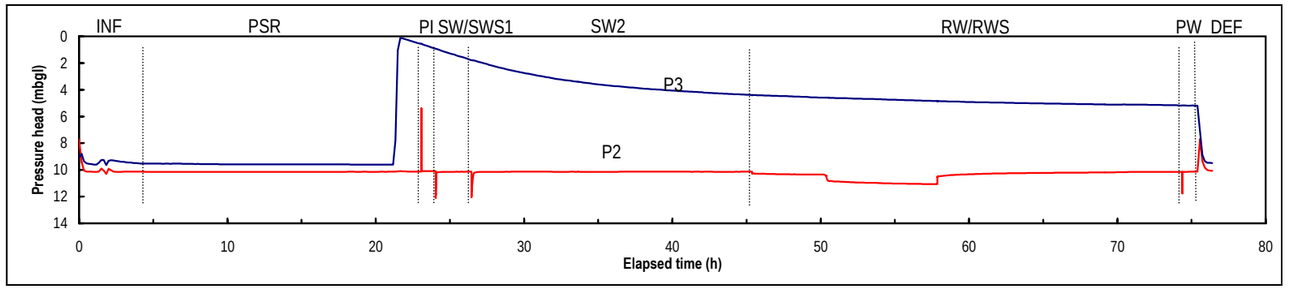
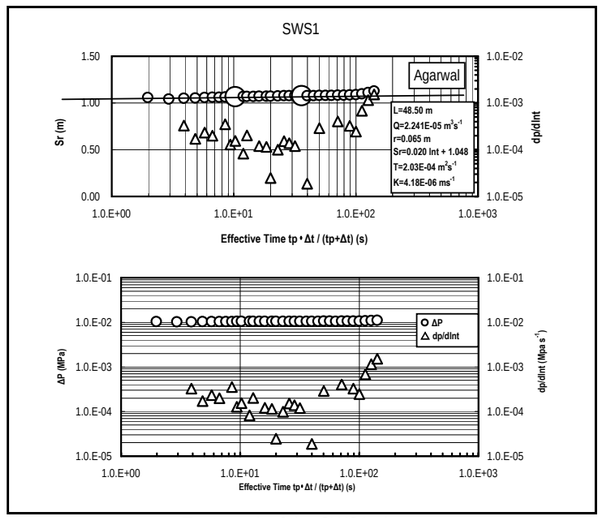
Appendix II

Results of hydraulic test estimation in MSB boreholes

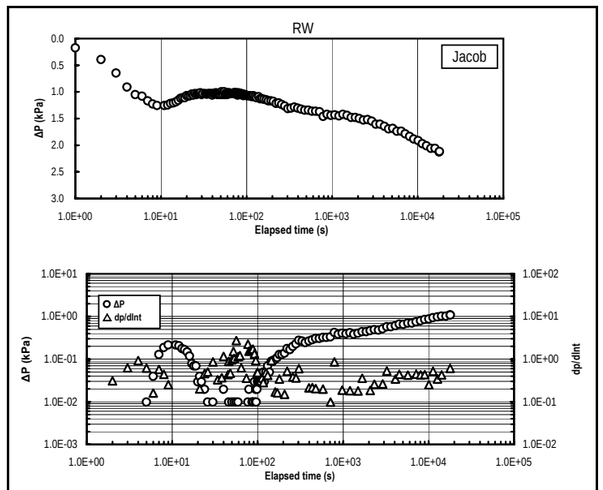
Result of Hydraulic Test MSB-2 No.1 (19.00-67.50 mabh)



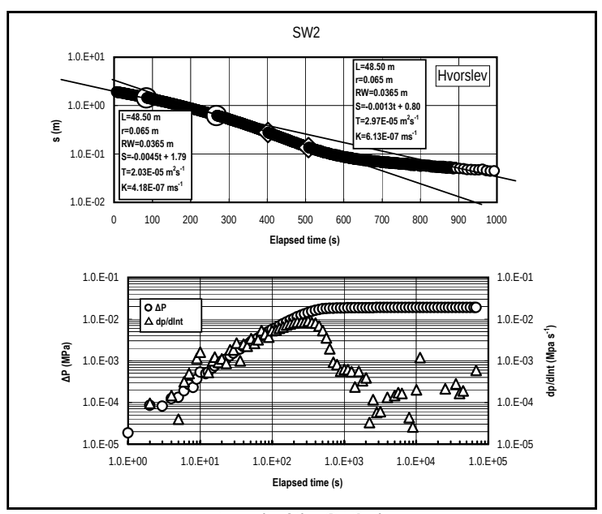
Pressure profile



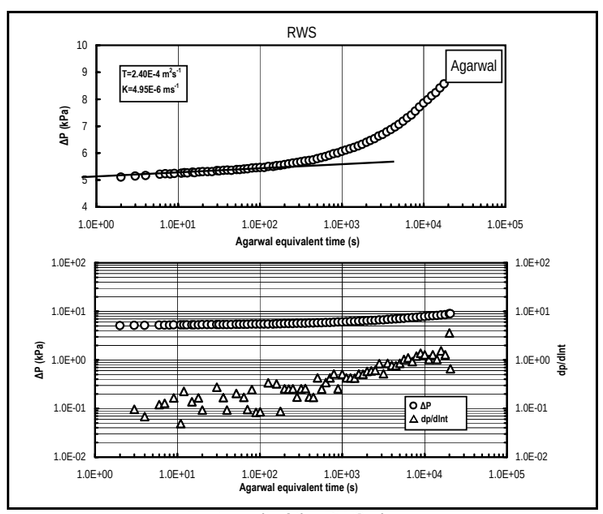
Test result of the SWS1 phase



Test result of the RW phase



Test result of the SW2 phase



Test result of the RWS phase

Summary of Hydraulic Test No.1

Start	15 June 2002		End	18 June 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-4	
Packer Configuration	~~Single~~ / Double		Engineer	Ibara (TKS co.,Ltd)	
Elevation of GL.	198.488	X-coordinates	-69069.074	Y-coordinates	6448.577

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	19.00	19.00	Borehole radius (m)	0.0650
Mid	43.25	43.25	Tubing radius (m)	0.0365
Bottom	67.50	67.50	Rod radius (m)	0.0179
Transducer depth	16.74	16.74	Interval length (m)	48.50
Borehole depth	84.00	84.00	Interval volume (m^3)	0.643

Test summary

Sequence: INF-PSR-PI-SW1-SWS1-SW2-RW1-RW2-RWS-PW-DEF

Objectives

T, K, S, Ss, H and M for the main part of the Akeyo Formation

Geology of the test interval

Tuffaceous sandstone and mudstone

Core losses:60.70-61.30 mabh, 62.15-62.50 mabh

Test Results

Best estimation : RWS

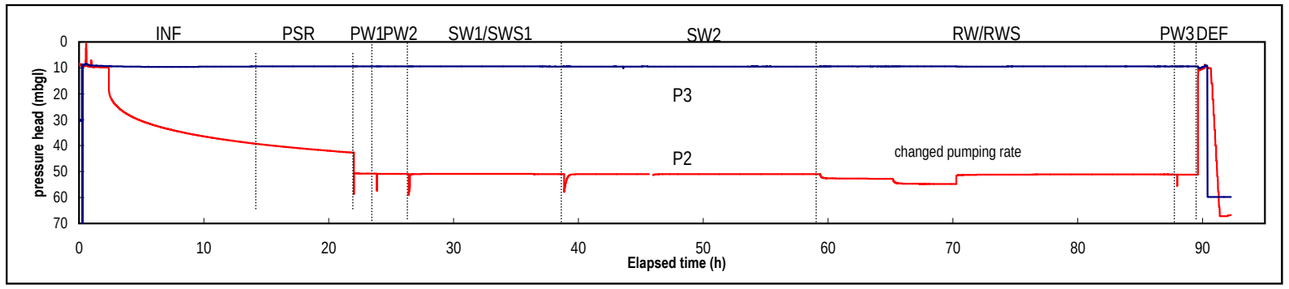
T (m^2s^{-1}) =	2.40E-04	S =	-
K (ms^{-1}) =	4.95E-06	Ss (m^{-1}) =	-
Flow Model :	Well with wellbore storage and skin in a composite? with Infinite Lateral Extent	H (mbgl) =	9.5
		Boundary :	closed boundary?

Comments

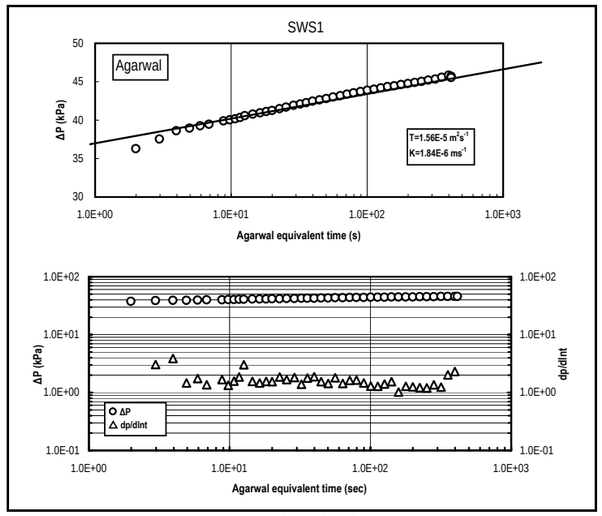
This test was conducted in the main part of the Akeyo Formation after drilling to the Toki Lignite-bearing Formation (84 mabh). The packer seal was checked by injecting water into the annulus during the earliest PSR phase, but leaking wasn't observed.
Pumping rate during the RW phase was increased to eliminating effects of a noise which was caused by the flow rate control system.
Best estimation of the result is from RWS, affecting larger region in this test sequence.

