Quantifying the contribution of snowmelt to groundwater recharge with portable mass spectrometry-based dissolved gas analysis

OLIVER S. SCHILLING*[1,2], MATTHIAS BRENNWALD[3], ROLF KIPFER[3,4], RENÉ THERRIEN[1,2]

[1] Department of Geology and Geological Engineering, Université Laval, Québec (QC), Canada (*correspondence: oliver.schilling.1@ulaval.ca)
[2] CentrEau, Québec Water Research Centre, Université Laval, Québec (QC), Canada
[3] Eawag, Swiss Federal Institute of Aquatic Science and Technology, 8600 Duebendorf, Switzerland
[4] ETH, Swiss Federal Institute of Technology, 8092 Zürich Switzerland

In catchments where snowmelt constitutes a major component of the annual hydrograph, groundwater recharge from snowmelt may account for the majority of annual groundwater input [1,2]. The currently established techniques to quantify the contribution of snowmelt to recharge, however, are still critically flawed. The often used approach of stable water isotopes analysis, for example, requires an unfeasibly large number of spatially and temporally distributed measurements in snow, snowpack, snowmelt, rain, surface water and groundwater. New methods to quantify the contribution of snowmelt to recharge are thus needed. In this study, a method to quantify recharge from snowmelt through portable mass spectrometry-based dissolved (noble gas) analysis (i.e., of N_2, Ar and Kr) is developed. As noble gases are inert, their concentrations in groundwater are controlled entirely by physical processes. Knowing them allows estimating the temperature at the moment of recharge [3], and noble gas recharge temperatures can be used to estimate mixing of water from different sources [4]. This method to quantify the sources of recharge is applied to snowmelt and tested alongside basic hydrological as well as stable water isotope analyses in the boreal Forêt Montmorency research catchment in Québec.

[1] Lundberg A. et al. (2016) *Hydrol. Process.* **30**, 1230-1250. [2] Hayashi M. et al. (2003). *J. Hydrol.* **270**(3), 214-229. [3] Kipfer R. et al. (2002) *Noble gases in geochemistry and cosmochemistry* **47**, 615-700. [4] Schilling O.S. et al. (2017) *Water Resour. Res.* **53**(12), 10465-10490.