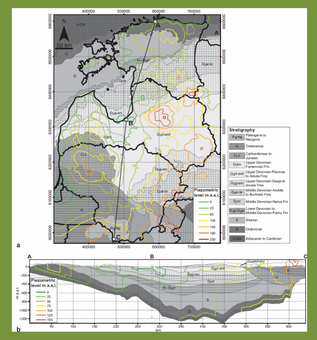
25-29th September 2016 Montpellier, France CORUM CONFERENCE CENTER 43rd IAH congress

A $\delta^{18}O$ isoscape for the shallow groundwater in the Baltic Artesian Basin

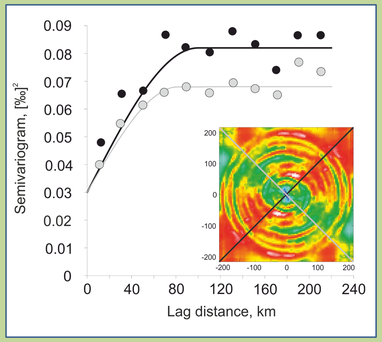
Valle Raidla[1], Zoltan Kern[2], Alise Babre[3], Jüri Ivask[1], Balázs Kohán[4], Tõnu Martma[1], Robert Mokrik[5], Joonas Pärn[1], Rein Vaikmäe[1]

Abstract n°1430

The study focused on geospatial modelling to estimate the isotopic composition of shallow groundwater on the territory of the Baltic States and to determine the interaction between precipitation and groundwater, based on water isotopes in the Baltic Artesian Basin (BAB). The BAB covers the territories of the Baltic States and parts of Russia, Poland, Sweden and Belarus. The study was based on 150 groundwater samples collected from springs and wells with depths of 10 to 70 m in Estonia, Latvia and Lithuania.

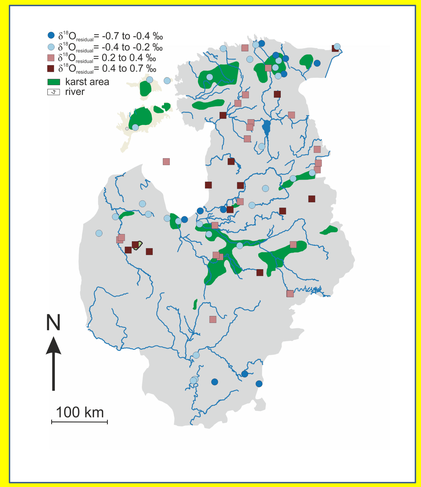


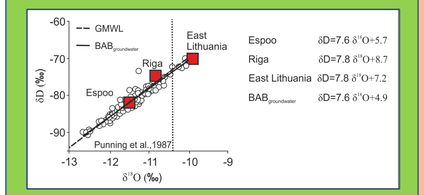
The topography of the BAB is low and slightly dissected, without any natural barriers against air mass movement. Groundwater flow in local and intermediate flow systems in the shallow and intermediate depths is directed from recharge areas in the uplands towards discharge areas in river valleys, lake depressions and the Baltic Sea according to groundwater piezometric levels.



An experimental variogram was utilized to analyse spatial variability of random variables. The directional variograms generally pointed out smaller variance along the SE-NW (gray line) and larger variance along the NE-SW directions (black line) indicating a zonal anisotropy component. A weak first sill was discernible at ~40 km. Directional variograms indicated there was a second sill robustly spreading in all directions in the variogram surface and presented a shorter range (~75 km) in the SE-NW direction and a slightly longer range (~90 km) in the NE-SW direction.

