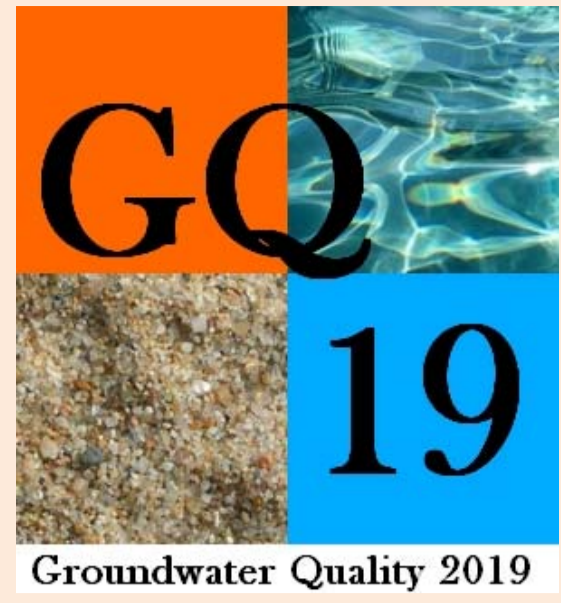
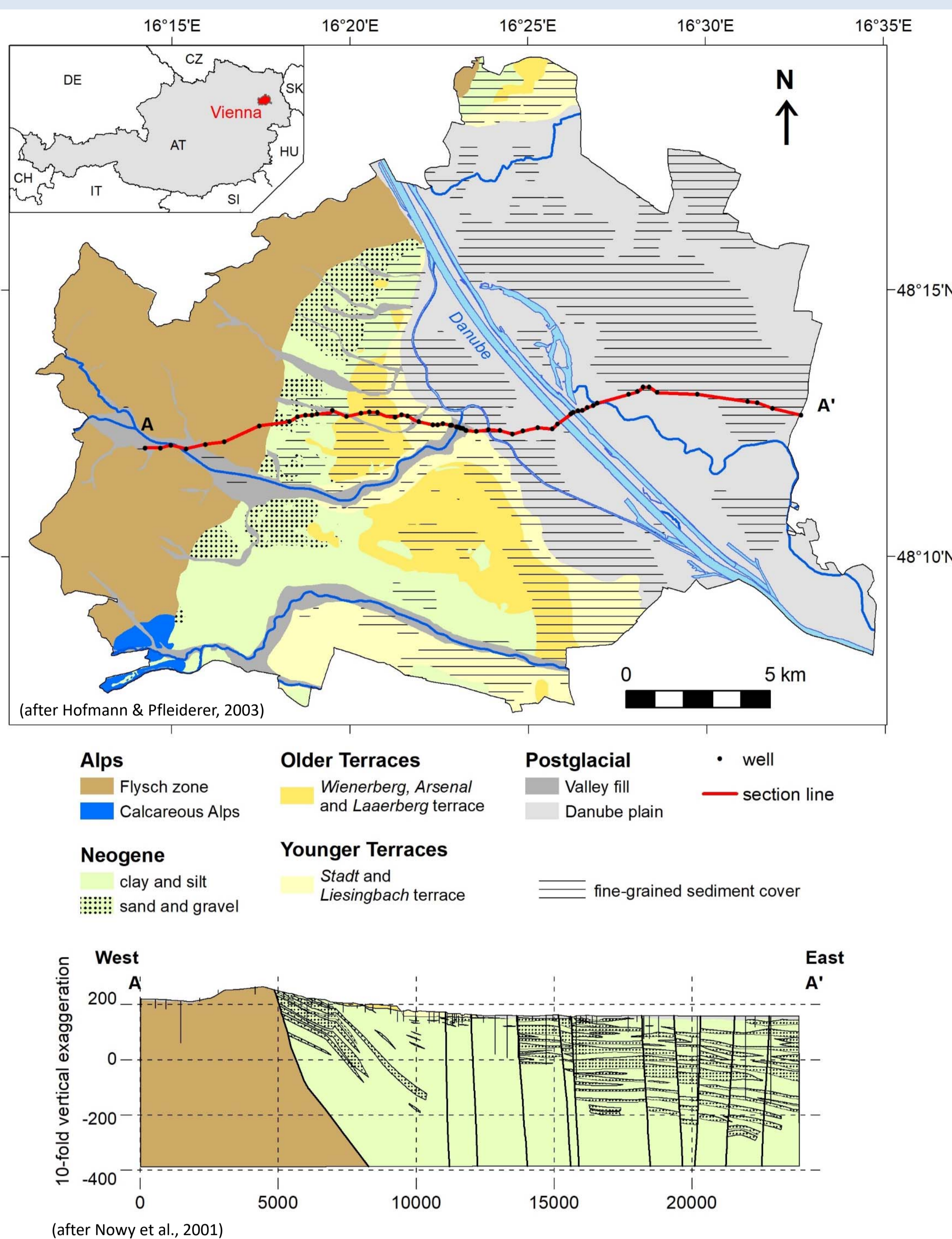


