P-06-190

Supplement 1

October 2007

Forsmark site investigation

Difference flow logging in borehole KFM10A

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Description

In the present supplement all groundwater head calculations have been redone on revised borehole elevation data (Z-coordinates).

Borehole coordinates that formed the basis for this revision of groundwater head data were retrieved from Sicada 2007-06-26 (#SICADA_07_263) /SKB 2007/.

Specifically the following appendices are revised and included in this supplement:

Revised appendix	Appendix number
Table of transmissivity and head of 5 m sections	Appendices 5.1–5.3
Transmissivity and head of 5 m sections	Appendix 6.2
Table of transmissivity and head of detected fractures	Appendices 7.1–7.2
Transmissivity and head of detected fractures	Appendix 8
Comparison between section transmissivity and fracture transmissivity	Appendix 9
Head in the borehole during flow logging	Appendix 10.1
Groundwater recovery after pumping	Appendix 10.3

Reference

SKB, 2007. Compilation of borehole deviation measurements in Forsmark (Nilsson, G. and Nissen, J.), SKB P-07-28, Svensk Kärnbränslehantering AB.

Table of transmissivity and head of 5 m sections

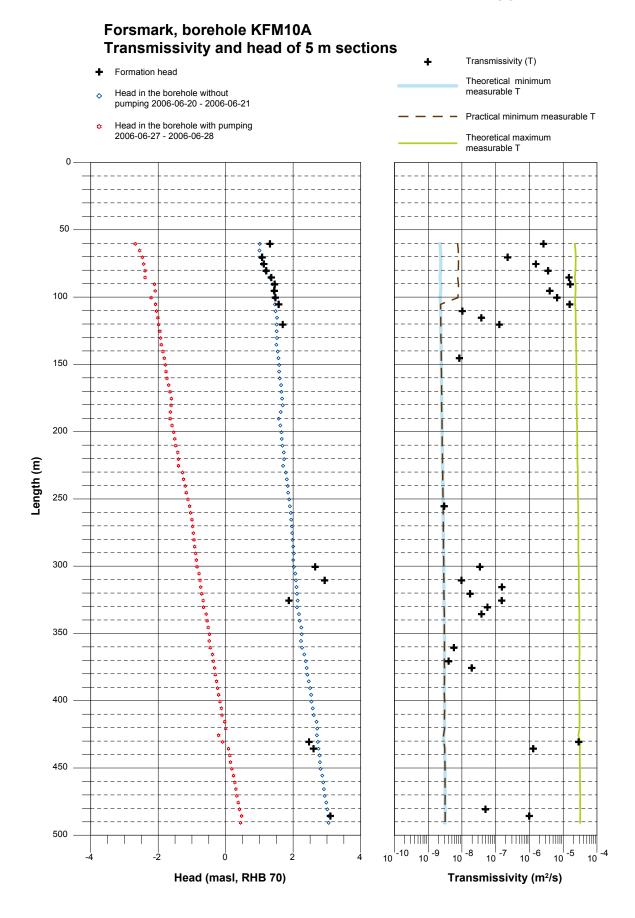
Difference flow logging – Sequential flow logging.