Pumping rate : 0.5 (litre min^{-1}) → 1.5 (litre min^{-1})

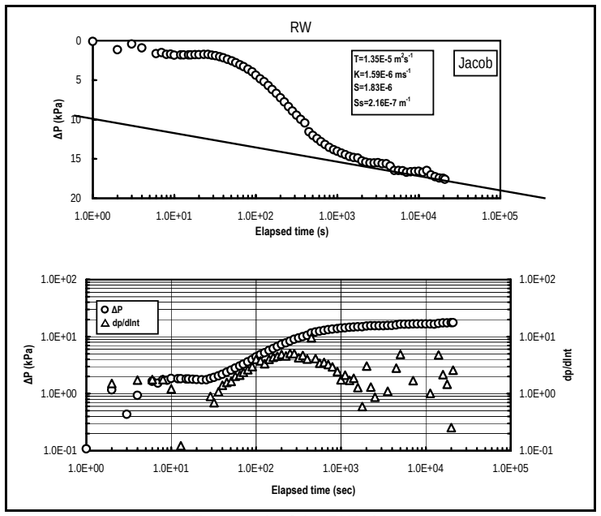
Result of Hydraulic Test MSB-2 No.2 (69.00-77.50 mabh)



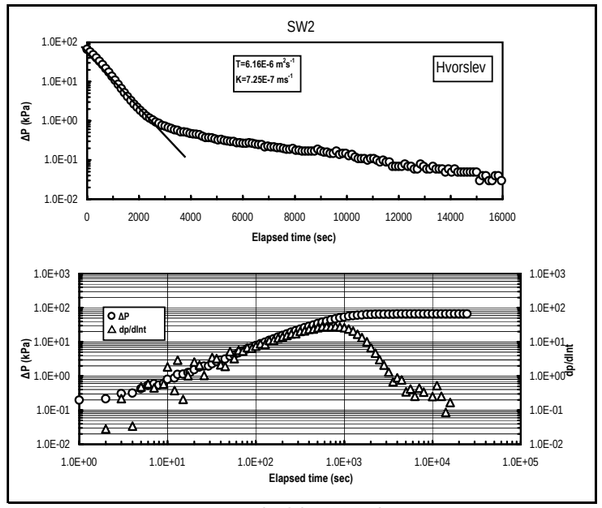
Pressure profile



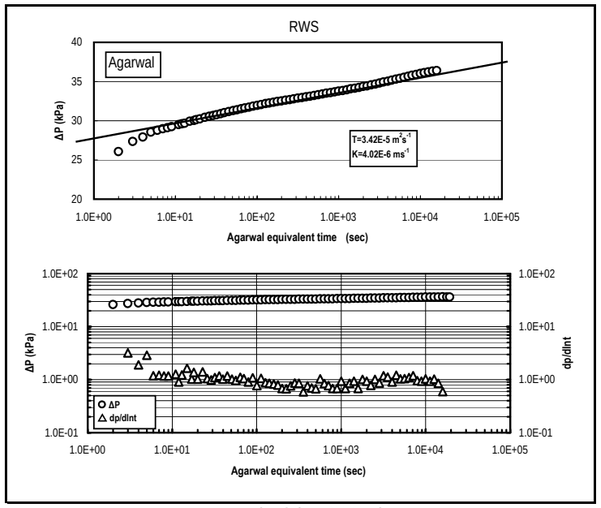
Test result of the SWS1 phase



Test result of the RW phase



Test result of the SW2 phase



Test result of the RWS phase

Summary of Hydraulic Test No.2

Start	10 June 2002		End	14 June 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-4	
Packer Configuration	~~Single~~ / Double		Engineer	Ibara (TKS co.,Ltd)	
Elevation of GL.	198.488	X-coordinates*	-69069.074	Y-coordinates*	6448.577

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	69.00	69.00	Borehole radius (m)	0.0650
Mid	73.25	73.25	Tubing radius (m)	0.0365
Bottom	77.50	77.50	Rod radius (m)	0.0179
Transducer depth	66.74	66.74	Interval length (m)	8.50
Borehole depth	84.00	84.00	Interval volume (m^3)	0.113

Test summary

Sequence: INF-PSR-PW1-PW2-SW1-SWS1-SW2-RW-RWS-PW3-DEF

Objectives

T, K, S, Ss, H and M for the basal conglomerate of the Akeyo Formation

Geology of the test interval

in the interval of 69.3-73.4 mabh, and included mainly granite granule in the interval of 73.4-77.5 mabh.

Core losses: 69.30-69.50 mabh, 69.60-69.70 mabh

Test Results

Best estimation : RWS

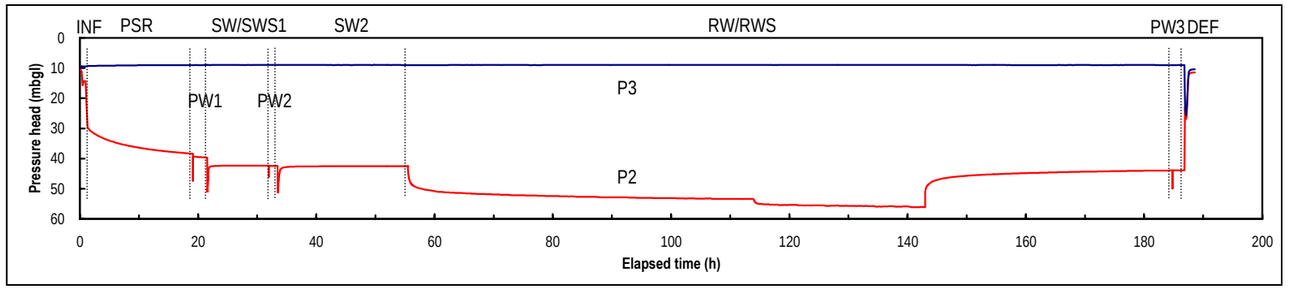
T (m^2s^{-1}) =	3.42E-05	S =	-
K (ms^{-1}) =	4.02E-06	Ss (m^{-1}) =	-
Flow Model :	Well with wellbore storage and skin in composite? medium with Infinite Lateral Extent	H (mbgl) =	51.1
		Boundary :	closed boundary?

Comments

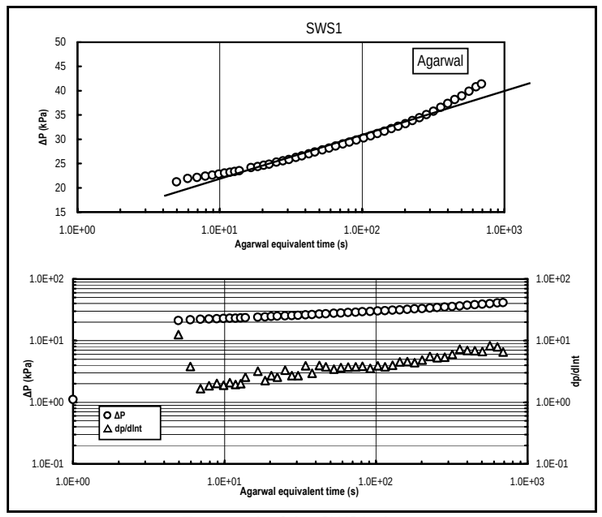
This test was conducted in the main part of the Akeyo Formation after drilling to the Toki Lignite-bearing Formation (84 mabh), not to expand the borehole diameter above this depth.
It was confirmed that the pressure head was different before and after PW1 phase. The reason is thought that the PW1phase was started before recovery of the constant head. Thereafter, the hydraulic head in each phase didn't practically change.
Best estimation of the result is from RWS, affecting lager region in this test sequence.

Pumping rate : 1 (litre min^{-1}) → 2 (litre min^{-1})

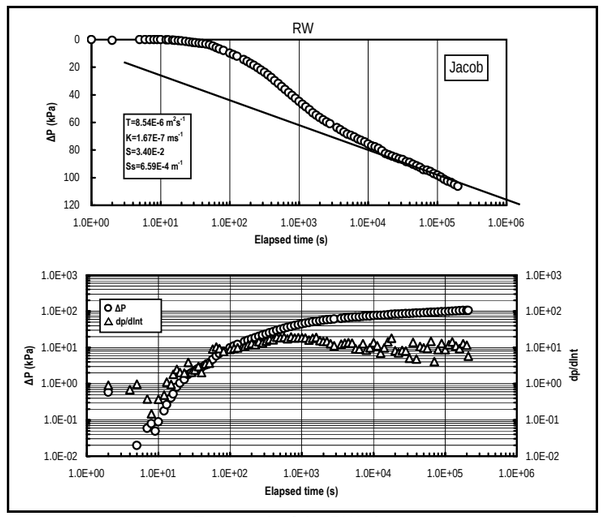
Result of Hydraulic Test MSB-2 No.3 (79.00-130.50 mabh)



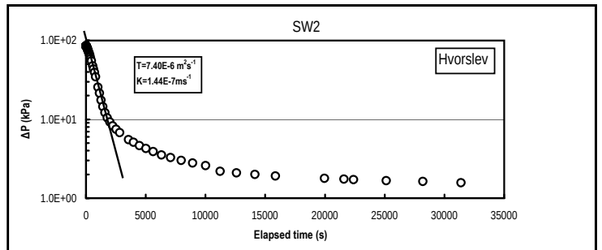
Pressure profile



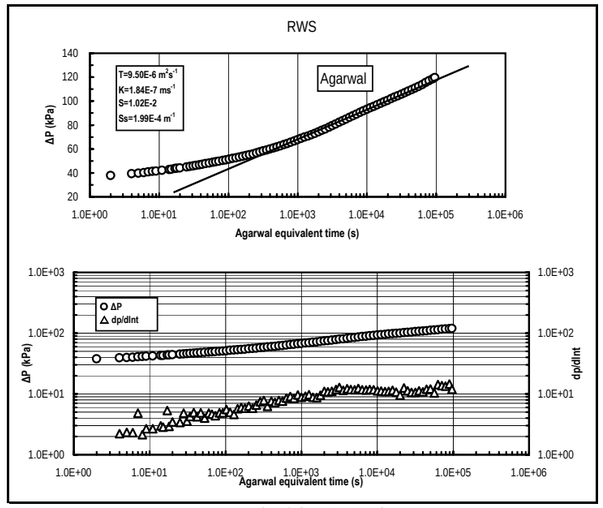
Test result of the SWS1 phase



Test result of the RW phase



Test result of the SW2 phase



Test result of the RWS phase

Summary of Hydraulic Test No.3

Start	1 July 2002		End	9 July 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-4	
Packer Configuration	~~Single~~ / Double		Engineer	Suzuki (TKS co.,Ltd)	
Elevation of GL.	198.488	X-coordinates	-69069.074	Y-coordinates	6448.577