HYDROCHEMISTRY OF GROUNDWATER IN THE CITY OF VIENNA, AUSTRIA



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Hydrogeological unit	Calcareous Alps	Flysch zone	Neogene	Older terraces	Younger terraces	Danube plain	Valley fill
sealed area	5 %	10 %	43 %	56 %	48 %	31 %	53 %
conditions for groundwater recharge	high infiltration rates	high infiltration rates in sandstones, strongly reduced recharge in clay- and marlstones	strongly reduced recharge due to sealing and loess cover, possible infiltration from leaky sewage systems	strongly reduced recharge due to sealing and loess cover, possible infiltration from leaky sewage systems	strongly reduced recharge due to sealing and loess cover, possible infiltration from leaky sewage systems	reduced recharge due to sealing and loam cover, river filtrate of the Danube	strongly reduced recharge due to sealing, possible infiltration from leaky sewage systems
lithology	limestone, dolomite	sandstone, claystone, marlstone	silt and clay with sand and gravel intercalations	sandy gravel with a significant portion of sand and silt intercalations	sandy gravel deposits with few sand and silt intercalations	sandy gravel with thin silt intercalations	silt, sand and gravel
aquifer type	karst aquifer	fracture aquifer	porous aquifer	porous aquifer	porous aquifer	porous aquifer	porous aquifer
occurrence and yield	local, low yield	separate, partially confined aquifers in sandstone layers, low yield	partially connected, partially artesian aquifers in coarse-grained layers, low yield	local, unconfined aquifers with flow along subsurface channels, moderate yield	local, unconfined aquifers, hydraulically linked to Danube plain, moderate yield	continuous, unconfined aquifer, high yield	local, unconfined aquifers with flow parallel to streams, moderate yield
groundwater use (number of extraction sites)		irrigation (4) industrial water (2) drinking water (3)	irrigation (18) geothermal heat (10) industrial water (16) drinking water (2)	irrigation (6) industrial water (4)	irrigation (16) geothermal heat (32) industrial water (9)	irrigation (827) geothermal heat (692) industrial water (236) drinking water (22)	irrigation (2) geothermal heat (4) industrial water (2)
Neogene underlying Quaternary sediments							
lithology	silt and clay, especially in the Upper Pannonian sand and gravel intercalations						
aquifer type	porous aquifer						
occurrence and yield	partially connected, partially artesian aquifers in coarse-grained layers, moderate yield						
groundwater use (number of extraction sites)	irrigation (18), geothermal heat (9), industrial water (12), drinking water (2)						
Calcareous Alps (deep geothermal aquifer)							
aquifer type and yield	artesian karst aquifer, high yield						
groundwater use (number of extraction sites)	balneology (2)						