Borehole ID	Secup L (m)	Seclow L (m)	Lw (m)	Q0 (m³/s)	dh0 (m)	Q1 (m³/s)	dh1 (m)	TD (m²/s)	hi (m)	Q-lower limit P (mL/h)	TD-measILT (m²/s)	TD-measILP (m²/s)	TD-measIU (m²/s)	Comments
KFM10A	57.90	62.90	5	7.94E-07	1.01	1.05E-05	-2.68	2.6E-06	1.3	100	2.2E-09	7.4E-09	2.2E-05	
KFM10A	62.90	67.90	5	_	1.00	_	-2.55	_	_	100	2.3E-09	7.7E-09	2.3E-05	
KFM10A	67.91	72.91	5	1.28E-08	1.02	8.08E-07	-2.47	2.3E-07	1.1	100	2.4E-09	7.9E-09	2.4E-05	
KFM10A	72.91	77.91	5	1.02E-07	1.07	5.58E-06	-2.43	1.5E-06	1.1	100	2.4E-09	7.9E-09	2.4E-05	
KFM10A	77.91	82.91	5	1.58E-07	1.16	1.29E-05	-2.39	3.5E-06	1.2	100	2.3E-09	7.7E-09	2.3E-05	
KFM10A	82.91	87.91	5	7.97E-07	1.30	5.61E-05	-2.39	1.5E-05	1.4	100	2.2E-09	7.4E-09	2.2E-05	
KFM10A	87.91	92.91	5	1.13E-06	1.38	5.81E-05	-2.11	1.6E-05	1.5	100	2.4E-09	7.9E-09	2.3E-05	
KFM10A	92.90	97.90	5	1.14E-07	1.41	1.42E-05	-2.09	4.0E-06	1.4	100	2.4E-09	7.9E-09	2.4E-05	
KFM10A	97.90	102.90	5	2.73E-07	1.43	2.44E-05	-2.21	6.5E-06	1.5	100	2.3E-09	7.5E-09	2.3E-05	
KFM10A	102.90	107.90	5	1.73E-06	1.46	5.75E-05	-2.08	1.6E-05	1.6	30	2.3E-09	2.3E-09	2.3E-05	
KFM10A	107.90	112.90	5	_	1.48	3.64E-08	-2.05	1.0E-08	_	30	2.3E-09	2.3E-09	2.3E-05	
KFM10A	112.90	117.90	5	_	1.52	1.34E-07	-2.01	3.8E-08	_	30	2.3E-09	2.3E-09	2.3E-05	
KFM10A	117.90	122.90	5	2.33E-08	1.51	4.75E-07	-1.99	1.3E-07	1.7	30	2.4E-09	2.4E-09	2.4E-05	
KFM10A	122.90	127.90	5	_	1.51	_	-1.95	_	_	30	2.4E-09	2.4E-09	2.4E-05	
KFM10A	127.90	132.90	5	_	1.52	_	-1.93	_	_	30	2.4E-09	2.4E-09	2.4E-05	
KFM10A	132.90	137.90	5	_	1.50	_	-1.91	_	_	30	2.4E-09	2.4E-09	2.4E-05	
KFM10A	137.90	142.90	5	_	1.54	_	-1.86	_	_	30	2.4E-09	2.4E-09	2.4E-05	
KFM10A	142.90	147.90	5	_	1.56	2.86E-08	-1.82	8.4E-09	_	30	2.4E-09	2.4E-09	2.4E-05	
KFM10A	147.91	152.91	5	_	1.58	_	-1.79	_	_	30	2.4E-09	2.4E-09	2.4E-05	
KFM10A	152.91	157.91	5	_	1.58	_	-1.77	_	_	30	2.5E-09	2.5E-09	2.5E-05	
KFM10A	157.90	162.90	5	_	1.60	_	-1.74	_	_	30	2.5E-09	2.5E-09	2.5E-05	
KFM10A	162.91	167.91	5	_	1.64	_	-1.69	_	_	30	2.5E-09	2.5E-09	2.5E-05	
KFM10A	167.92	172.92	5	_	1.65	_	-1.65	_	_	30	2.5E-09	2.5E-09	2.5E-05	
KFM10A	172.91	177.91	5	_	1.67	_	-1.61	_	_	30	2.5E-09	2.5E-09	2.5E-05	
KFM10A	177.91	182.91	5	_	1.69	_	-1.62	_	_	30	2.5E-09	2.5E-09	2.5E-05	
KFM10A	182.92	187.92	5	_	1.63	_	-1.64	_	_	30	2.5E-09	2.5E-09	2.5E-05	
KFM10A	187.90	192.90	5	_	1.57	_	-1.65	_	_	30	2.6E-09	2.6E-09	2.6E-05	
KFM10A	192.92	197.92	5	_	1.62	_	-1.59	_	_	30	2.6E-09	2.6E-09	2.6E-05	
KFM10A	197.93	202.93	5	_	1.65	_	-1.54	_	_	30	2.6E-09	2.6E-09	2.6E-05	

