TRACE ELEMENTS IN GROUNDWATER USED FOR WATER SUPPLY IN LATVIA

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INTRODUCTION

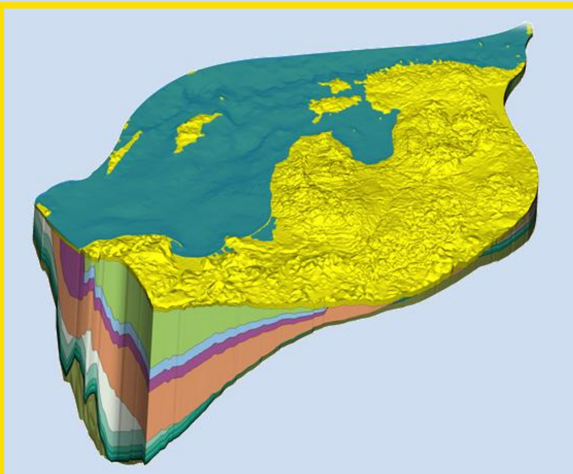

Figure 1. **Baltic Artesian basin**

The territory of Latvia is a part of the Baltic Artesian (Sedimentary) basin which considering water chemistry and water exchange intensity between aquifers can be divided into three major zones:

- **freshwater** (active water exchange),
- **saline** (delayed exchange),
- **brines** (passive water exchange zone).

Latvia is rich with groundwater resources of various chemical composition, therefore groundwater is the main drinking water source. Nevertheless, groundwater quality can be easily affected by pollution or overexploitation (for example, the formation of Riga depression cone in early 60's).

Generally trace elements are present in small quantities in low mineralised, unpolluted groundwater. On the one hand many trace elements are biologically essential and their deficiency can cause disorders or even illnesses, on the other hand some of them can become toxic when reach certain levels.

Most of studies on trace element content in aquifer systems concentrate on anthropogenic pollution and there are no large studies about the natural baseline concentrations of trace elements in Latvia.

THE AIM OF THE STUDY

... was to determine natural major and trace element concentrations in aquifers mainly used for water supply in Latvia and to find out the main geochemical processes affecting the quality of groundwater.

MATERIALS AND METHODS

The data on groundwater physical and chemical properties including trace element data from the previous studies (Levins and Gosk, 2007) were analyzed for the first time along with the new groundwater monitoring results in 2013 and the data collected from water supply wells during the groundwater prospect prior investigation (period 1998-2013).

Principal component analysis (PCA) with Varimax rotation was performed using SPSS 19. A preliminary cleaning of the data set included removal of strong outliers, variables with a poor reproducibility and variables with missing data more than 30% (including non-detects). The observations below detection limit (<DL) were substituted with 50% of DL.

References:

Levins I., Gosk, E. 2007. Trace elements in groundwater as indicators of anthropogenic impact. Environmental Geology, 55, 285–290.

Retike, I., Kalvans, A., Delina, A., Babre, A., Raga, B., Perkone, E., Bikse, J. 2012. Trace element content, source and distribution regularities in groundwater of Baltic Artesian basin. Vol. 14, EGU2012-942, 2012.

RESULTS

Table 1

Component Matrix*

	PC 1	PC 2	PC 3	PC 4
SO4	0,971	-0,001	0,029	-0,045
Ca	0,958	-0,104	0,055	0,084
TDS	0,945	0,053	0,095	0,227
F	0,737	0,235	-0,005	0,043
Na	-0,006	0,929	0,056	0,071
Br	0,02	0,834	-0,004	-0,196
Cl	-0,047	0,823	-0,103	0,179
K	0,115	0,649	0,076	0,372
B	0,393	0,583	0,215	-0,137
Fetot	0,018	-0,076	0,828	0,135
Mn	0,083	0,029	0,694	0,038
NH4	0,102	-0,026	0,571	0,036
As	-0,154	0,197	0,567	0,101
NO3	-0,151	-0,02	-0,529	0,481
HCO3	0,04	-0,059	0,253	0,826
Mg	0,283	0,245	0,065	0,772

*Rotation Method: Varimax with Kaiser Normalization

The first four PC explains 67,92% of total variance of the data set presented in Table 1.

PC 1 shows positive loadings of Ca, SO_4, TDS and F. Coponent describes Ca-SO_4 type waters formed by gypsum dissolution. F is present in secundary minerals of evaporites.

PC 2 shows positive loadings of Na, Cl, K, Br and B. It describes saline groundwater or groundwater with Cl ion as dominant anion formed by mixing with deeper, more mineralised water or sea water.

PC 3 shows positive loading of Fe_{tot}, Mn, NH_4 and As. Component represents metal dependence on acidity in presence of organic substances in oxidising conditions.

PC 4 shows positive loading of Mg, HCO_3 and NO_3. The results describe the most common water type with HCO_3 as dominant anion in reducing conditions.