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	79.00	79.00	Borehole radius (m)	0.0650
Mid	104.75	104.75	Tubing radius (m)	0.0365
Bottom	130.50	130.49	Rod radius (m)	0.0179
Transducer depth	76.74	76.74	Interval length (m)	51.50
Borehole depth	154.00	153.99	Interval volume (m^3)	0.683

Test summary

Sequence: INF-PSR-PW1-SW1-SWS1-PW2-SW2-RW-WS-RWS-PW3-DEF

Objectives

T, K, S, Ss, H and M for Toki-Lignite bearing Formation

Geology of the test interval

Arkosic sandstone, mudstone, granule conglomerate and lignite

Core losses: 100.00-100.05, 115.50-116.00, 116.55-116.95, 121.90-122.00, 123.90-124.00 mabh

Test Results

Best estimation : RWS

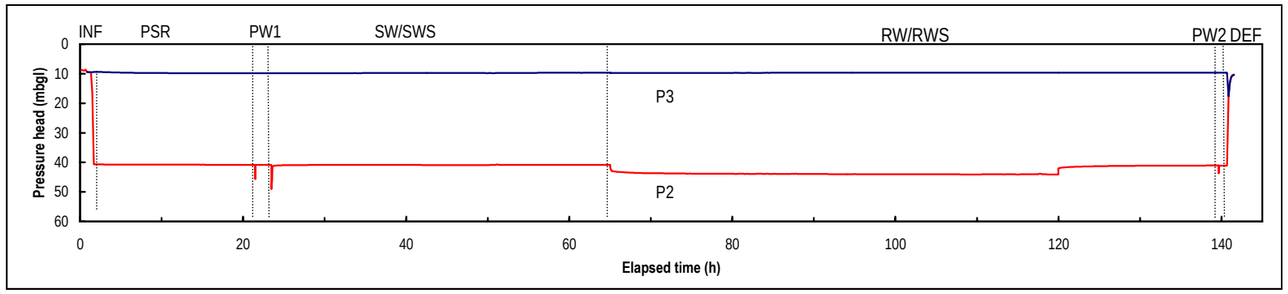
T (m^2s^{-1}) =	9.50E-06	S =	1.02E-02
K (ms^{-1}) =	1.84E-07	Ss (m^{-1}) =	1.99E-04
Flow Model :	Well with wellbore storage and skin in a homogeneous porous medium	H (mbgl) =	43.1
		Boundary :	Infinite acting?

Comments

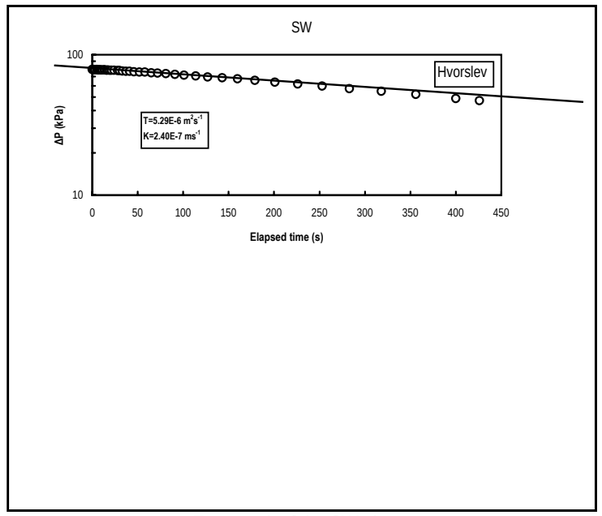
All test objectives were achieved. But it was confirmed that the pressure head was different before and after SW/SW1 phase. The reason was thought that the SW1 phase started before recovery of the constant head. Thereafter, the hydraulic head in each phase didn't practically change.
Best estimation of the result is from RWS, affecting larger region.

Pumping rate : 6.8 (litre min^{-1}) → 8.0 (litre min^{-1})

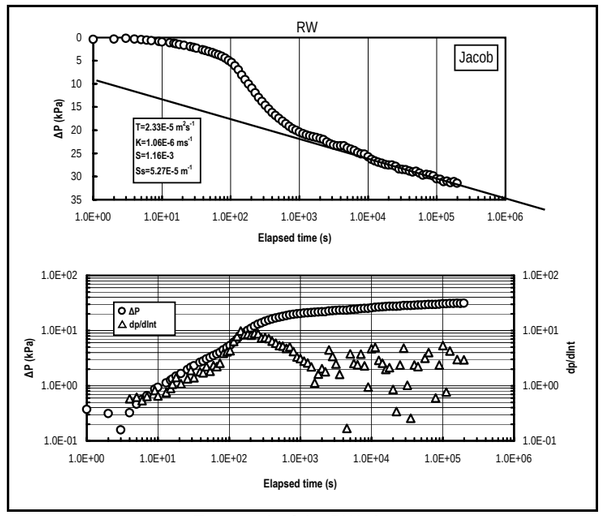
Result of Hydraulic Test MSB-2 No.4 (132.00-154.00 mabh)



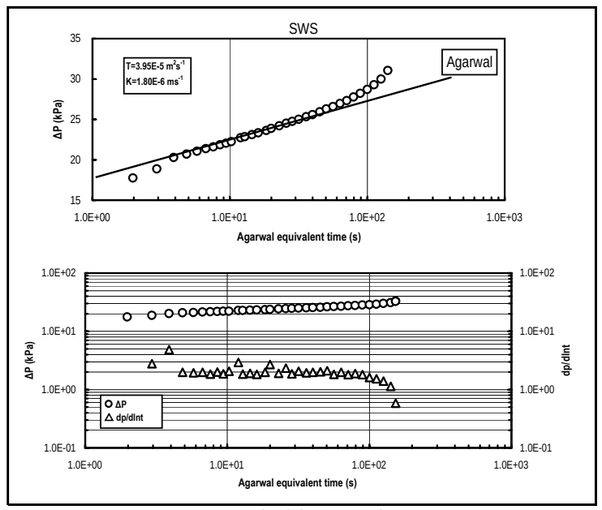
Pressure profile



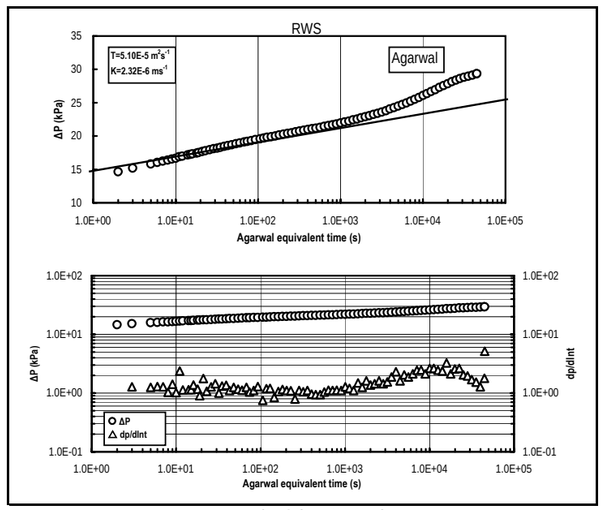
Test result of the SW phase



Test result of the RW phase



Test result of the SWS phase



Test result of the RWS phase

Summary of Hydraulic Test No.4

Start	24 June 2002		End	30 June 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-4	
Packer Configuration	Single / ~~Double~~		Engineer	Suzuki (TKS co.,Ltd)	
Elevation of GL.	198.488	X-coordinates	-69069.074	Y-coordinates	6448.577

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	132.00	131.99	Borehole radius (m)	0.0650
Mid	143.00	142.99	Tubing radius (m)	0.0365
Bottom	154.00	153.99	Rod radius (m)	0.0179
Transducer depth	129.74	129.74	Interval length (m)	22.00
Borehole depth	154.00	153.99	Interval volume (m^3)	0.292

Test summary

Sequence: INF-PSR-PW1-SW1-SWS1-RW-WS-RWS-PW2-DEF

Objectives

T, K, S, Ss, H and M for the basal conglomerate of the Toki-Lignite bearing Formation

Geology of the test interval

Basal conglomerate

Core losses : 141.00-141.20, 145.00-145.40, 150.30-150.85 mabh

Test Results

Best estimation : RWS

T (m^2s^{-1}) =	5.10E-05	S =	-
K (ms^{-1}) =	2.32E-06	Ss (m^{-1}) =	-
Flow Model :	Well with wellbore storage and skin in a homogeneous porous medium	H (mbgl) =	41.1
		Boundary :	?

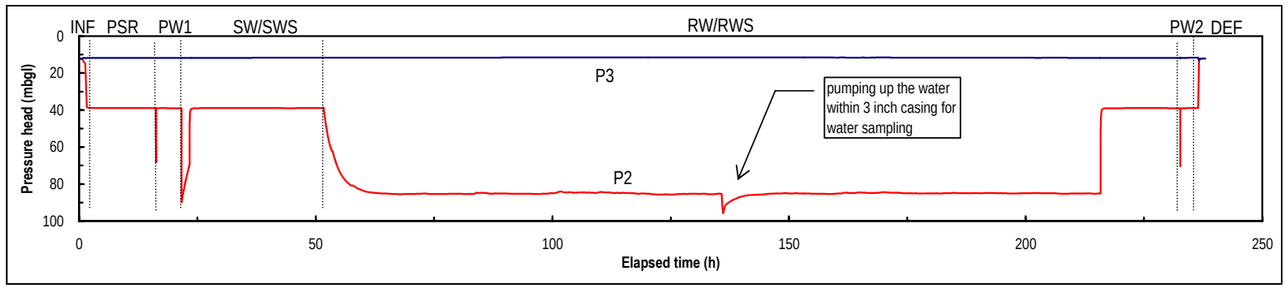
Comments

This test was conducted before drilling into the Toki Granite to avoid contamination between the sedimentary formation water and the granite water.