Borehole ID	Secup L (m)	Seclow L (m)	Lw (m)	Q0 (m³/s)	dh0 (m)	Q1 (m³/s)	dh1 (m)	TD (m²/s)	hi (m)	Q-lower limit P (mL/h)	TD-measILT (m²/s)	TD-measILP (m²/s)	TD-measIU (m²/s)	Comments
KFM10A	202.92	207.92	5	_	1.66	_	-1.51	_	_	30	2.6E-09	2.6E-09	2.6E-05	
KFM10A	207.92	212.92	5	_	1.68	_	-1.48	_	_	30	2.6E-09	2.6E-09	2.6E-05	
KFM10A	212.92	217.92	5	_	1.72	_	-1.42	_	_	30	2.6E-09	2.6E-09	2.6E-05	
KFM10A	217.91	222.91	5	_	1.73	_	-1.40	_	_	30	2.6E-09	2.6E-09	2.6E-05	
KFM10A	222.91	227.91	5	_	1.70	_	-1.40	_	_	30	2.7E-09	2.7E-09	2.7E-05	
KFM10A	227.91	232.91	5	_	1.78	_	-1.28	_	_	30	2.7E-09	2.7E-09	2.7E-05	
KFM10A	232.91	237.91	5	_	1.81	_	-1.25	_	_	30	2.7E-09	2.7E-09	2.7E-05	
KFM10A	237.91	242.91	5	_	1.84	_	-1.20	_	_	30	2.7E-09	2.7E-09	2.7E-05	
KFM10A	242.91	247.91	5	_	1.85	_	-1.17	_	_	30	2.7E-09	2.7E-09	2.7E-05	
KFM10A	247.91	252.91	5	_	1.88	_	-1.12	_	_	30	2.7E-09	2.7E-09	2.7E-05	
KFM10A	252.91	257.91	5	_	1.90	8.89E-09	-1.07	3.0E-09	_	30	2.8E-09	2.8E-09	2.8E-05	
KFM10A	257.91	262.91	5	_	1.93	_	-1.04	_	_	30	2.8E-09	2.8E-09	2.8E-05	
KFM10A	262.91	267.91	5	_	1.94	_	-1.00	_	_	30	2.8E-09	2.8E-09	2.8E-05	
KFM10A	267.91	272.91	5	_	1.96	_	-0.98	_	_	30	2.8E-09	2.8E-09	2.8E-05	
KFM10A	272.93	277.93	5	_	1.97	_	-0.96	_	_	30	2.8E-09	2.8E-09	2.8E-05	
KFM10A	277.94	282.94	5	_	1.98	_	-0.94	_	_	30	2.8E-09	2.8E-09	2.8E-05	
KFM10A	282.96	287.96	5	_	2.00	_	-0.92	_	_	30	2.8E-09	2.8E-09	2.8E-05	
KFM10A	287.97	292.97	5	_	2.02	_	-0.89	_	_	30	2.8E-09	2.8E-09	2.8E-05	
KFM10A	292.98	297.98	5	_	2.00	_	-0.87	_	_	30	2.9E-09	2.9E-09	2.9E-05	
KFM10A	297.99	302.99	5	2.17E-08	2.02	1.20E-07	-0.85	3.4E-08	2.6	30	2.9E-09	2.9E-09	2.9E-05	
KFM10A	303.01	308.01	5	_	2.06	_	-0.79	_	_	30	2.9E-09	2.9E-09	2.9E-05	
KFM10A	308.03	313.03	5	8.33E-09	2.08	3.61E-08	-0.76	9.7E-09	2.9	30	2.9E-09	2.9E-09	2.9E-05	
KFM10A	313.03	318.03	5	_	2.10	4.36E-07	-0.74	1.5E-07	_	30	2.9E-09	2.9E-09	2.9E-05	
KFM10A	318.04	323.04	5	_	2.11	4.94E-08	-0.71	1.7E-08	_	30	2.9E-09	2.9E-09	2.9E-05	
KFM10A	323.06	328.06	5	-3.94E-08	2.13	3.86E-07	-0.67	1.5E-07	1.9	30	2.9E-09	2.9E-09	2.9E-05	
KFM10A	328.07	333.07	5	_	2.11	1.59E-07	-0.66	5.7E-08	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	333.08	338.08	5	_	2.17	1.06E-07	-0.58	3.8E-08	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	338.10	343.10	5	_	2.19	_	-0.55	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	343.10	348.10	5	_	2.24	_	-0.52	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	348.10	353.10	5	_	2.25	_	-0.48	_	_	30	3.0E-09	3.0E-09	3.0E-05	

