

Supplementary material for article

Microbial communities and isotopes as novel tracers for groundwater flow paths in the multi-layered aquifer system in Kurikka, western Finland

Lotta Purkamo¹, Juuso Ikonen¹, Marie-Amelie Pétré¹, Niko Putkinen¹, Minna Myllyperkiö¹, Anna-Maria Hokajärvi², Tarja Pitkänen^{2,3}, Ilkka Miettinen²

¹Geological Survey of Finland (GTK), Espoo, 02150, Finland

²Finnish Institute for Health and Welfare (THL), Department of Public Health, Kuopio, 70210, Finland

³University of Helsinki, Faculty of Veterinary Medicine, Helsinki, 00014, Finland

Supplementary material includes three tables and three Krona-charts as .html-files in a zipped folder.

Supplementary Table 1: Geochemistry analysis results from the sampled water

ID	Ag	Al	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu	I	Li	Mn
	0.01	1	0.1	2	0.05	0.1	1	0.02	0.05	0.2	0.1	2	0.1	0.02
	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
NOPPA15	<0.01	2.1	2.48	6.55	17.4	<0.1	<1	<0.02	1.25	<0.2	<0.1	10.2	4.68	426
MIHP6	<0.01	3.12	0.2	8.59	17.2	<0.1	<1	<0.02	0.14	<0.2	<0.1	2.16	6.45	214
MIHP15	<0.01	1.26	3.07	7.54	22.6	<0.1	<1	<0.02	<0.05	<0.2	<0.1	3.88	5.66	403
R56	<0.01	3.52	<0.1	42	1.82	<0.1	<1	<0.02	<0.05	<0.2	0.14	15.4	1.39	52.3
LOHI30	<0.01	7.01	9.52	6.99	21.5	<0.1	<1	<0.02	<0.05	0.3	<0.1	2.9	4.25	969
KUU19	<0.01	<1	<0.1	2.79	6.82	<0.1	<1	<0.02	<0.05	0.55	<0.1	2.37	3.69	0.68
HÄJY30	<0.01	1.01	9.35	13.2	29.9	<0.1	<1	<0.02	0.16	<0.2	<0.1	5.29	4.91	594
MIETO17	<0.01	3.28	1.03	6.41	13.9	<0.1	<1	<0.02	0.74	<0.2	<0.1	2.24	6	654
HARJA10	<0.01	6.69	21	3.3	13.6	<0.1	<1	<0.02	2.16	1.26	0.11	2.1	2.74	563
HÄJY11	<0.01	1.63	<0.1	6.16	9.33	<0.1	<1	<0.02	<0.05	<0.2	<0.1	<2	4.18	2.29

ID	Mo	Ni	P	Pb	Rb	Sb	Se	Sn	Sr	Th	Tl	U	V	Zn
	0.1	0.05	50	0.05	0.01	0.1	0.5	1	0.1	0.01	0.01	0.01	0.05	0.5
	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
NOPPA15	<0.1	1.47	129	<0.05	0.5	<0.1	<0.5	<1	101	<0.01	<0.01	0.02	0.13	0.78
MIHP6	<0.1	0.22	<50	<0.05	0.16	<0.1	<0.5	<1	46.7	<0.01	<0.01	0.03	0.13	<0.5
MIHP15	<0.1	<0.05	194	<0.05	0.73	<0.1	<0.5	<1	82.7	<0.01	<0.01	<0.01	0.07	<0.5
R56	<0.1	<0.05	64.8	<0.05	1.95	<0.1	<0.5	<1	91.5	<0.01	<0.01	0.1	<0.05	<0.5
LOHI30	<0.1	0.06	681	<0.05	0.27	<0.1	<0.5	<1	86	<0.01	<0.01	0.02	1.13	0.5
KUU19	<0.1	0.42	<50	<0.05	0.02	<0.1	<0.5	<1	38.3	<0.01	<0.01	0.02	0.18	5.01
HÄJY30	<0.1	0.08	489	<0.05	0.26	<0.1	<0.5	<1	107	<0.01	<0.01	0.02	0.11	4.68
MIETO17	<0.1	0.58	118	<0.05	0.44	<0.1	<0.5	<1	70.1	<0.01	<0.01	<0.01	0.12	1.18
HARJA10	<0.1	2	698	<0.05	0.24	<0.1	<0.5	<1	74	0.01	<0.01	0.04	2.48	3.61
HÄJY11	<0.1	0.14	<50	<0.05	0.08	<0.1	<0.5	<1	56.5	<0.01	<0.01	0.02	0.25	1.21