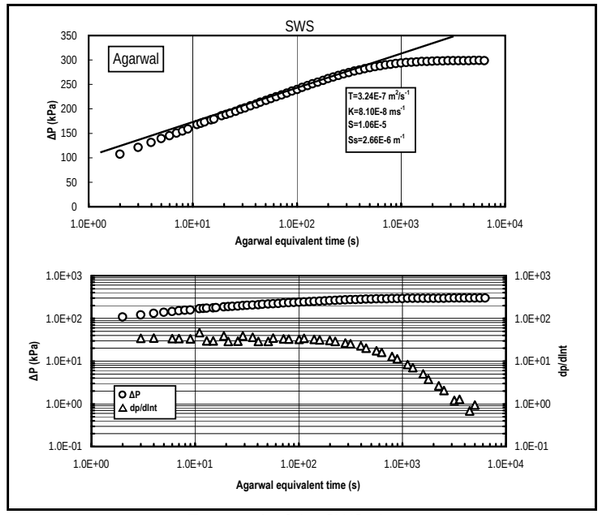
Best estimation of the result is from RWS, affecting larger region in this test sequence.

Pumping rate : 4.0 (litre min^{-1})

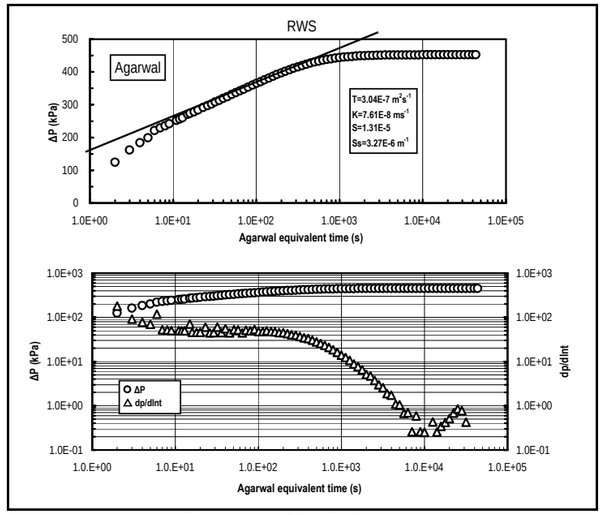
Result of Hydraulic Test MSB-2 No.5 (171.50-175.50 mabh)



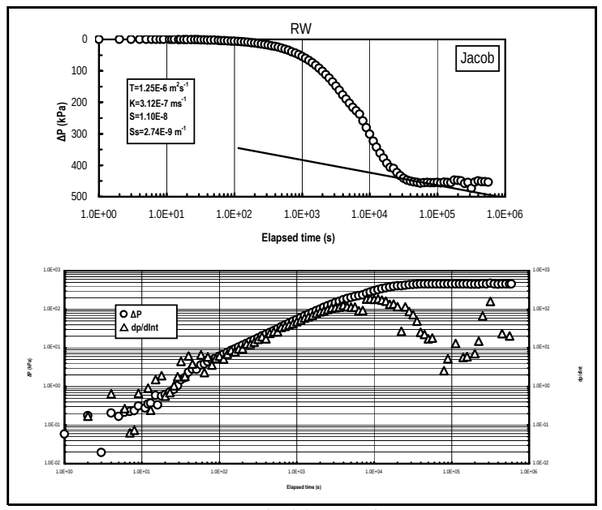
Pressure profile



Test result of the SWS phase



Test result of the RWS phase



Test result of the RW phase

Summary of Hydraulic Test No.5

Start	13 July 2002		End	23 July 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-4	
Packer Configuration	~~Single~~ / Double		Engineer	Suzuki (TKS co.,Ltd)	
Elevation of GL.	198.488	X-coordinates	-69069.074	Y-coordinates	6448.577

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	171.50	171.49	Borehole radius (m)	0.0650
Mid	173.50	173.49	Tubing radius (m)	0.0365
Bottom	175.50	175.49	Rod radius (m)	0.0179
Transducer depth	162.24	162.24	Interval length (m)	4.00
Borehole depth	180.00	179.99	Interval volume (m^3)	0.053

Test summary

Sequence: INF-PSR-PW1-SW1-SWS1-RW-WS-RWS-PW2-DEF

Objectives

T, K, S, Ss, H and M for weathered zone in the Toki Granite

Geology of the test interval

Weathered granite

Test Results

Best estimation : RWS

T (m^2s^{-1}) =	3.04E-07	S =	1.31E-05
K (ms^{-1}) =	7.61E-08	Ss (m^{-1}) =	3.27E-06
Flow Model :	Well with wellbore storage and skin in a homogeneous porous medium	H (mbgl) =	38.9
		Boundary :	?

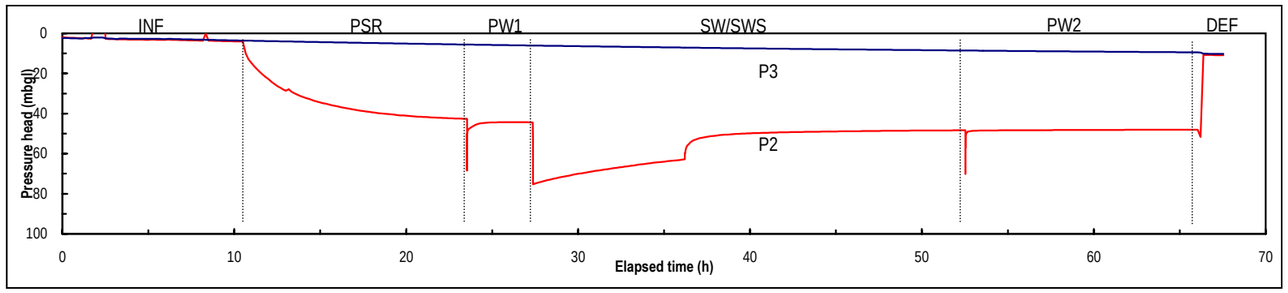
Comments

This test was conducted after drilling to the bottom of the borehole. All test objectives were achieved. Pumping rate was decided by the result from SW/SWS phase. Temporary pressure change during RW phase was caused by drawing up the water temporarily within 3 inch casing for water sampling.

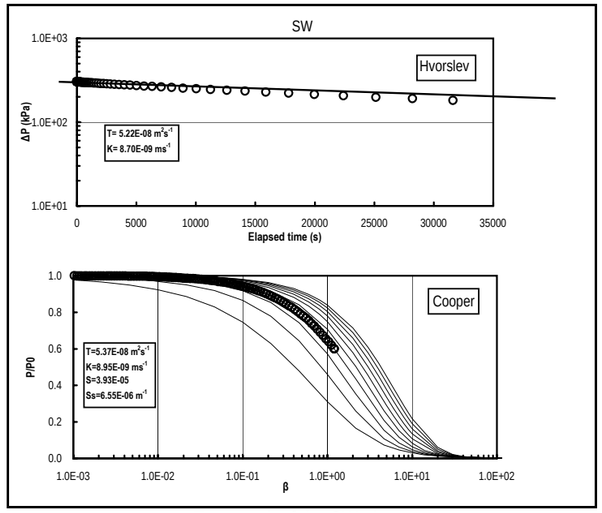
Best estimation of the result is from RWS, affecting larger region in this test sequence.

Pumping rate : 1.2 (litre min^{-1})

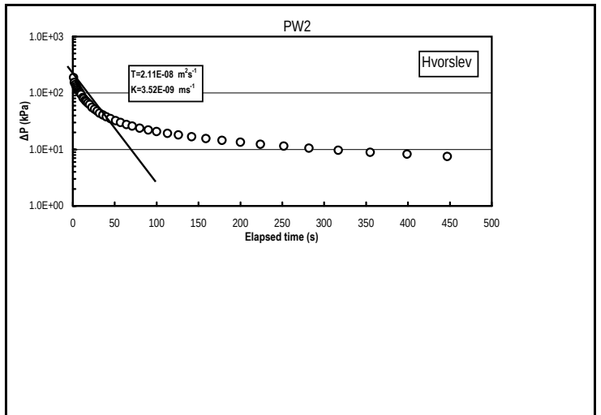
Result of Hydraulic Test MSB-3 No.1 (87.00-93.00 mabh)



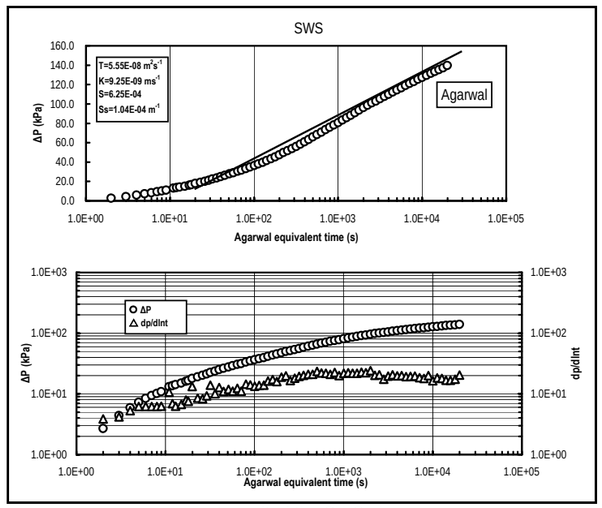
Pressure profile



Test result of the SW phase



Test result of the PW2 phase



Test result of the SWS phase

Summary of Hydraulic Test No.1

Start	16 September 2002		End	19 September 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-4	
Packer Configuration	~~Single~~ / Double		Engineer	Fujita (TKS co.,Ltd)	
Elevation of GL.	204.622	X-coordinates	-68962.856	Y-coordinates	6463.090

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	20
Top	87.00	82.23	Borehole radius (m)	0.0650
Mid	90.00	85.08	Tubing radius (m)	0.0365
Bottom	93.00	87.93	Rod radius (m)	0.0179
Transducer depth	79.63	80.10	Interval length (m)	6.0000
Borehole depth	102.00	96.45	Interval volume (m^3)	0.080