Borehole ID	Secup L (m)	Seclow L (m)	Lw (m)	Q0 (m³/s)	dh0 (m)	Q1 (m³/s)	dh1 (m)	TD (m²/s)	hi (m)	Q-lower limit P (mL/h)	TD-measILT (m²/s)	TD-measILP (m²/s)	TD-measIU (m²/s)	Comments
KFM10A	353.10	358.10	5	_	2.23	_	-0.49	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	358.10	363.10	5	_	2.26	1.58E-08	-0.46	5.8E-09	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	363.12	368.12	5	_	2.33	_	-0.39	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	368.13	373.13	5	_	2.37	1.11E-08	-0.37	4.0E-09	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	373.14	378.14	5	_	2.40	5.39E-08	-0.33	2.0E-08	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	378.14	383.14	5	_	2.42	_	-0.31	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	383.13	388.13	5	_	2.46	_	-0.27	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	388.14	393.14	5	_	2.50	_	-0.24	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	393.15	398.15	5	_	2.53	_	-0.21	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	398.14	403.14	5	_	2.54	_	-0.17	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	403.15	408.15	5	_	2.58	_	-0.13	_	_	30	3.0E-09	3.0E-09	3.0E-05	
FM10A	408.16	413.16	5	_	2.61	_	-0.11	_	_	30	3.0E-09	3.0E-09	3.0E-05	
CFM10A	413.16	418.16	5	_	2.69	_	-0.03	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	418.18	423.18	5	-	2.71	-	0.00	_	_	30	3.0E-09	3.0E-09	3.0E-05	
KFM10A	423.17	428.17	5	_	2.70	_	-0.21	_	_	30	2.8E-09	2.8E-09	2.8E-05	
KFM10A	428.15	433.15	5	-7.56E-06	2.73	7.44E-05	-0.09	2.9E-05	2.5	30	2.9E-09	2.9E-09	3.2E-05	
KFM10A	433.18	438.18	5	-1.91E-07	2.75	3.31E-06	0.08	1.3E-06	2.6	30	3.1E-09	3.1E-09	3.1E-05	
KFM10A	438.18	443.18	5	_	2.78	_	0.12	_	_	30	3.1E-09	3.1E-09	3.1E-05	
KFM10A	443.19	448.19	5	_	2.79	_	0.14	_	_	30	3.1E-09	3.1E-09	3.1E-05	
KFM10A	448.19	453.19	5	_	2.81	_	0.18	_	_	30	3.1E-09	3.1E-09	3.1E-05	
KFM10A	453.20	458.20	5	_	2.86	_	0.23	_	_	30	3.1E-09	3.1E-09	3.1E-05	
KFM10A	458.22	463.22	5	_	2.89	_	0.27	_	_	30	3.1E-09	3.1E-09	3.1E-05	
KFM10A	463.22	468.22	5	_	2.91	_	0.30	_	_	30	3.2E-09	3.2E-09	3.2E-05	
KFM10A	468.22	473.22	5	_	2.93	_	0.33	_	_	30	3.2E-09	3.2E-09	3.2E-05	
KFM10A	473.23	478.23	5	_	2.98	_	0.37	_	_	30	3.2E-09	3.2E-09	3.2E-05	
KFM10A	478.23	483.23	5	_	3.01	1.31E-07	0.41	5.0E-08	_	30	3.2E-09	3.2E-09	3.2E-05	
KFM10A	483.23	488.23	5	5.11E-08	3.05	2.63E-06	0.47	9.9E-07	3.1	30	3.2E-09	3.2E-09	3.2E-05	
KFM10A	488.23	493.23	5	_	3.05	_	0.44	_	_	30	3.2E-09	3.2E-09	3.2E-05	