ID	Ca	Fe	K	Mg	Na	S	Si	DOC	TOC	Br	Cl	F	NO3	SO4
	0.1	0.03	0.1	0.1	1	0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.2	0.1
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l							
NOPPA15	14.8	4.32	2.08	5.27	8.45	5.87	12.6	1.9	2	<1.0	7.6	0.1	<0.50	13
MIHP6	8.01	0.08	1.47	4.24	9.77	0.7	11.7	1.5	1.2	<1.0	1.7	0.7	<0.50	2.4
MIHP15	11.1	4.88	1.78	5.75	8.82	0.34	14.5	0.93	1.9	<1.0	2.6	0.3	<0.50	1.6
R56	10.2	0.39	1.08	2.09	46.5	0.5	8.1	1.6	2.2	<1.0	25	0.9	<0.50	2
LOHI30	11.5	9.75	1.65	4.85	6.57	0.26	15.6	2.7	2.9	<1.0	2.5	0.5	<0.50	1.4
KUU19	4.71	<0.03	1.12	2.34	5.39	0.39	10.7	0.93	1.5	<1.0	3.4	0.1	4.6	1.6
HÄJY30	15.8	4.33	1.88	6.83	11.6	0.57	14.9	2	1.4	<1.0	4.9	0.6	<0.50	1.8
MIETO17	8.42	1.47	1.97	4.03	8.32	0.93	14.6	1.3	1.2	<1.0	2.8	0.2	<0.50	2.7
HARJA10	7.76	31.5	1.54	3.37	4.82	<0.2	16.9	6.2	4.9	<1.0	5.1	0.5	<0.50	1.3
HÄJY11	7.52	<0.03	0.91	3.31	6.99	0.64	10.7	0.85	1	<1.0	1.8	0.1	<0.50	2.2

Supplementary Table 2. Sequencing statistics and ecological indices of bacteria, archaea and fungi

BACTERIA	input	filtered	denoisedF	nonchim	Observed	Shannon	InvSimpson		
HAJY30	88888	85405	82200	81763	1057	3,95	6,87		
MIETO17	111250	106901	103249	101466	1834	6,52	231,53		
NOPPA15	129603	124232	117975	116287	2468	6,69	198,54		
R56	116297	111468	110460	109656	329	2,91	6,69		
HARJA10	130910	125196	121306	120011	1897	6,25	138,12		
MIHP15	109288	104778	103311	99368	548	3,63	13,7		
LOHI30	310409	298127	294683	285277	3059	5,74	57,94		
ARCHAEA	input	filtered	denoisedF	nonchim	Observed	Shannon	InvSimpson		
HAJY30	180447	176050	173106	169508	1064	5,25	43,97		
MIETO17	126127	122966	120371	119426	670	4,67	20,45		
NOPPA15	139103	135718	132073	129952	1322	5,97	155,91		
R56	127166	123781	121905	120954	287	3,81	19,12		
HARJA10	143069	139093	135949	133467	947	5,24	35,96		
MIHP15	186686	181007	179189	178824	287	2,05	3,69		
FUNGI	input	filtered	denoisedF	denoisedR	merged	nonchim	Observed	Shannon	InvSimpson
HAJY30	74756	31808	31568	31177	30332	30332	202	3,91	22,03
MIETO17	106318	41977	41395	40931	39543	39443	183	3,59	15,37
NOPPA15	97693	35631	35062	34793	33596	33596	218	3,83	18,72
R56	95089	34793	34137	33812	32020	32020	266	4,04	18,02
HARJA10	150494	89321	88978	88551	84325	83575	261	2,66	4,80
MIHP15	125638	62057	61428	60942	56223	56068	197	2,22	3,05

