kPa]
10000
1000
100
10
1
1E-5
1E-4
1E-3
0.01
0.1
1
10
100
Time [hr]


Semi-Log plot
Bu 25-28m
Company Svensk Kärnbränslehantering AB
Well K03009F01
Field Äspö HRL
Test Name / # DETUM1 - Stora sprickor
p [kPa]
3000
2000
1000
0
-4
-3
-2
-1
C
Superposition Time

Response matrix

A4 Responsmatris 25.2–28.19 m K03009F01											Index 2-new					
Borehole	Sec#	Secup	Seclow	PoA	Dist-ance rs	dp_{1h}	dp_p		dp_{1h}	dp_p	I2n,dp1h = dp1h/Qp*Ln(rs/r0)	Log[I2n,dp1h]	Response, dp1h	I2n,dpp = dpp/Qp*Ln(rs/r0)	Log[I2n,dpp]	Response, dpp
				(m)	(m)	(kPa)	(kPa)	Kommentar	(m)	(m)						
K03009F01:2	Q = 0.6 l /min	25.20	28.19	26.70	2.72	3 182.0	3 182.0		324.47	324.47	1.95E+07	7.3	H	1.95E+07	7.3	H
KA2050A	1	155.00	211.57	185	83.10	1.5	2.0		0.15	0.20	4.07E+04	4.6	M	5.43E+04	4.7	M
KA2050A	2	102.00	154.00	125	75.90	1.5	2.5		0.15	0.25	3.99E+04	4.6	M	6.65E+04	4.8	M
KA2050A	3	6.00	101.00	75	101.80	1.0	2.0		0.10	0.20	2.84E+04	4.5	M	5.68E+04	4.8	M
KA2051A01	1	278	319.84	290	247.80	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	2	235	277	270	230.70	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	3	204	234	214	186.50	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	4	136	203	178	162.60	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	5	120	135	130	139.90	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	6	96	119	105	134.00	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	7	76	95	83	132.70	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	8	68	75	71	133.60	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	9	51	67	60	135.40	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	10	7	50	41	140.60	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2858A	2	39.77	40.77	40	176.80	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2862A	1	0	15.98	7	133.50	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	m
KA3005A		0.00	50.03	25.02	23.30	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	1	53.01	68.95	60.98	152.80	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	2	25.51	52.01	38.76	140.30	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	3	22.51	24.51	23.51	133.30	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	4	17.01	19.51	18.26	131.20	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	5	6.51	16.01	11.26	128.70	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3110A	1	20.05	26.83	23.44	142.30	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3110A	2	6.55	19.05	12.80	135.50	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT1	1	17.00	28.76	22.88	29.20	1.5	3.0		0.15	0.31	3.11E+04	4.5	M	6.22E+04	4.8	M
KXTT1	2	15.00	16.00	15.50	32.80	1.0	2.5		0.10	0.25	2.14E+04	4.3	L	5.36E+04	4.7	M
KXTT1	3	7.50	11.50	9.50	36.50	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT1	4	3.00	6.50	4.75	39.90	0.0	0.0	Tryck ej akvifärli	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT2	1	16.55	18.30	17.43	31.00	1.0	2.5		0.10	0.25	2.11E+04	4.3	L	5.27E+04	4.7	M
KXTT2	2	14.55	15.55	15.05	32.40	1.5	2.0		0.15	0.20	3.20E+04	4.5	M	4.27E+04	4.6	M
KXTT2	3	11.55	13.55	12.55	34.00	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT2	4	7.55	10.55	9.05	36.40	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT2	5	3.05	6.55	4.80	39.50	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT5	1	10.81	25.85	18.33	29.10	1.0	2.5		0.10	0.25	2.07E+04	4.3	L	5.18E+04	4.7	M
KXTT5	2	9.61	9.81	9.71	35.70	1.0	2.0		0.10	0.20	2.20E+04	4.3	L	4.39E+04	4.6	M
KXTT5	3	6.11	8.61	7.36	37.60	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT5	4	3.11	5.11	4.11	40.30	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
HAS06		0.00	100.00		355.50	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N

Response plot



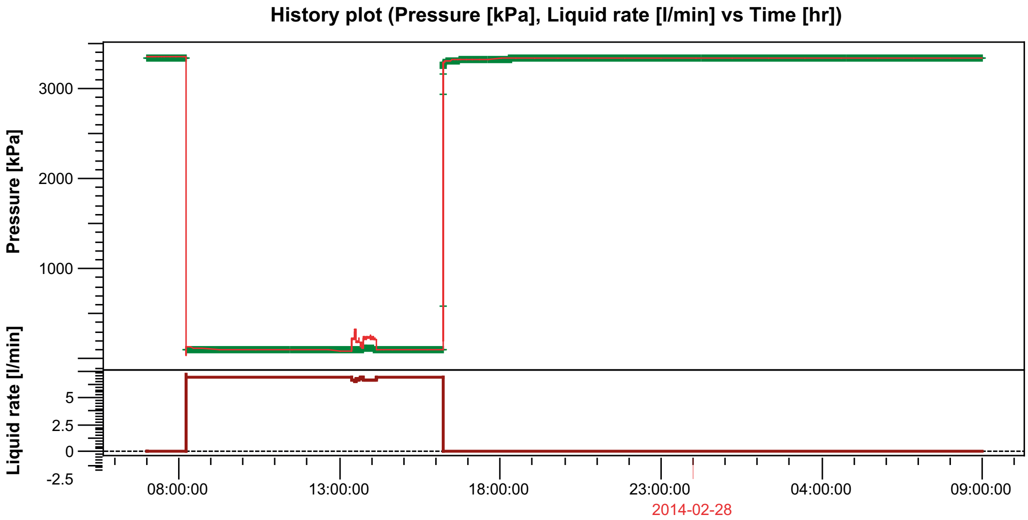
Interference test K03009F01 17.20–20.19 m