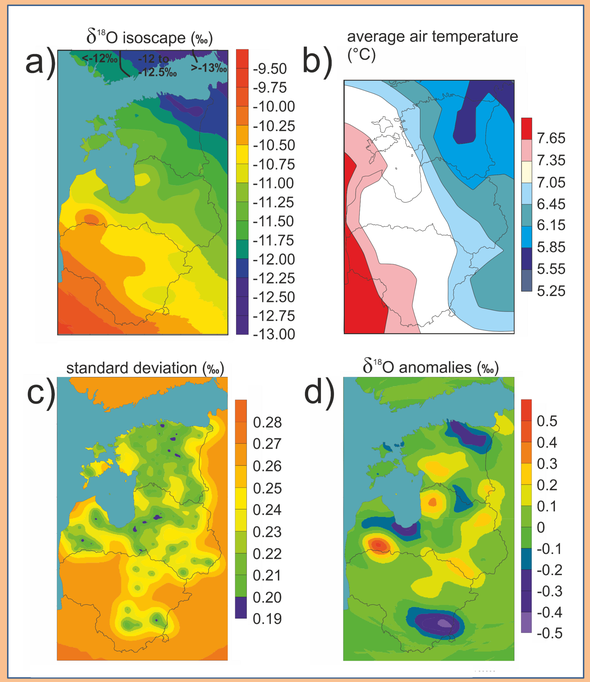
The compiled isoscape map shows abrupt local changes in $\delta^{18}O$ values (up to 1‰ in 50 km), which is abnormal to flat areas. We believe these phenomena depend on surface runoff conditions. The dense network of rivers or canals prevents the infiltration of autumn storm waters and spring meltwaters into the ground, while karst areas produce more negative isotopic composition in the local groundwater. While in the northern part of the BAB, karst areas and related spring systems serve as sources of rivers, the karst areas in the central part of the BAB are often drained by rivers that have good connection with karstic crevice systems. They cause anomalies in local recharge balance.





$\delta^{18}O$ mostly depleted with respect to precipitation values measured in GNIP station in Riga; similar result was obtained from Tiirikoja (Estonia), published by Punning et al. (1987). It is possible that the increased evapotranspiration rates during the summer growing season allow plants to consume most of the precipitation input, which means that groundwater is mostly recharged by isotopically more depleted snowmelt and autumn precipitation.

The measured $\delta^{18}O$ values varied from –10.7 to –12.5‰ and δD values from –80.4 to –90.4‰. More negative values were observed in the northern part of the basin, less depleted input signal in the southern part of the BAB (Fig a). Due to low data density, the standard deviation is the lowest in the southern part of the BAB (Fig. c), which is why the isoscape map covering that region is more speculative. Kortelainen and Karhu (2004) conducted the geographically closest long-term study on isotopic composition in shallow groundwaters of Finland. Our extrapolated isoscape map matches well with their results from southern Finland, despite the high standard deviation (0.3; Fig. a). The correlation between $\delta^{18}O$ isoscape and average local air temperatures is 0.72. It is also reflected in similarit between $\delta^{18}O$ values and temperatuure variations in Figures a and b.



Conclusion: isotopic composition shallow ground $\delta^{18}O$ of the collected water samples in the BAB area is more depleted compared to local precipitation, which due to seasonal variation in evapotranspiration and spatial difference of surface runoff.

Acknowledgements: Financial support by the Balace Institute in Hungary. The study is contributed to the Estonian Research Council Project IUT 19-22 and PUTJD 127.

1 Institute of Geology at Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn, Estonia; valle.raidla@ttu.ee
2 Institute for Geological and Geochemical Research, Research Centre for Astronomy and Earth Sciences, MTA, Budaörsi út 45. Budapest, Hungary
3 Department of Environmental and Landscape Geography, Eötvös University, Pázmány P stny 1/c, Budapest, Hungary
4 Faculty of Geography and Earth Sciences, Centre of Geological Processes Research and Modelling, University of Latvia, Riga, Latvia;
5 Department of Hydrogeology and Engineering Geology, Vilnius University, Èiurlionio 21, 2009 Vilnius, Lithuania

References

Kortelainen, N.M., Karhu, J.A., 2004. Regional and seasonal trends in the oxygen and hydrogen isotope ratios of Finnish groundwaters: a key for mean annual precipitation. Journal of Hydrology 285, 143-157.

Punning, J.M., Toots, M., Vaikmäe, R., 1987. O-18 in Estonian natural-waters. Isotopenpraxis 23, 232-234.