Appendix 6.2



Appendix 7.1

Table of transmissivity and head of detected fractures

(PFL – Difference flow logging – Inferred flow anomalies from overlapping flow logging).

Borehole ID	Length to flow anom. L (m)	Lw (m)	dL (m)	Q0 (m³/s)	dh0 (m)	Q1 (m³/s)	dh1 (m)	TD (m²/s)	hi (m)	Comments
KFM10A	60.3	1	0.1	_	1.01	2.89E-06	-2.90	7.3E-07	_	*
KFM10A	62.3	1	0.1	_	1.01	1.11E-06	-2.89	2.8E-07	_	*
KFM10A	71.1	1	0.1	1.28E-08	1.03	9.72E-08	-2.82	2.2E-08	1.6	*
KFM10A	72.3	1	0.1	_	1.04	5.56E-07	-2.82	1.4E-07	_	*
KFM10A	76.2	1	0.1	8.53E-08	1.08	7.19E-06	-2.78	1.8E-06	1.1	
KFM10A	82.1	1	0.1	1.63E-07	1.21	1.18E-05	-2.63	3.0E-06	1.3	
KFM10A	84.4	1	0.1	_	1.29	4.53E-07	-2.58	1.2E-07	_	
KFM10A	85.9	1	0.1	_	1.31	1.44E-05	-2.54	3.7E-06	_	
KFM10A	87.7	1	0.1	_	1.33	3.61E-05	-2.49	9.4E-06	_	
KFM10A	87.9	1	0.1	_	1.34	1.83E-05	-2.50	4.7E-06	_	
KFM10A	89.6	1	0.1	9.64E-07	1.36	5.31E-05	-2.34	1.4E-05	1.4	
KFM10A	90.5	1	0.1	_	1.38	7.00E-06	-2.31	1.9E-06	_	
KFM10A	92.0	1	0.1	_	1.38	4.00E-06	-2.27	1.1E-06	_	
KFM10A	93.8	1	0.1	_	1.39	1.39E-06	-2.22	3.8E-07	_	*
KFM10A	94.8	1	0.1	_	1.41	1.07E-05	-2.20	2.9E-06	_	
KFM10A	95.1	1	0.1	_	1.41	1.01E-06	-2.20	2.8E-07	_	
KFM10A	96.5	1	0.1	_	1.41	1.33E-06	-2.19	3.6E-07	_	
KFM10A	98.3	1	0.1	_	1.42	5.00E-07	-2.18	1.4E-07	_	
KFM10A	99.9	1	0.1	_	1.42	2.29E-05	-2.16	6.3E-06	_	
KFM10A	101.6	1	0.1	_	1.44	1.99E-07	-2.15	5.5E-08	_	