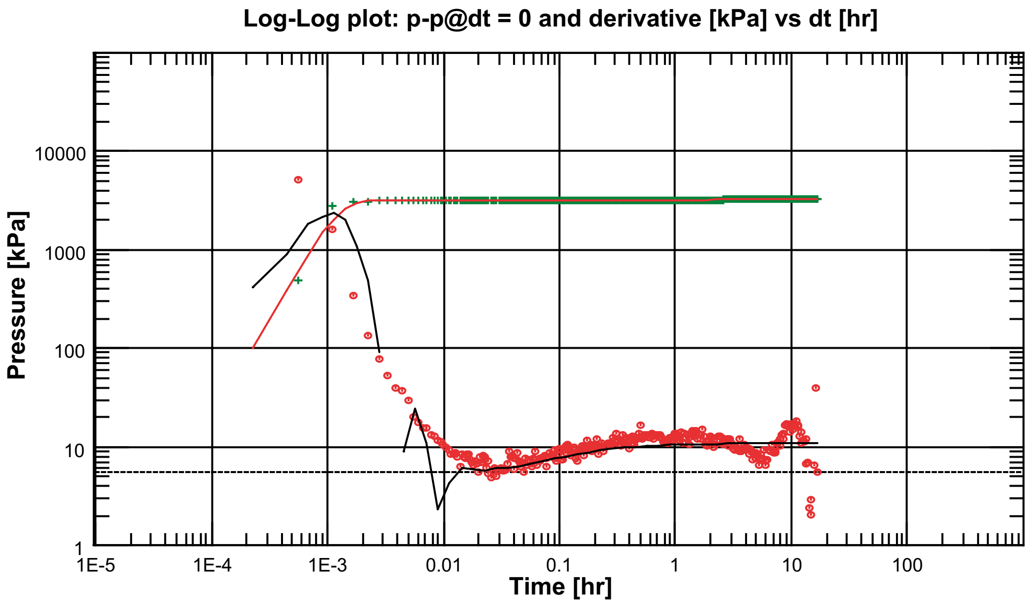
Test report

Main results	Leaky fault 17.20-20.19m reco...
Company Svensk Kärnbränslehantering AB	Field Äspö HRL
Well K03009F01	Test Name / # DETUM1 - Stora sprickor

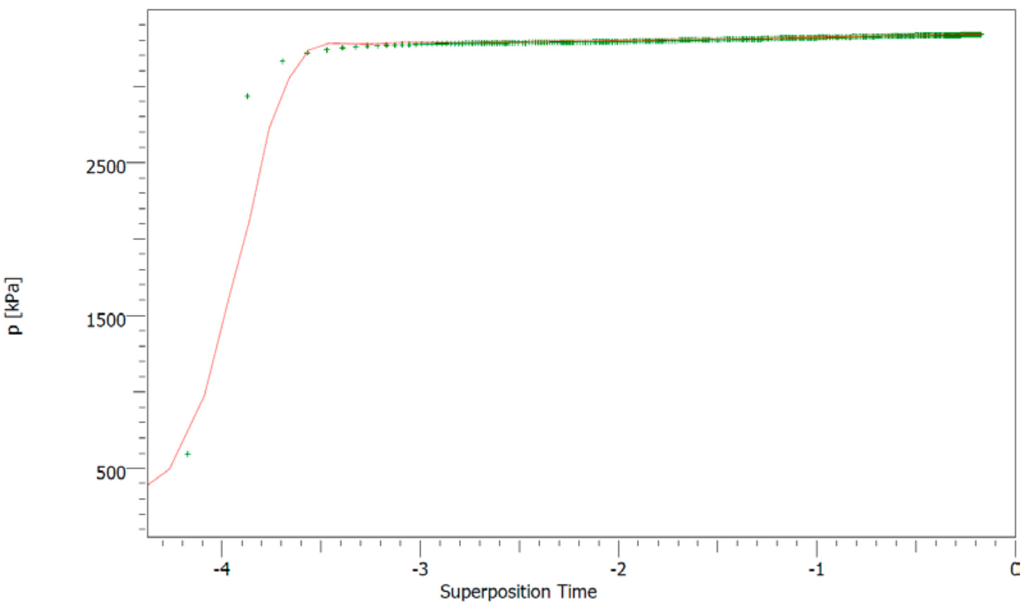
Test date / time	2014-02-27 08:13
Formation interval	17.20 - 20.19m
Perforated interval	open hole
Gauge type / #	Druck PTX 17517-1, 0-5mPa, accur:+-0.15%
Gauge depth	-399.226m RHB70
Analyzed by	Mansueto Morosini, SKB
Analysis date / time	
Field crew	Lars Andersson (SKB) & Pierre Nilsson (TEQ)
TEST TYPE	Standard
Porosity Phi (%)	5
Well Radius rw	0.038 m
Pay Zone h	3 m
Form. compr.	8.70226E-10 Pa-1
Reservoir T	15 °C
Reservoir P	3300 kPa
Fluid type	Water
Volume Factor B	0.998534 m3/stm3
Viscosity	0.00124603 Pa.sec
Total Compr. ct	1.36162E-9 Pa-1
Selected Model	
Model Option	Standard Model
Well	Vertical, Changing Storage (Hegeman)
Reservoir	Homogeneous
Boundary	Leaky fault
Main Model Parameters	
TMatch	1.9E+6 [hr]-1
PMatch	0.091 [kPa]-1
C	1.97E-11 m3/Pa
Total Skin	282
T	1.64E-5 m2/s
K	5.46E-6 m/s
Pi	3345.52 kPa
Model Parameters	
Well & Wellbore parameters (K03009F01)	
C	1.97E-11 m3/Pa
Ci/Cf	58.4
delta_t	0.0032 hr
Skin	282
Reservoir & Boundary parameters	
Pi	3345.52 kPa
T	1.64E-5 m2/s
K	5.46E-6 m/s
L	51.5 m
Leakage	1E-3
Derived & Secondary Parameters	
P @ dt=0	103.598 kPa
Delta P (Total Skin)	3099.2 kPa
Delta P Ratio (Total Skin)	0.957214 Fraction

Ecrin v4.30.04 K03009F01 17-20m 2014-04-17 Page 1/4





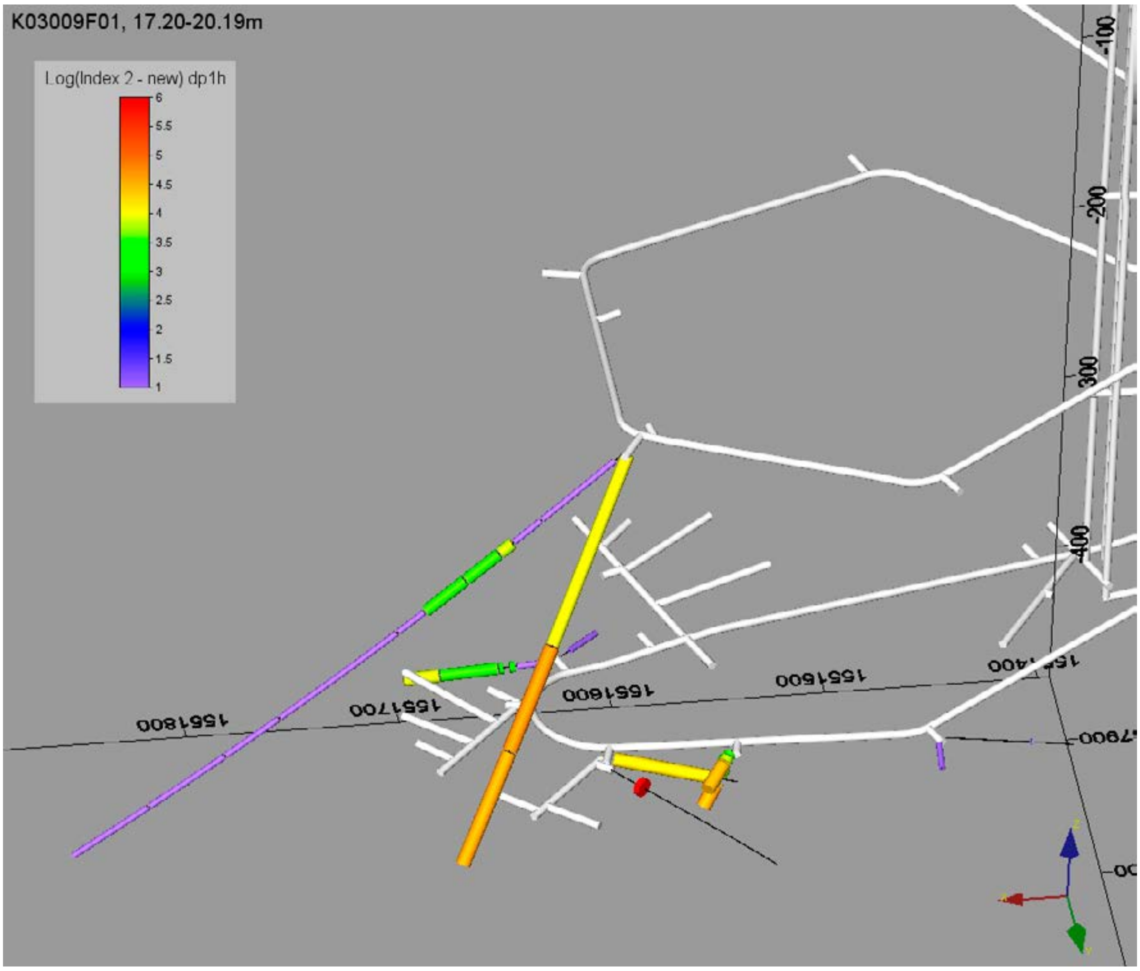
Semi-Log plot	Bu Leaky fault 17.20-20.19m
Company Svensk Kärnbränslehantering AB Well K03009F01	Field Äspö HRL Test Name / # DETUM1 - Stora sprickor



