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Using in-stream chemical measurements to characterize groundwater circulation and biogeochemical activity in the aquifer

Camille Vautier (1), Ronan Abherve (1), Christophe Petton (1), Thierry Labasque (1), Aurélie Guillou (1), Eliot Chatton (1), Ben Abbott (1,2), Jean Marcais (1), Anniet Laverman (1), Zahra Thomas (3), Luc Aquilina (1), Gilles Pinay (4), and Jean-Raynald de Dreuzy (1)

(1) OSUR, Université de Rennes 1, Rennes, France (camille.vautier@univ-rennes1.fr), (2) Department of Plant and Wildlife Sciences, Brigham Young University, Provo, Utah, USA, (3) Agrocampus Ouest, Rennes, France, (4) IRSTEA Lyon, Lyon, France

Stream water chemistry results from biochemical activity occurring in the surface, but also from processes occurring in the contributing compartments (soils, aquifers, hyporheic and riparian zones). Consequently, in-stream chemical signals contain information on circulations and reactivity in the deep compartment, which is spatially more integrative than information extracted from well data. Here we use data collected in first and second order streams over a 35 km2 agricultural catchment to infer physical and biochemical processes occurring in the aquifer.

Spatially-distributed radon measurements reveal a strong heterogeneity of groundwater inputs into the streams. This high localization degree of groundwater discharge is related to large-scale topography and confirms groundwater flow models based on well data [1]. In addition, repetition of measurements at different time periods shows a temporal heterogeneity, signed by major variations of groundwater discharge over the year, in link with water table fluctuations.

Nitrate concentrations and isotopic compositions, as well as gas data (N2, N2O, O_2) inform us on biological reactivity. To extract information originating from the aquifer, we quantify in-stream biological activity and physical degassing using nutrients and inert gases injections coupled with continuous in-situ measurements with membrane inlet mass spectrometry (MIMS).

This approach gives an indirect yet integrative view of the processes occurring in the aquifer. In an upscaling perspective, we aim to apply it at a regional scale.

[1] Kolbe, Tamara & Marçais, J & Thomas, Zahra & Abbott, Benjamin & de Dreuzy, Jean-Raynald & Rousseau-Gueutin, Pauline & Aquilina, Luc & Labasque, T & Pinay, Gilles. (2016). Coupling 3D groundwater modeling with CFC-based age dating to classify local groundwater circulation in an unconfined crystalline aquifer. Journal of Hydrology.