KFM10A	103.3	1	0.1	_	1.45	7.44E-06	-2.14	2.1E-06	_	
KFM10A	103.9	1	0.1	4.44E-07	1.44	3.28E-05	-2.14	8.9E-06	1.5	
KFM10A	106.0	1	0.1	1.02E-06	1.45	4.53E-05	-2.09	1.2E-05	1.5	
KFM10A	107.3	1	0.1	_	1.48	6.08E-08	-2.09	1.7E-08	_	
KFM10A	108.3	1	0.1	_	1.48	2.08E-08	-2.08	5.8E-09	_	
KFM10A	113.0	1	0.1	_	1.51	4.25E-08	-2.06	1.2E-08	_	
KFM10A	114.6	1	0.1	_	1.52	1.75E-08	-2.05	4.9E-09	_	*
KFM10A	115.2	1	0.1	5.00E-09	1.52	3.47E-08	-2.05	8.2E-09	2.1	
KFM10A	116.9	1	0.1	_	1.50	7.36E-08	-2.04	2.1E-08	_	
KFM10A	118.7	1	0.1	8.89E-09	1.50	1.03E-07	-2.04	2.6E-08	1.8	
KFM10A	120.9	1	0.1	1.47E-08	1.50	2.34E-07	-2.05	6.1E-08	1.7	
KFM10A	122.0	1	0.1	_	1.49	2.72E-08	-2.05	7.6E-09	_	*
KFM10A	144.3	1	0.1	_	1.55	5.83E-09	-1.97	1.6E-09	_	*
KFM10A	144.7	1	0.1	_	1.55	1.53E-08	-1.96	4.3E-09	_	
KFM10A	254.9	1	0.1	_	1.91	8.33E-09	-1.25	2.6E-09	_	*
KFM10A	299.5	1	0.1	2.17E-08	2.01	1.31E-07	-1.01	3.6E-08	2.6	*
KFM10A	308.8	1	0.1	8.06E-09	2.07	3.47E-08	-0.92	8.8E-09	3.0	*
KFM10A	315.3	1	0.1	_	2.09	6.11E-07	-0.88	2.0E-07	_	*
KFM10A	322.0	1	0.1	_	2.12	2.86E-08	-0.85	9.5E-09	_	
KFM10A	327.3	1	0.1	-4.06E-08	2.13	3.03E-07	-0.82	1.2E-07	1.8	
KFM10A	328.1	1	0.1	_	2.14	5.83E-08	-0.82	2.0E-08	_	
KFM10A	328.8	1	0.1	_	2.14	6.72E-08	-0.82	2.3E-08	_	
KFM10A	332.9	1	0.1	_	2.16	1.03E-08	-0.81	3.4E-09	_	*
KFM10A	334.5	1	0.1	_	2.17	1.70E-07	-0.81	5.6E-08	_	
KFM10A	360.5	1	0.1	_	2.26	1.39E-08	-0.64	4.7E-09	_	*