Response matrix

A5 Responsmatris 17.2–20.19 m K03009F01											Index 2-new					
BOREHOLE	**Sec#**	**Secup**	**Seclow**	**PoA**	**Dis-tance rs**	**dp_{1h}**	**dp_p**		**dp_{1h}**	**dp_p**	**I2n,dp1h = dp1h/Qp*Ln(rs/r0)**	**Log[I2n,dp1h]**	**Response, dp1h**	**I2n,dpp = dpp/Qp*Ln(rs/r0)**	**Log[I2n,dpp]**	**Response, dpp**
		(m)	**(m)**	**(m)**	**(m)**	**(kPa)**	**(kPa)**	**Kommentar**	**(m)**	**(m)**						
K03009F01:2	Q = 6.9 l/in	17.20	20.19	18.70	2.72	3220.0	3220.0		328.35	328.35	1.97E+06	6.3	H	1.97E+06	6.3	H
KA2050A	1	155.00	211.57	185	76.60	15.0	31.0		1.53	3.16	3.98E+04	4.6	M	8.23E+04	4.9	M
KA2050A	2	102.00	154.00	125	68.30	21.0	40.0		2.14	4.08	5.43E+04	4.7	M	1.03E+05	5.0	M
KA2050A	3	6.00	101.00	75	96.00	3.5	20.0		0.36	2.04	9.77E+03	4.0	L	5.58E+04	4.7	M
KA2051A01	1	278	319.84	290	241.40	0.0	0.0	Svag Indikat	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	2	235	277	270	224.20		5.0	Lagg 60 min	0.00	0.51	0.00E+00	1.0	N	1.66E+04	4.2	L
KA2051A01	3	204	234	214	179.50		4.5	Lagg 60 min	0.00	0.46	0.00E+00	1.0	N	1.43E+04	4.2	L
KA2051A01	4	136	203	178	155.30		8.0	Lagg 60 min	0.00	0.82	0.00E+00	1.0	N	2.47E+04	4.4	L
KA2051A01	5	120	135	130	132.60		11.0	Lagg 30 min	0.00	1.12	0.00E+00	1.0	N	3.29E+04	4.5	M
KA2051A01	6	96	119	105	127.00	1.0	14.0	Lagg 15 min	0.10	1.43	2.96E+03	3.5	L	4.15E+04	4.6	M
KA2051A01	7	76	95	83	126.20	1.0	16.0	Lagg 30 min	0.10	1.63	2.96E+03	3.5	L	4.73E+04	4.7	M
KA2051A01	8	68	75	71	127.40	2.0	19.0	Lagg 25 min	0.20	1.94	5.93E+03	3.8	L	5.63E+04	4.8	M
KA2051A01	9	51	67	60	129.60		9.0	Lagg 30 min	0.00	0.92	0.00E+00	1.0	N	2.68E+04	4.4	L
KA2051A01	10	7	50	41	135.40		5.0		0.00	0.51	0.00E+00	1.0	N	1.50E+04	4.2	L
KA2858A	2	39.77	40.77	40	182.10	0.0	0.0	Svag Indikat	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2862A	1	0	15.98	7	139.20	0.0	0.0	Svag Indikat	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3005A		0.00	50.03	25.02	21.10	8.0	18.0		0.82	1.84	1.49E+04	4.2	L	3.36E+04	4.5	M
KA3105A	1	53.01	68.95	60.98	145.00	2.5	18.0	Lagg 10 min	0.25	1.84	7.61E+03	3.9	L	5.48E+04	4.7	M
KA3105A	2	25.51	52.01	38.76	132.60	1.0	5.5	Lagg 10 min	0.10	0.56	2.99E+03	3.5	L	1.64E+04	4.2	L
KA3105A	3	22.51	24.51	23.51	125.70	0.5	4.0		0.05	0.41	1.48E+03	3.2	L	1.18E+04	4.1	L
KA3105A	4	17.01	19.51	18.26	123.70	0.5	4.0		0.05	0.41	1.47E+03	3.2	L	1.18E+04	4.1	L
KA3105A	5	6.51	16.01	11.26	121.40	0.0	0.0	Svag Indikat	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3110A	1	20.05	26.83	23.44	136.20	0.0	0.0	Svag Indikat	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3110A	2	6.55	19.05	12.80	129.10	0.0	0.0	Svag Indikat	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT1	1	17.00	28.76	22.88	33.40	17.0	32.0		1.73	3.26	3.65E+04	4.6	M	6.87E+04	4.8	M
KXTT1	2	15.00	16.00	15.50	36.50	11.0	23.0		1.12	2.35	2.42E+04	4.4	L	5.06E+04	4.7	M
KXTT1	3	7.50	11.50	9.50	39.90	2.0	5.5		0.20	0.56	4.51E+03	3.7	L	1.24E+04	4.1	L
KXTT1	4	3.00	6.50	4.75	43.00			Tryck ej akvifärlikt								
KXTT2	1	16.55	18.30	17.43	34.40	12.0	26.0		1.22	2.65	2.60E+04	4.4	L	5.63E+04	4.8	M
KXTT2	2	14.55	15.55	15.05	35.70	9.0	23.0		0.92	2.35	1.97E+04	4.3	L	5.03E+04	4.7	L
KXTT2	3	11.55	13.55	12.55	37.10	2.5	7.0		0.25	0.71	5.53E+03	3.7	L	1.55E+04	4.2	L
KXTT2	4	7.55	10.55	9.05	39.30	1.0	5.0		0.10	0.51	2.25E+03	3.4	L	1.12E+04	4.1	L
KXTT2	5	3.05	6.55	4.80	42.20	1.0	4.0		0.10	0.41	2.29E+03	3.4	L	9.16E+03	4.0	L
KXTT5	1	10.81	25.85	18.33	34.20	12.0	27.0		1.22	2.75	2.59E+04	4.4	L	5.83E+04	4.8	M
KXTT5	2	9.61	9.81	9.71	39.50	11.0	24.0		1.12	2.45	2.47E+04	4.4	L	5.40E+04	4.7	M
KXTT5	3	6.11	8.61	7.36	41.10	3.0	9.0		0.31	0.92	6.82E+03	3.8	L	2.05E+04	4.3	L
KXTT5	4	3.11	5.11	4.11	43.50	1.5	4.0		0.15	0.41	3.46E+03	3.5	L	9.23E+03	4.0	L
HAS06		0.00	100.00		355.40	0.0	0.0	Svag Indikat	0.00	0.00	0.00E+00	1.0	L	0.00E+00	1.0	N