Test summary

Sequence: INF-PSR-PW1-SW-SWS-PW2-DEF

Objectives

T, K, S, Ss, H and M of NNW fault

Geology of the test interval

NNW fault

Test Results

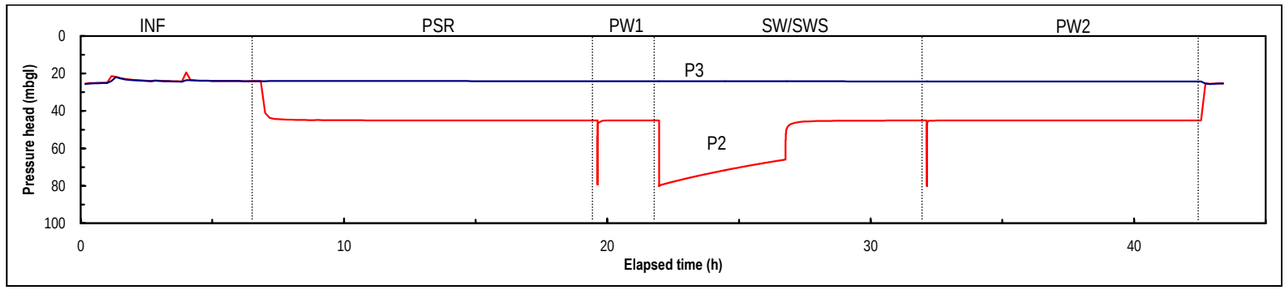
Best estimation : SWS

T (m^2s^{-1}) =	5.55E-08	S =	6.25E-04
K (ms^{-1}) =	9.25E-09	Ss (m^{-1}) =	1.04E-04
Flow Model :	Well with wellbore storage and skin in a homogeneous? porous medium	H (mbgl) =	48.6
		Boundary :	Infinite acting

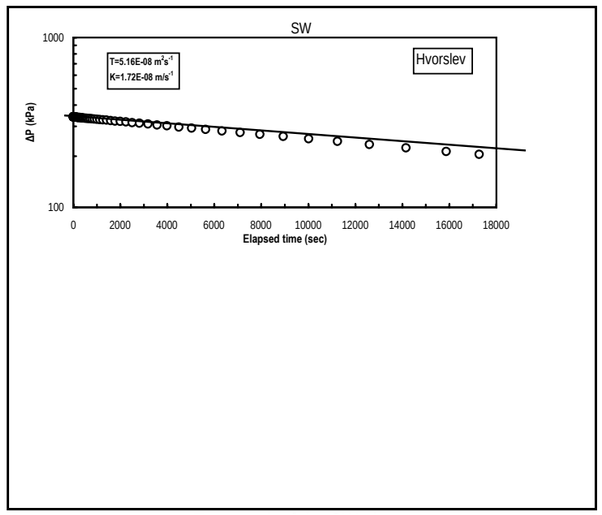
Comments

This test was conducted after drilling into NNW fault (102 mabh).
All test objectives were achieved. But pumping test wasn't performed because of a low hydraulic conductivity of test interval.
Best estimation of the result is from SWS, affecting larger region in this test sequence.

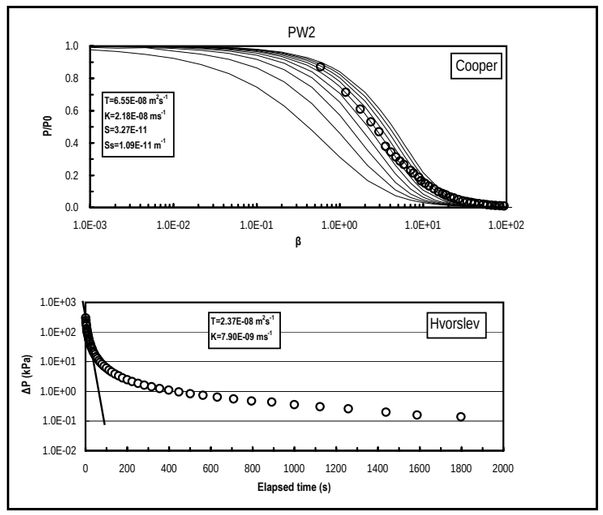
Result of Hydraulic Test MSB-3 No.2 (178.5.00-181.50 mabh)



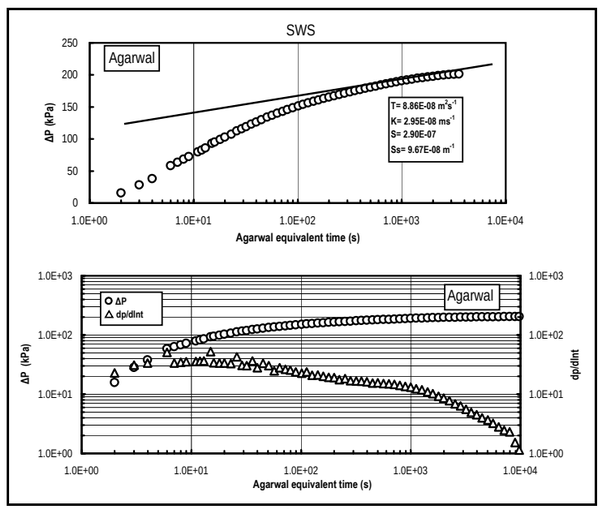
Pressure profile



Test result of the SW phase



Test result of the PW2 phase



Test result of the SWS phase

Summary of Hydraulic Test No.2

Start	13 October 2002		End	15 October 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-3	
Packer Configuration	~~Single~~ / Double		Engineer	Fujita (TKS co.,Ltd)	
Elevation of GL.	204.622	X-coordinates	-68962.856	Y-coordinates	6463.090

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	20
Top	178.50	169.03	Borehole radius (m)	0.0650
Mid	180.00	170.45	Tubing radius (m)	0.0300
Bottom	181.50	171.87	Rod radius (m)	0.0179
Transducer depth	176.24	166.87	Interval length (m)	3.0000
Borehole depth	199.00	188.53	Interval volume (m^3)	0.040

Test summary

Sequence: INF-PSR-PW1-SW-SWS-PW2-DEF

Objectives

T, K, S, Ss, H and M of the weathered zone in the Toki Granite

Geology of the test interval

Weathered granite

Core losses : 177.80-179.05 mabh

Test Results

Best estimation : SWS

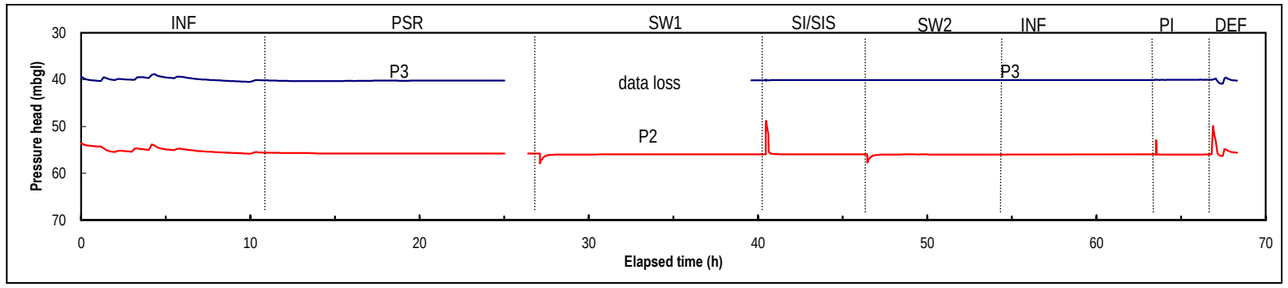
T (m^2s^{-1}) =	8.86E-08	S =	2.90E-07
K (ms^{-1}) =	2.95E-08	Ss (m^{-1}) =	9.67E-08
Flow Model :	Well with wellbore storage and skin in a homogeneous porous medium	H (mbgl) =	46.4
		Boundary :	constant pressure

Comments

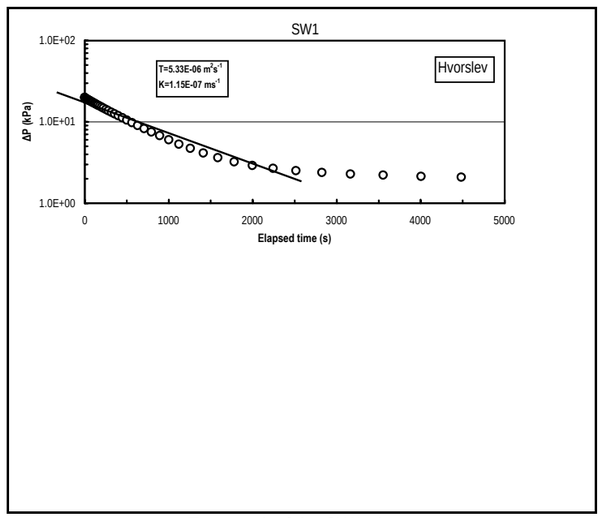
This test was conducted after drilling to the bottom of the borehole. All test objectives were achieved. But pumping test wasn't performed because of a low hydraulic conductivity of test interval.

Best estimation of the result is from SWS, affecting larger region in this test sequence.