Appendix 7.2

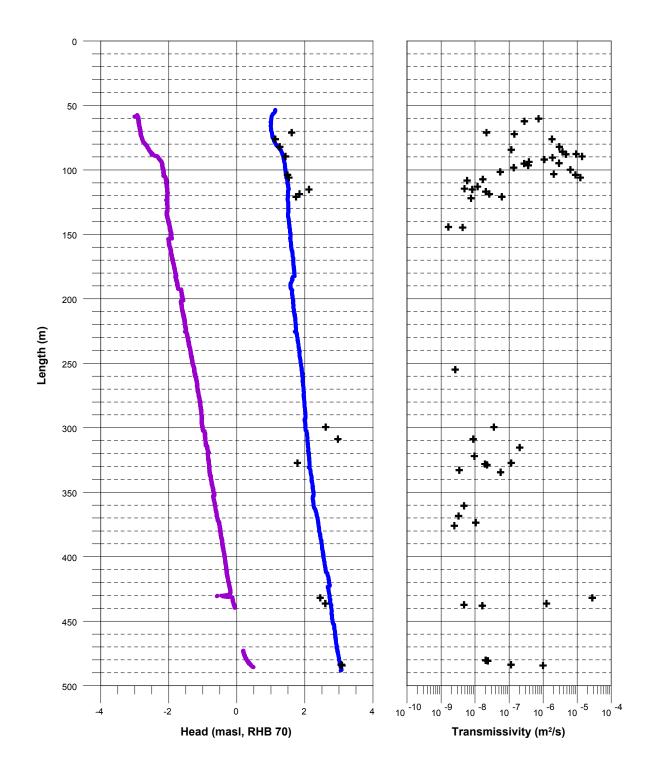
Borehole ID	Length to flow anom. L (m)	Lw (m)	dL (m)	Q0 (m³/s)	dh0 (m)	Q1 (m³/s)	dh1 (m)	TD (m²/s)	hi (m)	Comments
KFM10A	368.4	1	0.1	_	2.35	9.72E-09	-0.59	3.3E-09	_	*
KFM10A	373.6	1	0.1	-	2.39	3.06E-08	-0.51	1.0E-08	_	
KFM10A	376.0	1	0.1	-	2.40	7.22E-09	-0.51	2.5E-09	_	*
KFM10A	431.9	1	0.1	-7.53E-06	2.72	7.28E-05	-0.13	2.8E-05	2.5	
KFM10A	436.3	1	0.1	-1.94E-07	2.75	3.44E-06	-0.10	1.3E-06	2.6	
KFM10A	437.3	1	0.1	-	2.76	1.36E-08	-0.08	4.7E-09	_	*
KFM10A	438.0	1	0.1	-	2.77	4.67E-08	-0.07	1.6E-08	_	
KFM10A	480.3	1	0.1	-	3.00	5.58E-08	0.29	2.0E-08	_	
KFM10A	480.8	1	0.1	-	3.01	6.42E-08	0.32	2.4E-08	_	
KFM10A	483.8	1	0.1	4.44E-09	3.03	3.06E-07	0.41	1.1E-07	3.1	
KFM10A	484.4	1	0.1	4.83E-08	3.04	2.67E-06	0.42	9.9E-07	3.1	

^{*} Uncertain = The flow rate is less than 30 mL/h or the flow anomalies are overlapping or they are unclear because of noise.

Forsmark, borehole KFM10A Transmissivity and head of detected fractures

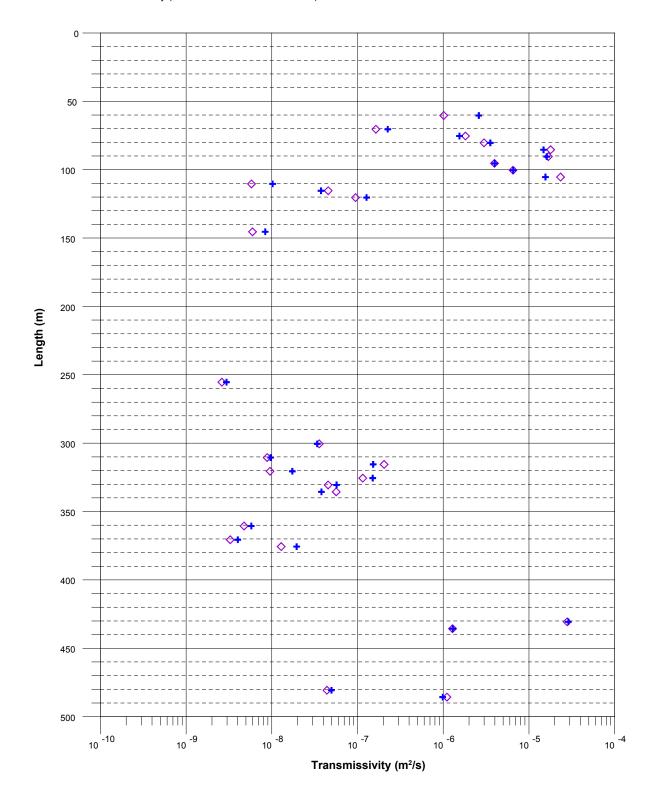
- ♣ Fracture head
- Head in the borehole without pumping (L=5 m, dL=0.5 m) 2006-06-20 2006-06-21
- Head in the borehole with pumping (L=1 m, dL=0.1 m) 2006-06-28 2006-06-30