Major ions

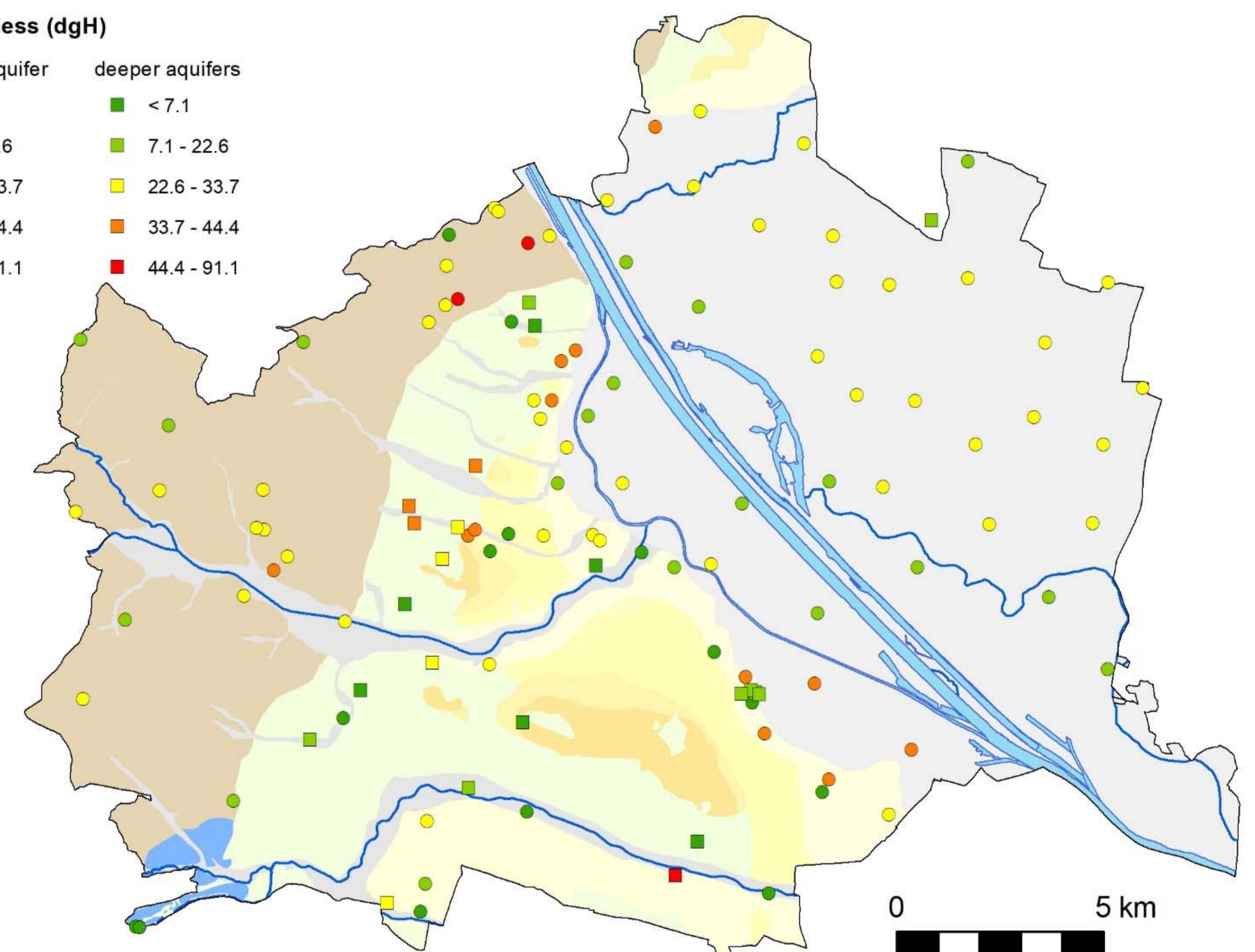
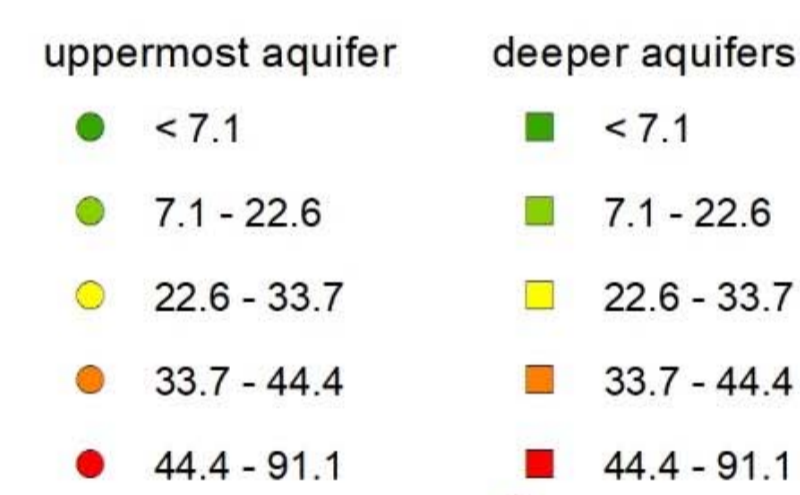
The table below lists median values of major ion concentration in groundwater samples, grouped by hydrogeological unit. In general, values are highest in groundwater of postglacial deposits and decrease towards the Pleistocene and Neogene deposits, the Flysch zone and the Calcareous Alps, which show the lowest concentrations.