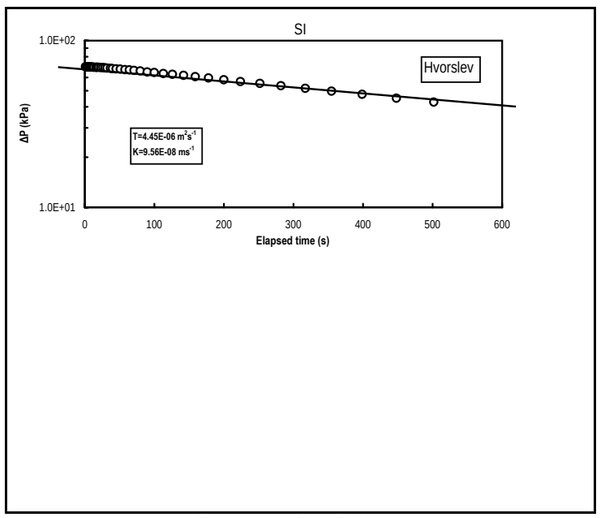
Result of Hydraulic Test MSB-4 No.1 (15.50-62.00 mabh)



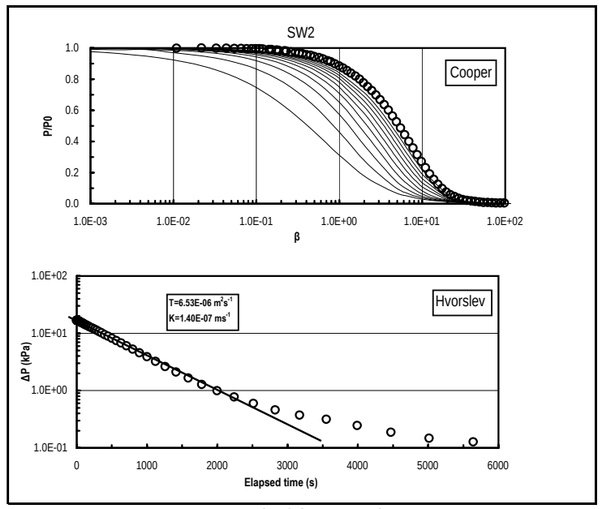
Pressure profile



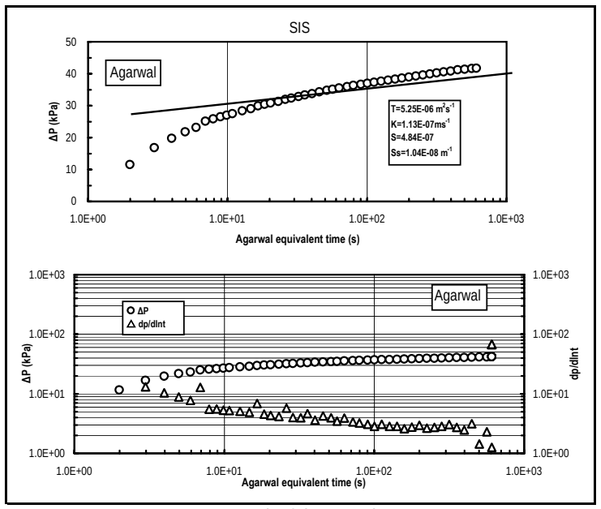
Test result of the SW1 phase



Test result of the SI phase



Test result of the SW2 phase



Test result of the SIS phase

Summary of Hydraulic Test No.1

Start	27 July 2002		End	4 August 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-3	
Packer Configuration	~~Single~~ / Double		Engineer	Ibara (TKS co.,Ltd)	
Elevation of GL.	214.448	X-coordinates	-68774.222	Y-coordinates	6470.129

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	15.50	15.50	Borehole radius (m)	0.0650
Mid	38.75	38.75	Tubing radius (m)	0.0365
Bottom	62.00	62.00	Rod radius (m)	0.0179
Transducer depth	13.24	13.24	Interval length (m)	46.50
Borehole depth	91.00	91.00	Interval volume (m^3)	0.617

Test summary

Sequence: INF-PSR-SW1-SI-SIS-SW2-INF-PI-DEF

Objectives

T, K, S, Ss, H and M for main part of the Akeyo Formation

Geology of the test interval

Tuffaceous sandstone, mudstone, tuff and granule conglomerate

Core losses:37.30-37.40 mabh

Test Results

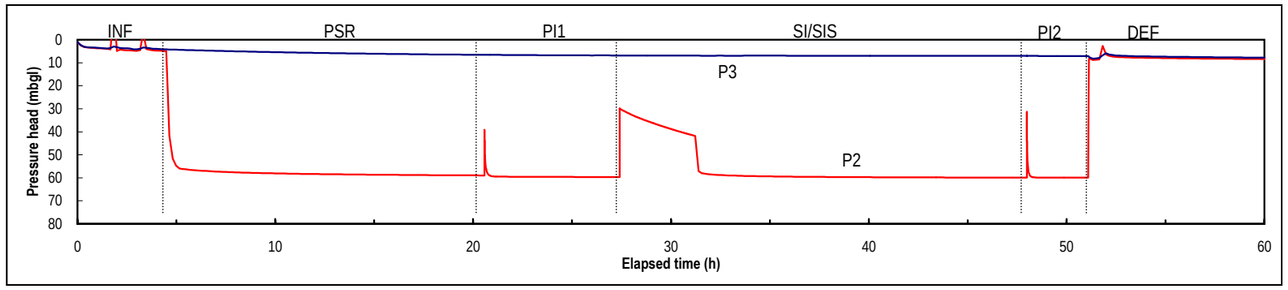
Best estimation : SIS

T (m^2s^{-1}) =	5.25E-06	S =	4.84E-07
K (ms^{-1}) =	1.13E-07	Ss (m^{-1}) =	1.04E-08
Flow Model :	Well with wellbore storage and skin in a homogeneous porous medium	H (mbgl) =	8.00
		Boundary :	Infinite acting ?

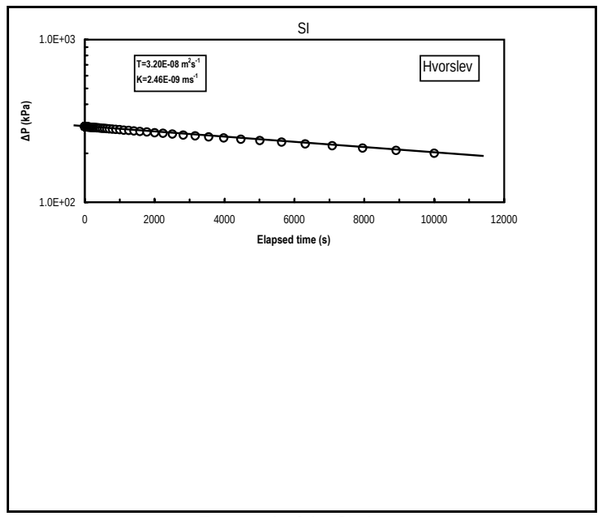
Comments

This test was conducted before drilling into the Toki Granite (91 mabh). All test objectives were achieved. But injection test was performed because of a low hydraulic head of the test interval. Best estimation of the result is from SIS, affecting larger region in this test sequence.

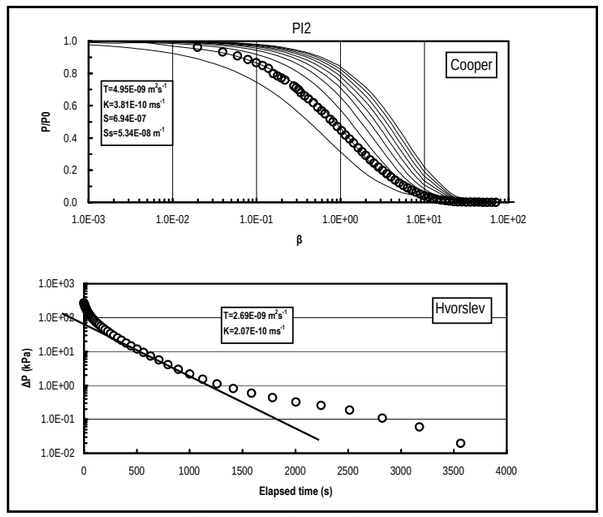
Result of Hydraulic Test MSB-4 No.2 (63.50-76.50 mabh)



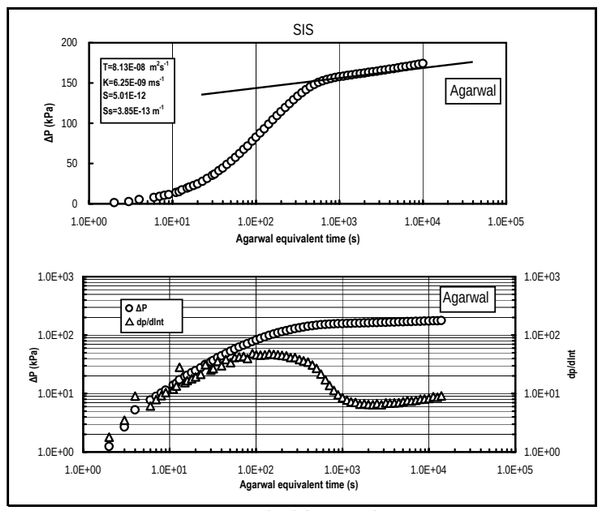
Pressure profile



Test result of the SI phase



Test result of the PI2 phase



Test result of the SIS phase

Summary of Hydraulic Test No.2

Start	24 July 2002		End	27 July 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-3	
Packer Configuration	~~Single~~ / Double		Engineer	Ibara (TKS co.,Ltd)	
Elevation of GL.	214.448	X-coordinates	-68774.222	Y-coordinates	6470.129

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	63.50	63.50	Borehole radius (m)	0.0650
Mid	70.00	70.00	Tubing radius (m)	0.0365
Bottom	76.50	76.50	Rod radius (m)	0.0179
Transducer depth	61.24	61.24	Interval length (m)	13.00
Borehole depth	91.00	91.00	Interval volume (m^3)	0.172

Test summary

Sequence INF-PSR-PI1-SI/SIS-PI2-DEF

Objectives

T, K, S, Ss, H and M in the basal conglomerate of the Akeyo Formation

Geology of the test interval

Basal conglomerate

Core losses : 73.45-73.50, 73.70-73.75, 74.18-74.28, 75.05-75.10 mabh

Test Results

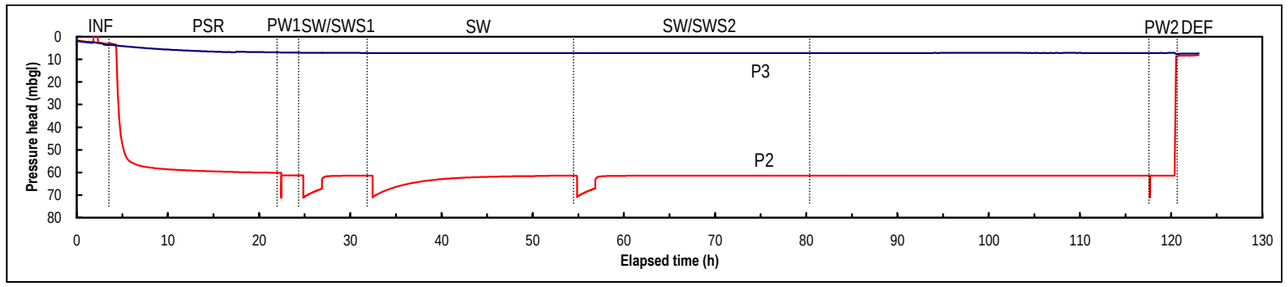
Best estimation : SIS

T (m^2s^{-1}) =	8.13E-08	S =	5.01E-12
K (ms^{-1}) =	6.25E-09	Ss (m^{-1}) =	3.85E-13
Flow Model :	Well with wellbore storage and skin in a homogeneous porous medium	H (mbgl) =	59.97
		Boundary :	linear impermeable?