+ Transmissivity of fracture



Forsmark, borehole KFM10A Comparison between section transmissivity and fracture transmissivity

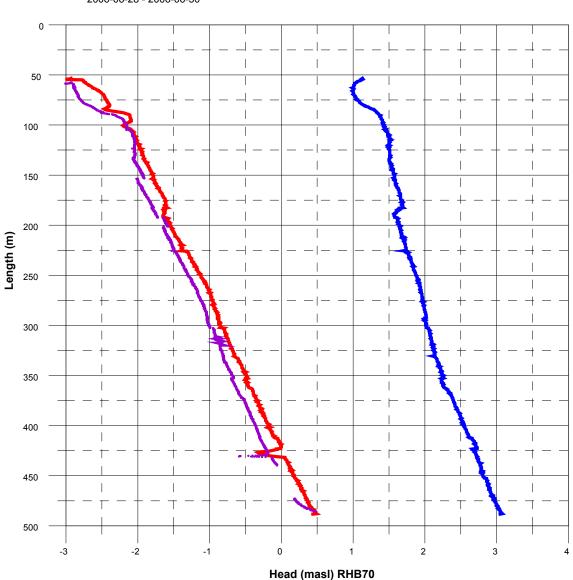
- ♦ Transmissivity (sum of fracture specific results Tf)
- + Transmissivity (results of 5m measurements Ts)



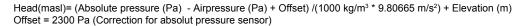
Forsmark, borehole KFM10A Head in the borehole during flow logging

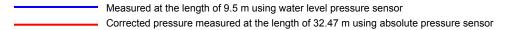
Head(masl)= (Absolute pressure (Pa) - Airpressure (Pa) + Offset) $/(1000 \text{ kg/m}^3 * 9.80665 \text{ m/s}^2)$ + Elevation (m) Offset = 2300 Pa (Correction for absolut pressure sensor)

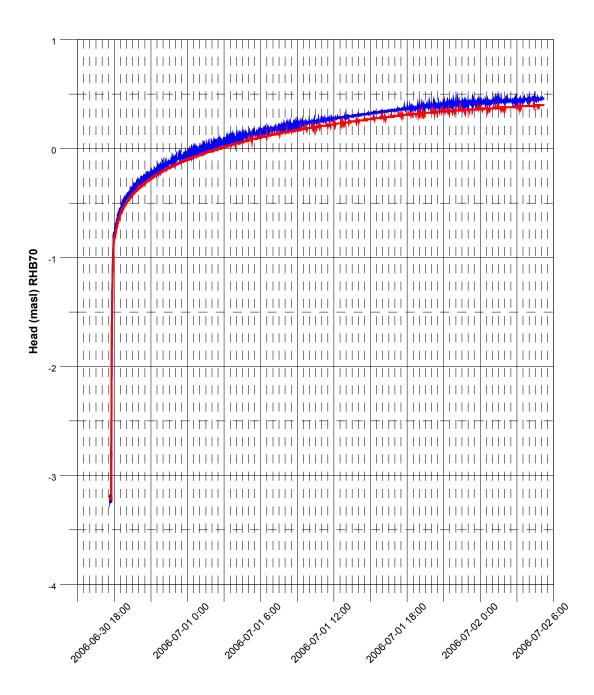
- Without pumping (upwards during flow logging, L=5 m, dL=0.5 m), 2006-06-20 2006-06-21
- With pumping (upwards during flow logging, Drawdown =4 m, L=5 m, dL=0.5 m), 2006-06-27 2006-06-28
 - With pumping (upwards during flow logging, Drawdown =4 m, L=5 m, dL=0.5 m), 2006-06-28-2006-06-30



Forsmark, borehole KFM10A Groundwater recovery after pumping







Year-Month-Day / Hour:Minute

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