Response plot



Interference test K03009F01 14.20–17.19 m

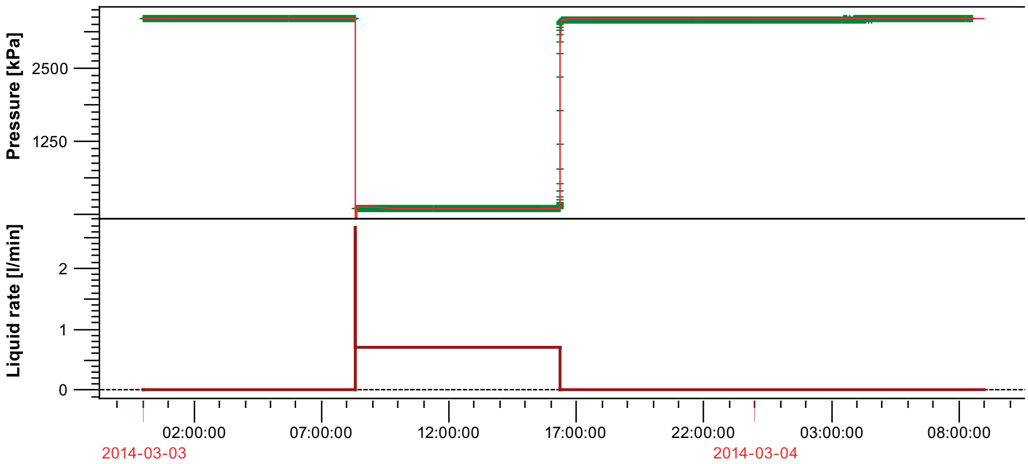
Test report

Main results	IARF 14.20-17.19m
Company Svensk Kärnbränslehantering AB Well Tested well	Field Äspö HRL Test Name / # DETUM1 - Stora sprickor

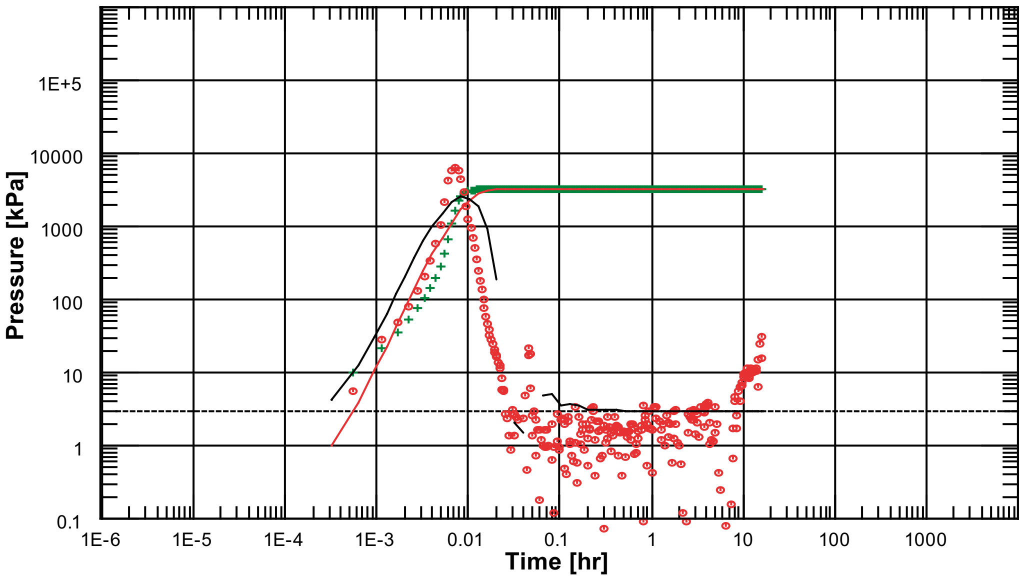
Test date / time	2014-02-19 08:00
Formation interval	14.20 - 17.19m)
Perforated interval	open hole
Gauge type / #	Druck PTX 7517-1, 0-5MPa, accur:+-0.15%
Gauge depth	-399,226m RHB70
Analyzed by	Mansueto Morosini, SKB
Analysis date / time	
Field crew	Lars Andersson (SKB) & Pierre Nilsson (TEQ)
TEST TYPE	Standard
Porosity Phi (%)	5
Well Radius rw	0.038 m
Pay Zone h	3 m
Form. compr.	8.70226E-10 Pa-1
Reservoir T	15 °C
Reservoir P	3300 kPa
Fluid type	Water
Volume Factor B	0.998534 m3/stm3
Viscosity	0.00124603 Pa.sec
Total Compr. ct	1.36162E-9 Pa-1
Selected Model	
Model Option	Standard Model
Well	Vertical, Changing Storage (Hegeman)
Reservoir	Homogeneous
Boundary	Infinite
Main Model Parameters	
TMatch	3.49E+5 [hr]-1
PMatch	0.169 [kPa]-1
C	2.03E-11 m3/Pa
Total Skin	538
T	3.09E-6 m2/s
K	1.03E-6 m/s
Pi	3349.3 kPa
Model Parameters	
Well & Wellbore parameters (Tested well)	
C	2.03E-11 m3/Pa
Ci/Cf	1000
delta_t	0.0252 hr
Skin	538
Reservoir & Boundary parameters	
Pi	3349.3 kPa
T	3.09E-6 m2/s
K	1.03E-6 m/s
Derived & Secondary Parameters	
P @ dt=0	110.775 kPa
Rinv	529 m
Test. Vol.	0.132059 MMm3
Delta P (Total Skin)	3185.11 kPa
Delta P Ratio (Total Skin)	0.983862 Fraction