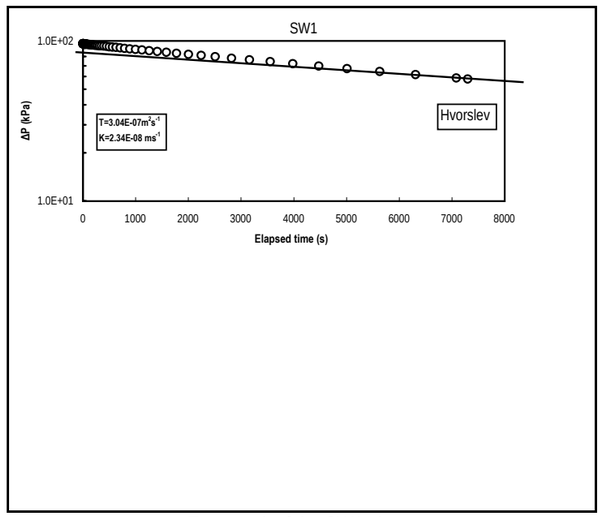
Comments

This test was conducted before drilling into the Toki Granite (91 mabh). All test objectives were achieved. But injection test was performed because of a low hydraulic head of the test interval. Best estimation of the result is from SIS, affecting larger region in this test sequence.

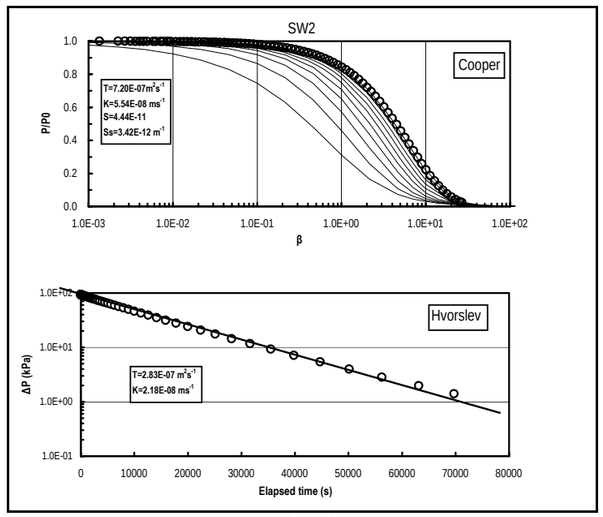
Result of Hydraulic Test MSB-4 No.3 (78.00-91.00 mabh)



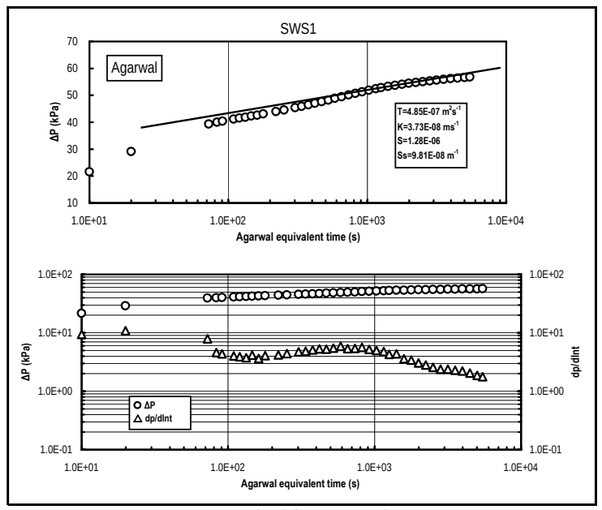
Pressure profile



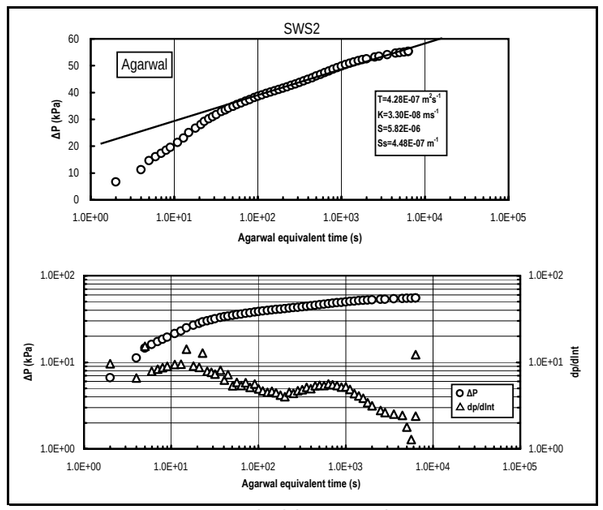
Test result of the SW1 phase



Test result of the SW2 phase



Test result of the SWS1 phase



Test result of the SWS2 phase

Summary of Hydraulic Test No.3

Start	24 July 2002		End	27 July 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-3	
Packer Configuration	Single / ~~Double~~		Engineer	Ibara (TKS co.,Ltd)	
Elevation of GL.	214.448	X-coordinates	-68774.222	Y-coordinates	6470.129

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	78.00	78.00	Borehole radius (m)	0.0650
Mid	84.50	84.50	Tubing radius (m)	0.0365
Bottom	91.00	91.00	Rod radius (m)	0.0179
Transducer depth	75.74	75.74	Interval length (m)	13.00
Borehole depth	91.00	91.00	Interval volume (m^3)	0.172

Test summary

Sequence: INF-PSR-PW1-SW1-SWS1-SW-SW2-SWS2-PW2-DEF

Objectives

T, K, S, Ss, H and M in the main part of the Toki Lignite-bearing Formation

Geology of the test interval

Arkosic sandstone, mudstone, granule conglomerate and lignite

Core losses : 78.83-78.95 mabh

Test Results

Best estimation : SWS2

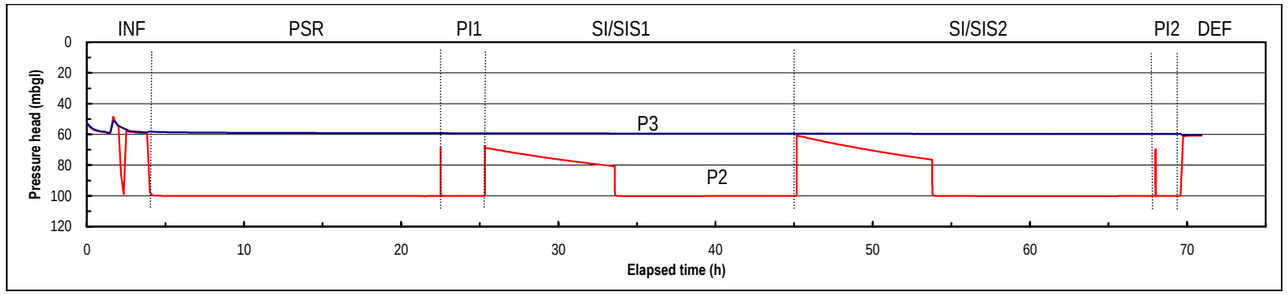
T (m^2s^{-1}) =	4.28E-07	S =	5.82E-06
K (ms^{-1}) =	3.30E-08	Ss (m^{-1}) =	4.48E-07
Flow Model :	Well with wellbore storage and skin in a homogeneous porous medium	H (mbgl) =	61.39
		Boundary :	constant pressure

Comments

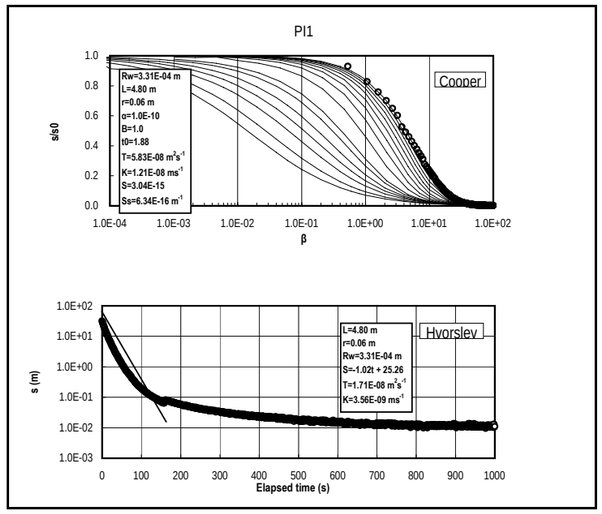
All test objectivities were achieved. But pumping test wasn't performed because of a low hydraulic head of test interval.

Best estimation of the result is from SWS2, affecting larger region.