Within the Danube plain, the regional distribution of individual major ion concentrations shows a distinct pattern. Values for Ca, Mg, Na, SO₄, Cl and NO₃ are generally low near the Danube River and increase towards the East and West. This is due to river filtrate from the Danube which is less mineralised and dilutes the groundwater near the river.

20 % of groundwater samples in the Flysch zone exceed the Austrian national drinking water guideline values for Mn concentrations (50 µg/l). The natural chemical composition of Flysch rocks is the most likely cause for this. The frequent exceedance of Fe, Mn and Na concentrations in groundwater within Neogene units may also have natural causes, as samples here were taken at great depth (100 m below ground on average) and are thus more highly mineralized. 25 % of groundwater samples in the Danube plain, and 50 % of groundwater samples in the younger terraces, exceed NO₃ concentrations of 50 mg/l. Here, anthropogenic activities, such as fertilization of agricultural land, are assumed to be the cause.

parameter	valley fill	Danube plain	younger terraces	older terraces	Neogene	Flysch zone	Calcareous Alps	Calcareous Alps (deep geothermal aquifer)
number of analyses	2	284	57	6	18	129	13	3
Ca (mg/l)	165.1	116.5	112.25	112.21	96	143.84	92.288	446.6
Cl (mg/l)	40	100.745	51.9175	40	26	13.73	14.373	840
Fe (mg/l)	0.07	0.005	0.0075		0.135	0.014	0.025	< 0.015
H ₂ SiO ₃ (mg/l)						18.36	8.955	42.9
HCO ₃ (mg/l)	452	392	399.5	385.5	422	407	328.92	263.5
K (mg/l)		9.7175	6.515		2	2.3275	2.01	23.8
Mg (mg/l)	48.55	41.7	65.995	60.61	30.16	24.62	21.015	133
Mn (mg/l)	0.03	0.0015	0.0015		0.1	0.0023	0.0007	< 0.015
Na (mg/l)		48.825	51.5		27.56	11.245	9.01	531
NH ₄ ⁺ (mg/l)		0.005	0.005		1	0.03	0.0275	1.31
NO ₂ (mg/l)		0.0025	0.0025			0.011	0.0068	
NO ₃ (mg/l)		39.805	28.835		0.5	12.453	4.53	< 0.35
PO ₄ (mg/l)		0.0295	0.0325			0.08	0.1	
SO ₄ (mg/l)	175	112.5	151.6	152	93.5	80	33.065	1302
Sr (mg/l)						1.385	0.565	13.9
TDS (mg/l)	881	856	951	770	738	727	483	3700.89
total hardness (dGH)	33.6	26.1	31.3	32.0	20.3	25.5	22.1	
carbonate hardness (dGH)	18.0	18.0	19.6	17.7	19.4	18.7	15.8	

Total hardness (dgH)



Trace elements

The table below lists median values of trace element concentration in groundwater samples, grouped by hydrogeological unit. None of the analyses show concentrations above Austrian national drinking water guideline values. For groundwater in Quaternary units, maximum concentrations of Al, As, Cd, Cr, Cu, Hg, Ni, Pb and Zn are 2 – 50 times lower than the guideline values, in the Flysch zone and the Calcareous Alps even 6 – 104 times lower.

parameter	valley fill	Danube plain	younger terraces	Flysch zone	Calcareous Alps	Calcareous Alps (deep geothermal aquifer)
number of analyses	2	145	26	114	12	1
Al (µg/l)		3.5	3.5	7.45	6.6	< 20
As (µg/l)	0.5	0.875	0.5	0.45	0.28	7
Cd (µg/l)	0.05	0.04	0.04		0.1	< 0.3
Cr (µg/l)	1	0.3	1.275	0.2	0.2	< 5
Cu (µg/l)		2.3	2.5	3.8	5.7	< 5
Hg (µg/l)	0.25	0.035	0.035			0.19
Ni (µg/l)		0.425	0.35			< 2
Pb (µg/l)	2.5	0.35	0.35	0.45	0.3	3
Zn (µg/l)		8.25	10	13	17.75	< 100