Ecrin v4.30.04 K03009F01 14-17m 2014-04-17 Page 1/1

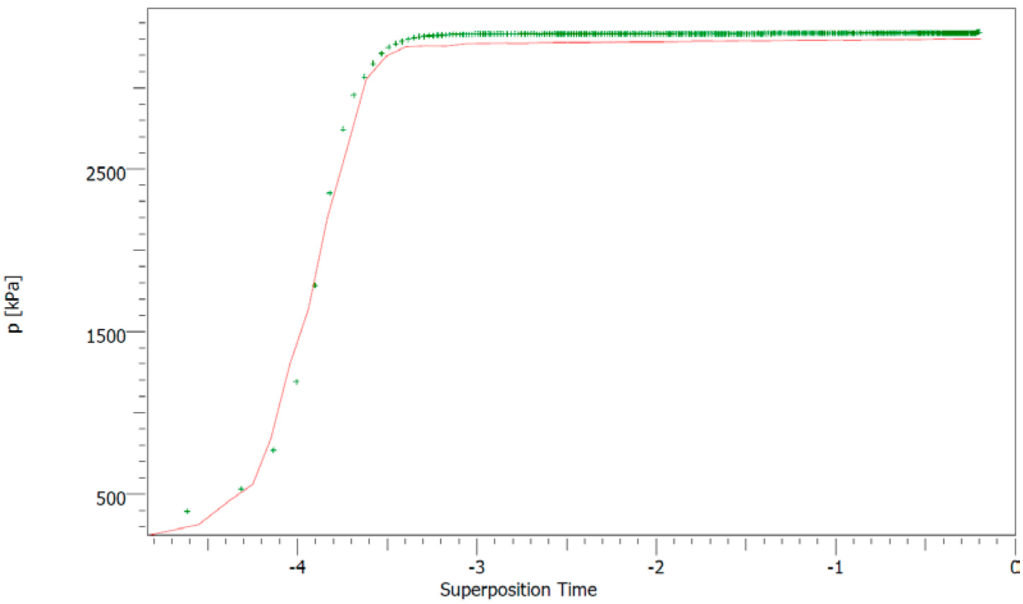
History plot (Pressure [kPa], Liquid rate [l/min] vs Time [hr])



Log-Log plot: p-p@dt = 0 and derivative [kPa] vs dt [hr]



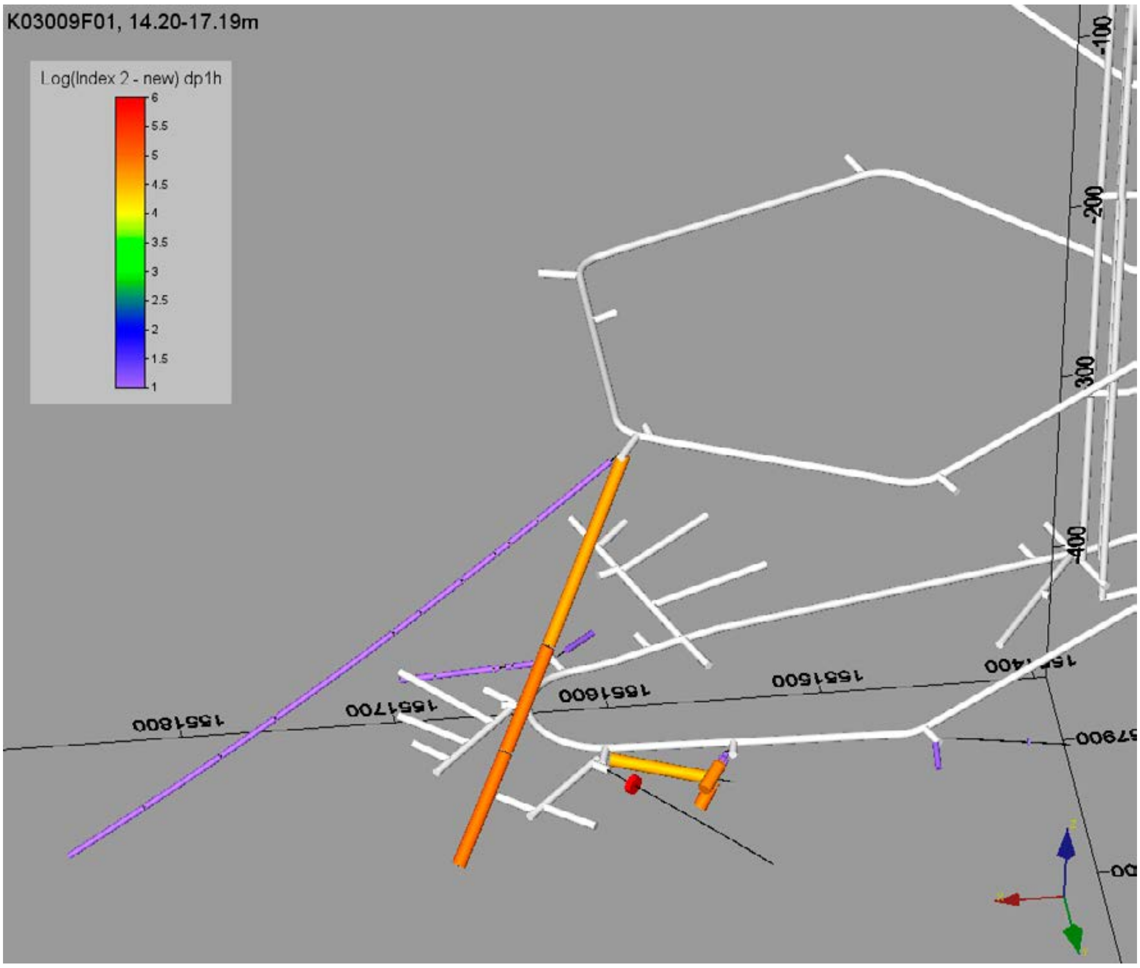
Semi-Log plot	Bu
Company Svensk Kärnbränslehantering AB Well Tested well	Field Äspö HRL Test Name / # DETUM1 - Stora sprickor