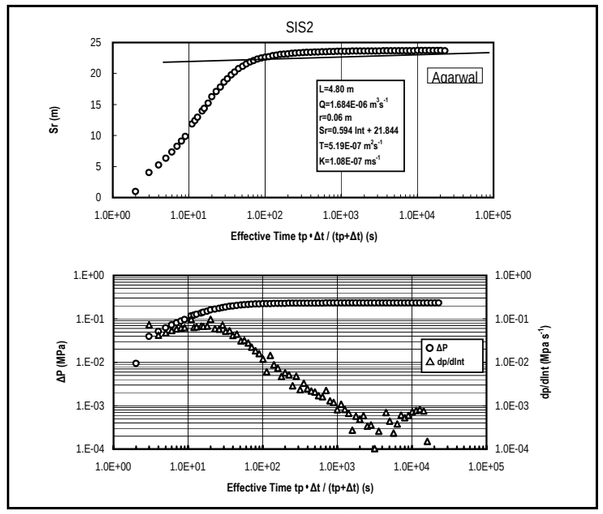
Result of Hydraulic Test MSB-1 No.1 (196.20-201.00 mabh)



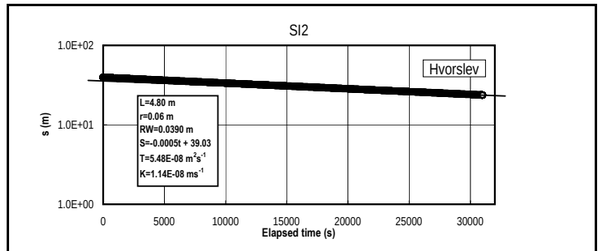
Pressure profile



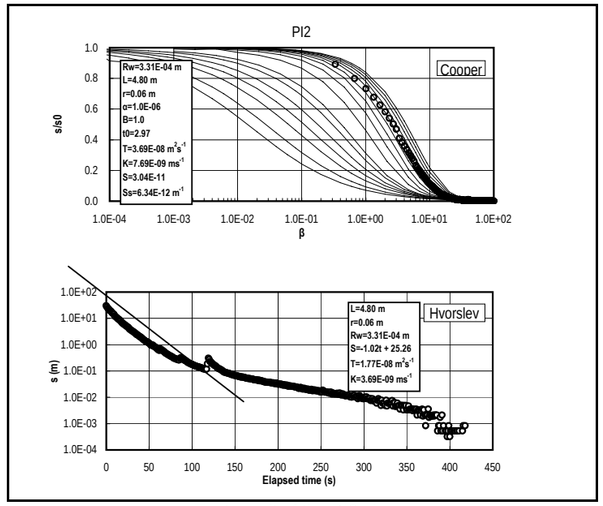
Test result of the PI1 phase



Test result of the SIS2 phase



Test result of the SI2 phase



Test result of the PI2 phase

Summary of Hydraulic Test No.1

Start	7 October 2002		End	10 October 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-4	
Packer Configuration	Single / ~~Double~~		Engineer	Fujita (TKS co.,Ltd)	
Elevation of GL.	253.081	X-coordinates	-68858.514	Y-coordinates	6378.611

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	196.20	196.20	Borehole radius (m)	0.0650
Mid	198.60	198.60	Tubing radius (m)	0.0390
Bottom	201.00	201.00	Rod radius (m)	0.0179
Transducer depth	193.94	193.94	Interval length (m)	4.8000
Borehole depth	201.00	201.00	Interval volume (m^3)	0.064

Test summary

Sequence: INF-PSR-PI1-SI1-SIS1-SI2-SIS2-PI2-DEF

Objectives

T, K, S, Ss, H and M of fresh granite in the Toki Granite

Geology of the test interval

Fresh granite in the Toki Granite.

Test Results

Best estimation : SIS2

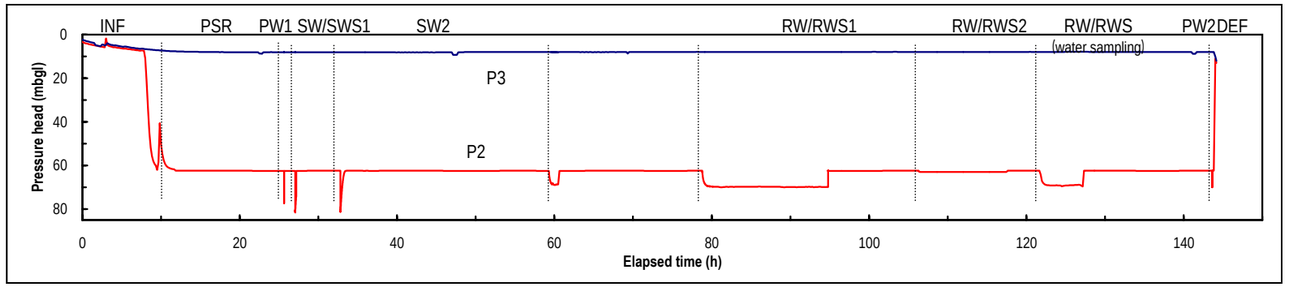
T (m^2s^{-1}) =	5.19E-07	S =	-
K (ms^{-1}) =	1.08E-07	Ss (m^{-1}) =	-
Flow Model :	Well with wellbore storage and skin in a homogeneous porous medium with Infinite Lateral Extent	H (mbgl) =	100.1
		Boundary :	Infinite acting?

Comments

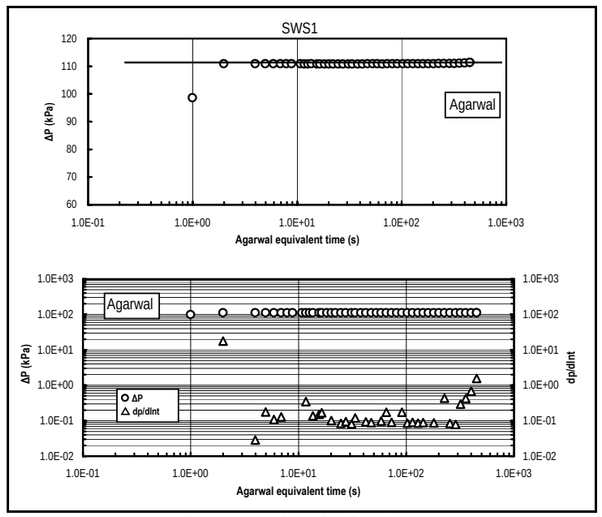
Injection test was performed instead of pumping test because of a low hydraulic head in this test interval.

Best estimation of the result is from SIS2, affecting larger region in this test sequence.

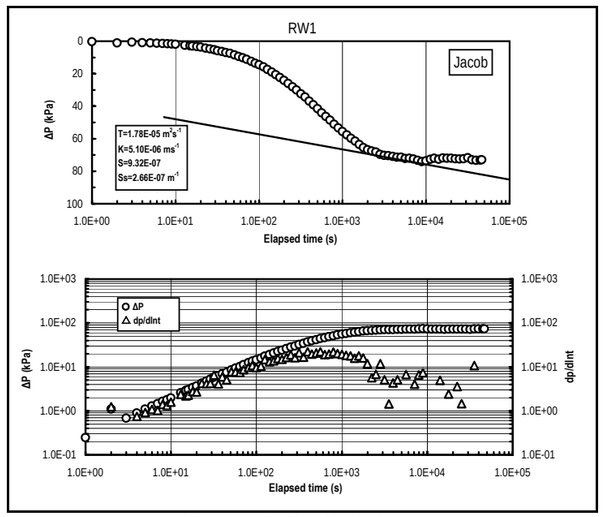
Result of Hydraulic Test MSB-4 No.4 (95.50-99.00 mabh)



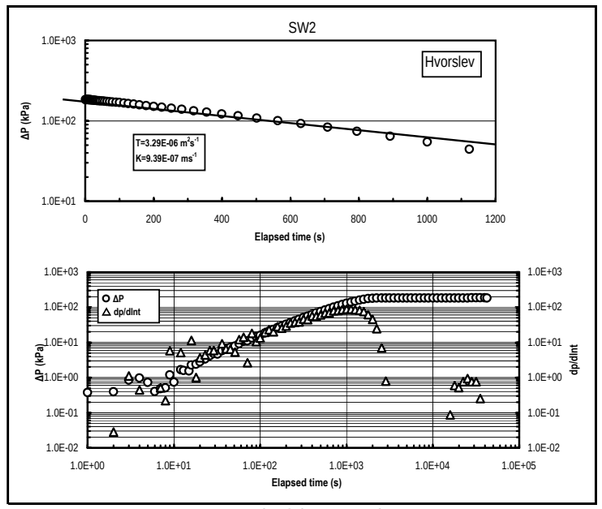
Pressure profile



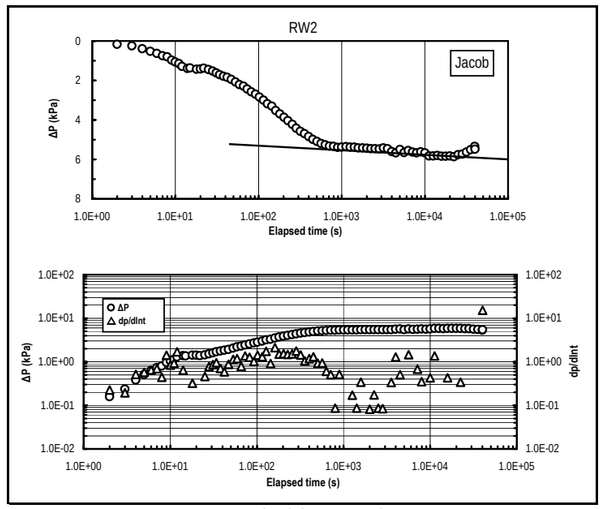
Test result of the SWS1 phase



Test result of the RW1 phase



Test result of the SW2 phase



Test result of the RW2 phase

Summary of Hydraulic Test No.4

Start	8 August 2002		End	14 August 2002	
Test Tool	Pumping Test Tool No.2 for 1000 m		Test Tool No.	15402-3	
Packer Configuration	Single / ~~Double~~		Engineer	Suzuki (TKS co.,Ltd)	
Elevation of GL.	214.448	X-coordinates	-68774.222	Y-coordinates	6470.129

Test Condition

	mabh	mbgl		
Test interval			Angle from vertical (°)	0
Top	95.50	95.50	Borehole radius (m)	0.0650
Mid	97.25	97.25	Tubing radius (m)	0.0365
Bottom	99.00	99.00	Rod radius (m)	0.0179
Transducer depth	93.24	93.24	Interval length (m)	3.50
Borehole depth	99.00	99.00	Interval volume (m^3)	0.046

Test summary

Sequence: INF-PSR-PW1-SW1-SWS1-SW2-RW1-RWS1-RW2-RWS2-RW-WS-RWS-PW2-DEF

Objectives

T, K, S, Ss, H and M in the upper part of the Toki Granite

Geology of the test interval

Fresh granite

Test Results

Best estimation : RW1

T (m^2s^{-1}) =	1.78E-05	S =	9.32E-07
K (ms^{-1}) =	5.10E-06	Ss (m^{-1}) =	2.66E-07
Flow Model :	Well with wellbore storage and skin in a homogeneous porous medium	H (mbgl) =	62.40
		Boundary :	Infinite acting

Comments

All test objectives were achieved.

Best estimation of the result is from RW1, affecting larger region because of a longer pumping and drawdown than RW2.

Pumping rate : 5.5 (litre min^{-1})