



## **Analysis of multicomponent groundwater flow in karst aquifer by CFC, tritium, tracer test and modelling, case study at Skaistkalnes vicinity, Latvia**

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Groundwater in karst environments tends to have difficulties to distinguish multiple flows if several sources of water are present. Skaistkalne vicinity faces with such situation where old groundwater, fresh groundwater and inflow from river Iecava occurs. Attempts were made to distinguish groundwater residence time of multiple components of water applying CFC and tritium dating techniques supplied by tracer test and numerical model of study area.

Study area covers territory between two rivers Iecava and Memele with water level difference of 7 meters and horizontal distance of 2.2 kilometres between both. Study area consists of karst affected Devonian gypsum and carbonaceous rocks covered by Quaternary low to high permeable deposits. Confined groundwater at depth of 10-25 meters where analysed by CFC's and tritium. At this depth groundwater exhibits anoxic reducing environment that has caused degradation of CFC's at similar degree in all samples. Taking it into account, mean residence time based on CFC piston flow model is 22 – 42 years and 28 – 34 years based on binary mixing model. Tritium results show signs of incensement of groundwater residence time towards discharge area. CFC combined with tritium proved increased vertical velocity in middle part between the rivers likely caused by hydrogeological window in Quaternary deposits created by karst processes. Numerical model (Delina et al. 2012) was applied and calculations yielded groundwater flow velocity rate at 0.3 – 1 m/day in area between the rivers. Investigation of CFC data resulted in possible groundwater flow rate of at a minimum of 0.2 m/day although it's not applicable to all sampled wells due to specific hydrogeological conditions. Tracer test was made between the rivers in order to distinguish main water flow paths and flow velocity. Results showed that very high permeable conduits connect rivers and karst lakes with velocity rates of 800 – 1300 m/day.

Complex investigation leads to conclude that three different sources of groundwater occur characterized by different flow velocity, recharge age and chemical composition. Although CFC's has been degraded, it is possible to use the results to distinguish groundwater different components and even to estimate groundwater flow velocity because of near located recharge and discharge areas. Tritium results doesn't show considerable variations along flow path with 6 TU in average confirming conclusions based on CFC's. Tracer test approve very high groundwater velocity zones in study area that supposedly doesn't mix with groundwater in matrix.

### References

Delina A., Babre A., Popovs K., Sennikovs J., Grinberga B. 2012. Effects of karst processes on surface water and groundwater hydrology at Skaistkalne vicinity, Latvia. – *Hydrology Research*, 43(4), IWA Publishing, pp. 445-459, doi:10.2166/nh.2012.123.

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