Response matrix

A6 Responsmatris 14.2–17.19 m K03009F01											Index 2-new					
Borehole	Sec#	Secup	Seclow	PoA	Dis-tance rs	dp_{1h}	dp_p		dp_{1h}	dp_p	I2n,dp1h = dp1h/Qp*Ln(rs/r0)	Log[I2n,dp1h]	Response, dp1h	I2n,dpp = dpp/Qp*Ln(rs/r0)	Log[I2n,dpp]	Response, dpp
		(m)	(m)	(m)	(m)	(kPa)	(kPa)	Kommentar	(m)	(m)						
K03009F01:2	Q = 0.75 l/min	14.20	17.19	15.70	2.72	3240.0	3240.0		330.39	330.39	3.60E+07	7.6	H	3.60E+07	7.6	H
KA2050A	1	155.00	211.57	185	74.30	2.0	4.5		0.20	0.46	9.58E+04	5.0	M	2.16E+05	5.3	M
KA2050A	2	102.00	154.00	125	65.50	2.0	5.5		0.20	0.56	9.30E+04	5.0	M	2.56E+05	5.4	M
KA2050A	3	6.00	101.00	75	93.90	1.0	3.0		0.10	0.31	5.05E+04	4.7	M	1.52E+05	5.2	M
KA2051A01	1	278	319.84	290	239.10			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	2	235	277	270	221.70		0.5	Svag indikatio	0.00	0.05	0.00E+00	1.0	N	3.00E+04	4.5	M
KA2051A01	3	204	234	214	176.90			Svag indikatio	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	4	136	203	178	152.60			Svag indikatio	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2051A01	5	120	135	130	129.90		0.5	Svag indikatio	0.00	0.05	0.00E+00	1.0	N	2.71E+04	4.4	L
KA2051A01	6	96	119	105	124.40		1.0	Svag indikatio	0.00	0.10	0.00E+00	1.0	N	5.37E+04	4.7	M
KA2051A01	7	76	95	83	123.80		1.0	Svag indikatio	0.00	0.10	0.00E+00	1.0	N	5.36E+04	4.7	M
KA2051A01	8	68	75	71	125.10		1.0	Svag indikatio	0.00	0.10	0.00E+00	1.0	N	5.37E+04	4.7	M
KA2051A01	9	51	67	60	127.40		1.0	Svag indikatio	0.00	0.10	0.00E+00	1.0	N	5.39E+04	4.7	M
KA2051A01	10	7	50	41	133.50			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2858A	2	39.77	40.77	40	184.20			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2862A	1	0	15.98	7	141.40			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3005A		0.00	50.03	25.02	21.00	1.0	3.0		0.10	0.31	3.39E+04	4.5	M	1.02E+05	5.0	M
KA3105A	1	53.01	68.95	60.98	142.00		1.5		0.00	0.15	0.00E+00	1.0	N	8.27E+04	4.9	M
KA3105A	2	25.51	52.01	38.76	129.70			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	3	22.51	24.51	23.51	122.90			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	4	17.01	19.51	18.26	121.00			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	5	6.51	16.01	11.26	118.70			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3110A	1	20.05	26.83	23.44	134.00			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3110A	2	6.55	19.05	12.80	126.80			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT1	1	17.00	28.76	22.88	35.30	2.0	4.0		0.20	0.41	7.93E+04	4.9	M	1.59E+05	5.2	M
KXTT1	2	15.00	16.00	15.50	38.30	1.5	3.5		0.15	0.36	6.08E+04	4.8	M	1.42E+05	5.2	M
KXTT1	3	7.50	11.50	9.50	41.50			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT1	4	3.00	6.50	4.75	44.50			Tryck ej akvifär	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT2	1	16.55	18.30	17.43	36.10	2.0	3.5		0.20	0.36	7.98E+04	4.9	M	1.40E+05	5.1	M
KXTT2	2	14.55	15.55	15.05	37.30	1.0	3.0		0.10	0.31	4.03E+04	4.6	M	1.21E+05	5.1	M
KXTT2	3	11.55	13.55	12.55	38.60			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT2	4	7.55	10.55	9.05	40.70			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT2	5	3.05	6.55	4.80	43.50			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT5	1	10.81	25.85	18.33	36.30	1.5	3.5		0.15	0.36	5.99E+04	4.8	M	1.40E+05	5.1	M
KXTT5	2	9.61	9.81	9.71	41.20	1.5	3.5		0.15	0.36	6.20E+04	4.8	M	1.45E+05	5.2	M
KXTT5	3	6.11	8.61	7.36	42.80			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT5	4	3.11	5.11	4.11	45.00			Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
HAS06		0.00	100.00		355.30	0.0	0.0	Ingen respons	0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N

Response plot



Appendix 7

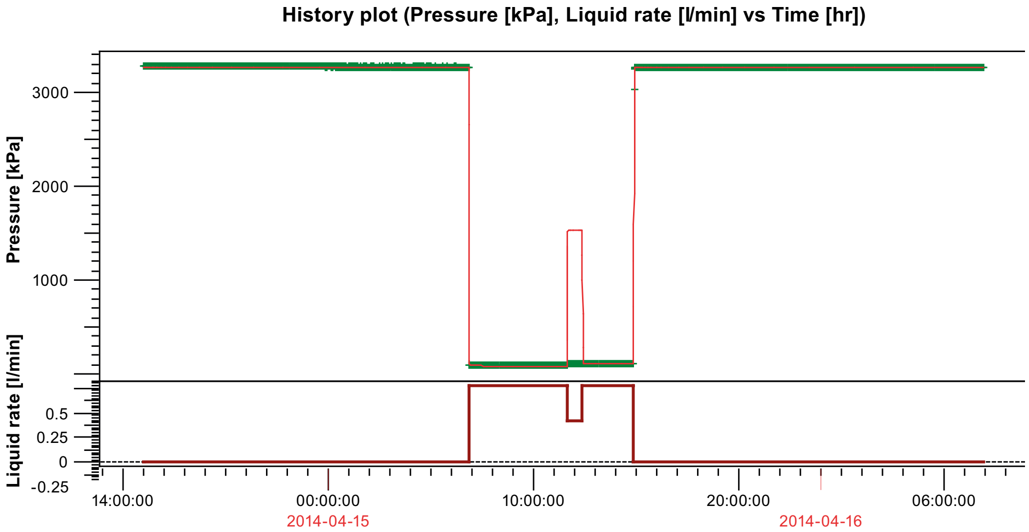
Interference test K03009F01 30.00–33.99 m

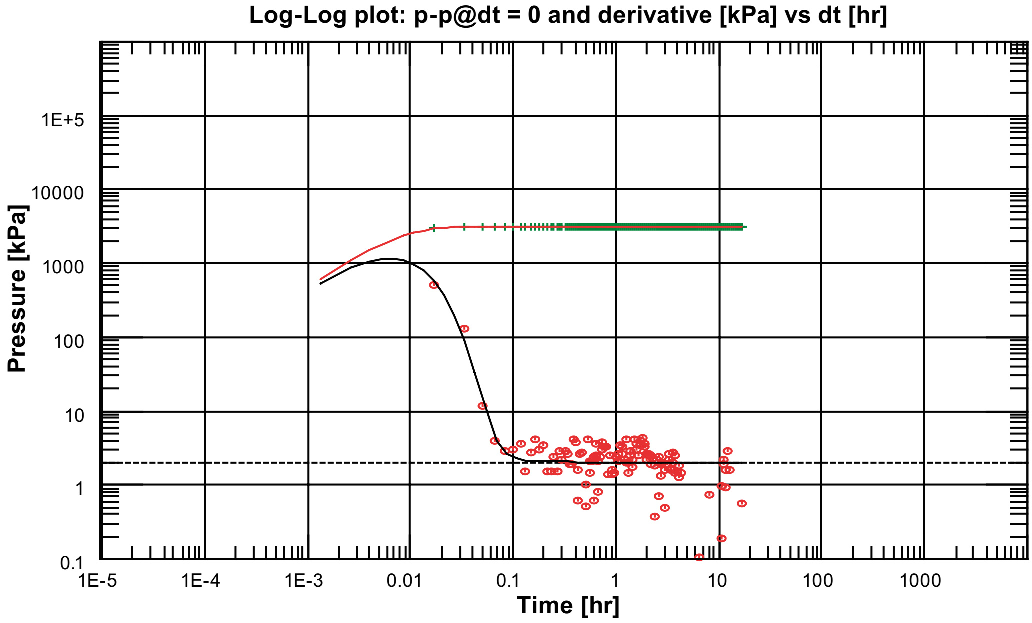
Test report

	Main results	Analysis 1
SKB	Company Svensk Kärnbränslehantering AB Well K03009F01	Field Äspö HRL Test Name / # DETUM1 - Stora sprickor