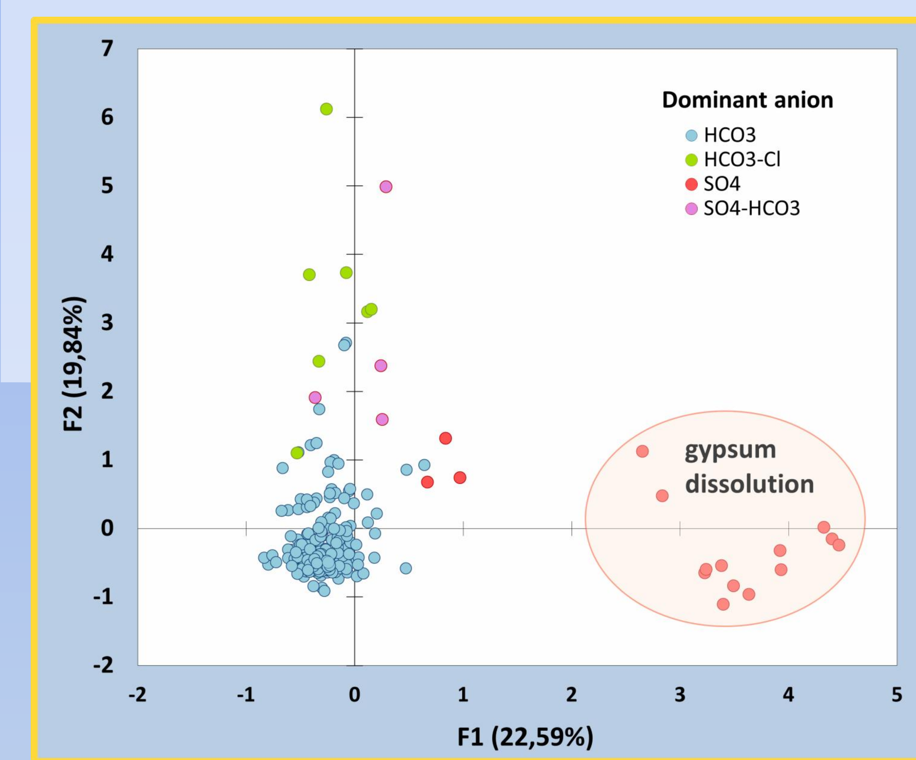

Figure 2. **F1 scores vs F2 scores**

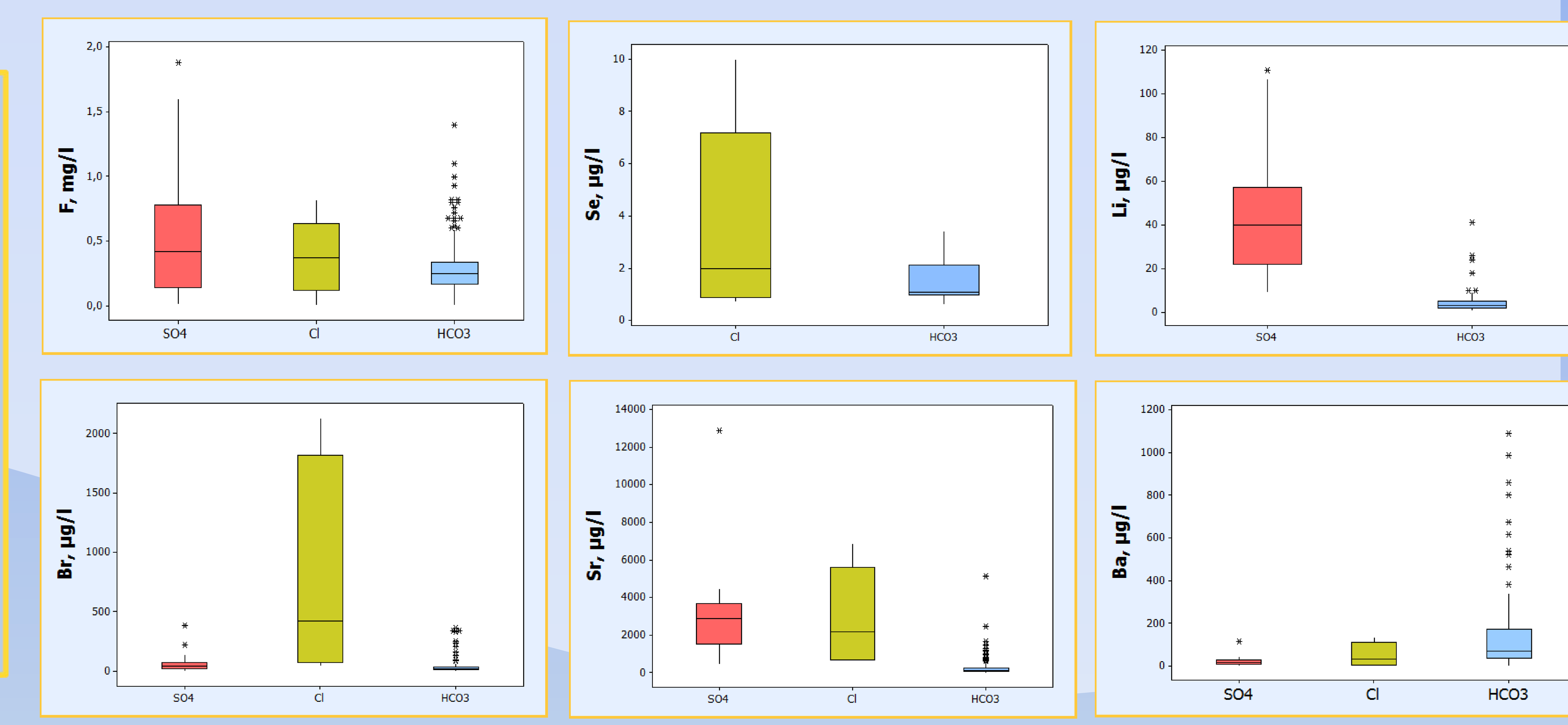

Figure 3. **Trace element concentrations in SO_4, Cl and HCO_3 anion dominant waters**

SUMMARY

- The main natural processes affecting the quality of drinking groundwater are gypsum dissolution and low mineralised groundwater mixing with water of higher mineralisation.
- The highest F and Li concentrations are observed in sulphate rich groundwater due to gypsum dissolution.
- In groundwater with Cl as dominant anion are the highest Se, Sr, Br and B concentrations.
- The highest Ba concentrations are observed in HCO_3 water type, while the lowest in SO_4 rich groundwater. Hight SO_4 content in groundwater limits dissolved Ba concentrations due to Ba precipitation.

Acknowledgement

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