Supplementary Table 3. Prevalence of bacterial and archaeal ASVs in phylum level

BACTERIA			ARCHAEA		
Phylum	any ASV belonging to the phylum on average	total prevalence numbers of all phylum' ASVs	Phylum	any ASV belonging to the phylum on average	total prevalence numbers of all phylum' ASVs
Patescibacteria	1.378026	2220	Nanoarchaeota	1.729965	2979
Verrucomicrobiota	1.550877	1768	Micrarchaeota	1.716418	460
Chloroflexi	1.424125	1464	Crenarchaeota	1.804233	341
Proteobacteria	1.301911	1022	Iainarchaeota	1.466102	173
Nanoarchaeota	1.404463	1007	NA	1.586538	165
Bacteroidota	1.203463	556	Aenigmarchaeota	1.707865	152
Desulfobacterota	1.771127	503	Thermoplasmatota	1.869565	129
Firmicutes	1.401099	255	Halobacterota	1.764706	90
Acidobacteriota	1.360000	238	Euryarchaeota	1.485714	52
Actinobacteriota	1.320755	210	Altiaarchaeota	1.700000	17
Nitrospirota	1.568182	207	Hadarchaeota	1.875000	15
Micrarchaeota	1.320611	173	Hydrothermarchaeota	1.000000	4
Sva0485	2.047619	172			
Elusimicrobiota	1.226562	157			
Planctomycetota	1.094203	151			
Myxococcota	1.287234	121			
Iainarchaeota	1.391892	103			
Crenarchaeota	1.508772	86			
Methyloirabilota	2.088235	71			
Spirochaetota	1.244898	61			
Latescibacterota	1.270833	61			
Aenigmarchaeota	1.500000	54			
Bdellovibrionota	1.045455	46			
Cyanobacteria	1.166667	42			
Zixibacteria	1.950000	39			
Halobacterota	1.789474	34			
WOR-1	1.476190	31			
Gemmatimonadota	1.428571	30			
Thermoplasmatota	1.588235	27			
Armatimonadota	1.333333	24			
Fibrobacterota	1.150000	23			
Euryarchaeota	1.583333	19			
Dependentiae	1.000000	18			
DTB120	1.062500	17			
Campylobacterota	2.000000	16			
MBNT15	1.555556	14			
Desantisbacteria	1.181818	13			
Sumerlaeota	1.222222	11			
Nitrospinota	1.571429	11			
Edwardsbacteria	2.200000	11			
Margulisbacteria	1.250000	10			
NKB15	2.500000	10			
TA06	1.125000	9			
CK-2C2-2	1.600000	8			
WS4	1.750000	7			
Caldisericota	1.200000	6			
WPS-2	1.200000	6			
Caldatribacteriota	3.000000	6			
FCPU426	1.000000	5			
WS2	1.000000	5			
Hadarchaeota	1.666667	5			
LCP-89	2.500000	5			
Calditrichota	1.000000	4			
Firestonebacteria	1.000000	4			
Schekmanbacteria	1.333333	4			
Abditibacteriota	1.000000	3			
Acetothermia	1.000000	2			
Entotheonellaeota	1.000000	2			
Hydrogenedentes	1.000000	2			
NB1-j	1.000000	2			
TX1A-33	1.000000	1			

Supplementary Figure 1: a) Bacterial b) archaeal and c) fungal communities in groundwater samples, shown as interactive Krona-charts.

Provided as .html -files

Kurikkabac-krona1.html

Kurikkaarc-krona1.html

Kurikkafun-krona1.html