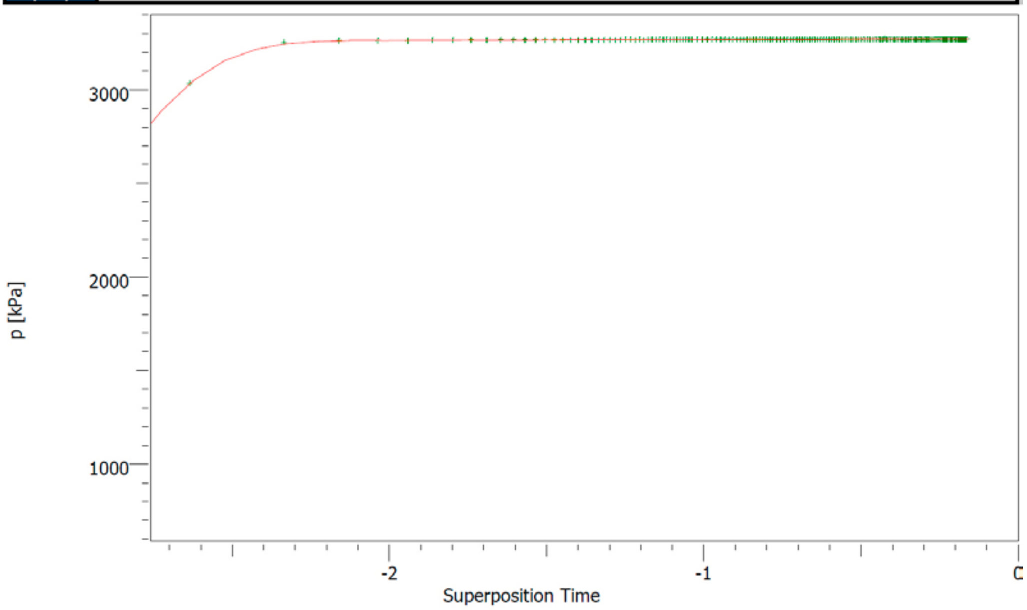
Test date / time	2014-04-15 07:52
Formation interval	30.00 - 33.99m
Perforated interval	open hole
Gauge type / #	PTX 7517-1 0-5MPa a, Accur: +-0.15%
Gauge depth	-399.226m RHB70
Analyzed by	Mansueto Morosini, SKB
Analysis date / time	
Field crew	Lars Andersson (SKB) & Pierre Nilsson (TEQ)
TEST TYPE	Standard
Porosity Phi (%)	5
Well Radius rw	0.038 m
Pay Zone h	4 m
Form. compr.	8.70226E-10 Pa-1
Reservoir T	15 °C
Reservoir P	3300 kPa
Fluid type	Water
Volume Factor B	0.998534 m3/stm3
Viscosity	0.00124603 Pa.sec
Total Compr. ct	1.36162E-9 Pa-1
Selected Model	
Model Option	Standard Model
Well	Vertical
Reservoir	Homogeneous
Boundary	Infinite
Main Model Parameters	
TMatch	1.27E+5 [hr]-1
PMatch	0.255 [kPa]-1
C	9.31E-11 m3/Pa
Total Skin	800
T	5.18E-6 m2/s
K	1.3E-6 m/s
Pi	3273.11 kPa
Model Parameters	
Well & Wellbore parameters (K03009F01)	
C	9.31E-11 m3/Pa
Skin	800
Reservoir & Boundary parameters	
Pi	3273.11 kPa
T	5.18E-6 m2/s
K	1.3E-6 m/s
Derived & Secondary Parameters	
P @ dt=0	106.583 kPa
Rinv	609 m
Test. Vol.	0.233109 MMm3
Delta P (Total Skin)	3130.97 kPa
Delta P Ratio (Total Skin)	0.988997 Fraction

Ecrin v4.30.04 K03009F01 30 - 34m 2014-04-17 Page 1/1





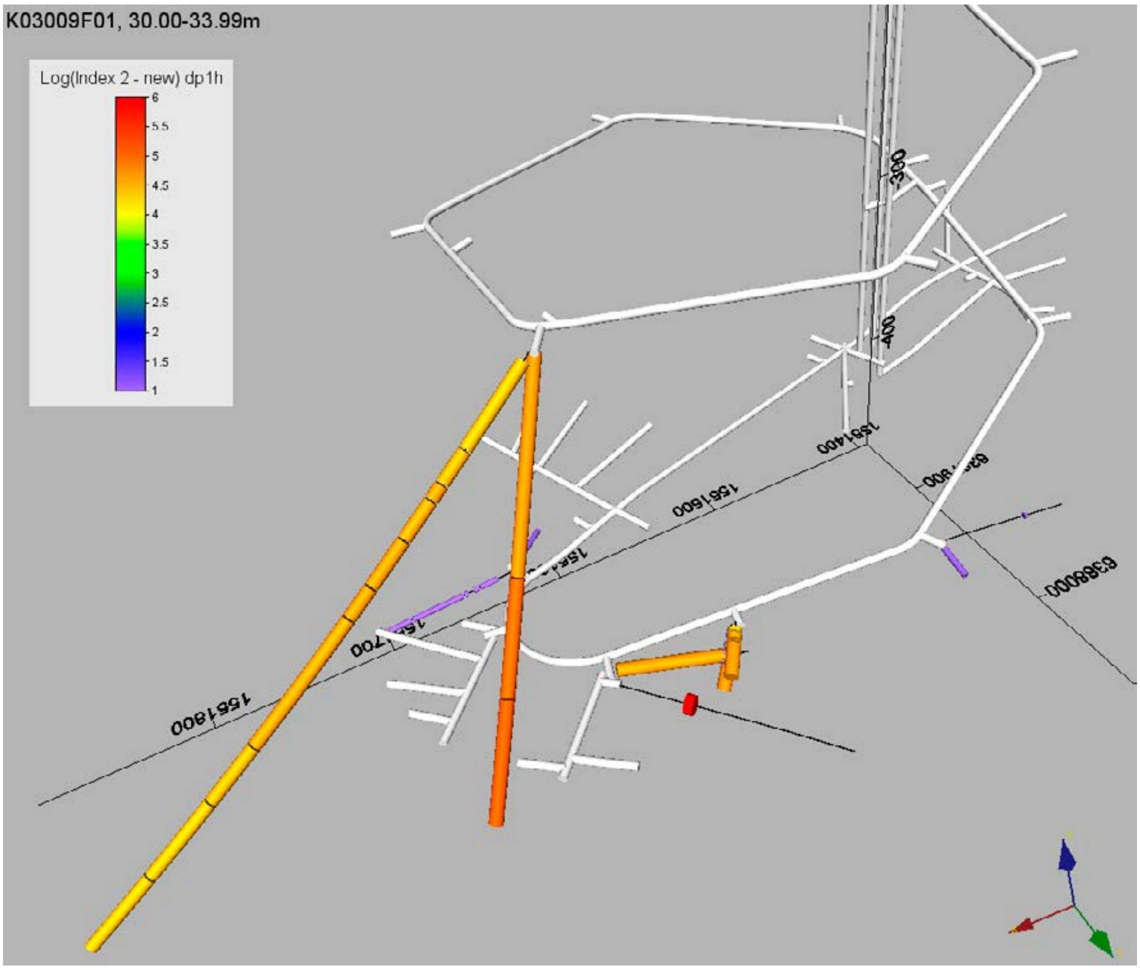
Semi-Log plot	Bu 30-34m
Company Svensk Kärnbränslehantering AB Well K03009F01	Field Äspö HRL Test Name / # DETUM1 - Stora sprickor



Response matrix

A7 Responsmatris 30.00–33.99 m K03009F01											Index 2-new					
Borehole	Sec#	Secup	Seclow	PoA	Dis-tance rs	dp_{1h}	dp_p	Kom-mentar	dp_{1h}	dp_p	I2n,dp1h = dp1h/Qp*Ln(rs/r0)	Log[I2n,dp1h]	Response, dp1h	I2n,dpp = dpp/Qp*Ln(rs/r0)	Log[I2n,dpp]	Response, dpp
		(m)	(m)	(m)	(m)	(kPa)	(kPa)		(m)	(m)						
K03009F01	Q = 0.8 L/min	30.00	33.99	32.00	2.72	3 175.0	3 175.0		323.76	323.76	3.53E+07	7.5	H	3.53E+07	7.5	H
KA2050A	1	155.00	211.57	185	83.10	2.5	5.5		0.25	0.56	1.23E+05	5.1	M	3.19E+05	5.5	M
KA2050A	2	102.00	154.00	125	75.90	2.0	7.0		0.20	0.71	9.63E+04	5.0	M	3.76E+05	5.6	M
KA2050A	3	6.00	101.00	75	101.80	1.0	4.5		0.10	0.46	5.14E+04	4.7	M	2.16E+05	5.3	M
KA2051A01	1	278	319.84	290	247.80	0.4	2.0		0.04	0.20	2.45E+04	4.4	L	1.26E+05	5.1	M
KA2051A01	2	235	277	270	230.70	0.4	2.0		0.04	0.20	2.42E+04	4.4	L	1.25E+05	5.1	M
KA2051A01	3	204	234	214	186.50	0.5	2.5		0.05	0.25	2.91E+04	4.5	M	1.49E+05	5.2	M
KA2051A01	4	136	203	178	162.60	0.7	3.0		0.07	0.31	3.96E+04	4.6	M	1.73E+05	5.2	M
KA2051A01	5	120	135	130	139.90	0.8	3.6		0.08	0.37	4.40E+04	4.6	M	1.95E+05	5.3	M
KA2051A01	6	96	119	105	134.00	0.8	3.5		0.08	0.36	4.36E+04	4.6	M	1.81E+05	5.3	M
KA2051A01	7	76	95	83	132.70	0.7	3.5		0.07	0.36	3.81E+04	4.6	M	1.72E+05	5.2	M
KA2051A01	8	68	75	71	133.60	0.8	3.5		0.08	0.36	4.36E+04	4.6	M	1.66E+05	5.2	M
KA2051A01	9	51	67	60	135.40	0.6	3.0		0.06	0.31	3.28E+04	4.5	M	1.37E+05	5.1	M
KA2051A01	10	7	50	41	140.60	0.5	2.6		0.05	0.27	2.75E+04	4.4	L	1.07E+05	5.0	M
KA2858A	2	39.77	40.77	40	176.80	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA2862A	1	0	15.98	7	133.50	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3005A	1	0.00	50.03	25.02	23.30	1.2	4.0		0.12	0.41	4.20E+04	4.6	M	1.43E+05	5.2	M
KA3105A	1	53.01	68.95	60.98	152.80	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	2	25.51	52.01	38.76	140.30	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	3	22.51	24.51	23.51	133.30	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	4	17.01	19.51	18.26	131.20	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3105A	5	6.51	16.01	11.26	128.70	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3110A	1	20.05	26.83	23.44	142.30	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KA3110A	2	6.55	19.05	12.80	135.50	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT1	1	17.00	28.76	22.88	29.20	1.5	5.0		0.15	0.51	5.63E+04	4.8	M	1.74E+05	5.2	M
KXTT1	2	15.00	16.00	15.50	32.80	1.2	4.0		0.12	0.41	4.66E+04	4.7	M	1.22E+05	5.1	M
KXTT1	3	7.50	11.50	9.50	36.50	0.7	2.0		0.07	0.20	2.80E+04	4.4	L	5.01E+04	4.7	M
KXTT1	4	3.00	6.50	4.75	39.90	0.0	0.0		0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N
KXTT2	1	16.55	18.30	17.43	31.00	0.0	5.0		0.00	0.51	0.00E+00	1.0	N	1.59E+05	5.2	M
KXTT2	2	14.55	15.55	15.05	32.40	0.0	4.0		0.00	0.41	0.00E+00	1.0	N	1.21E+05	5.1	M
KXTT2	3	11.55	13.55	12.55	34.00	0.0	1.5		0.00	0.15	0.00E+00	1.0	N	4.22E+04	4.6	M
KXTT2	4	7.55	10.55	9.05	36.40	0.0	2.0		0.00	0.20	0.00E+00	1.0	N	4.90E+04	4.7	M
KXTT2	5	3.05	6.55	4.80	39.50	0.0	1.5		0.00	0.15	0.00E+00	1.0	N	2.62E+04	4.4	M
KXTT5	1	10.81	25.85	18.33	29.10	1.2	5.0		0.12	0.51	4.50E+04	4.7	M	1.62E+05	5.2	M
KXTT5	2	9.61	9.81	9.71	35.70	1.0	4.0		0.10	0.41	3.98E+04	4.6	M	1.01E+05	5.0	M
KXTT5	3	6.11	8.61	7.36	37.60	0.9	2.5		0.09	0.25	3.63E+04	4.6	M	5.55E+04	4.7	M
KXTT5	4	3.11	5.11	4.11	40.30	0.5	1.5		0.05	0.15	2.06E+04	4.3	L	2.36E+04	4.4	M
HAS06		0.00	100.00		355.50				0.00	0.00	0.00E+00	1.0	N	0.00E+00	1.0	N

Response plot



Arkitektkopia AB, Bromma, 2018

SKB is responsible for managing spent nuclear fuel and radioactive waste produced by the Swedish nuclear power plants such that man and the environment are protected in the near and distant future.

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