UNIVERSITÉ DE NEUCHÂTEL

CHYN
Centre d'hydrogéologie et de géothermie

MSc in Hydrogeology and Geothermics

Thesis topic proposal 2017

CHARACTERISING ALPINE HEADWATER FLOW PATHWAY DYNAMICS USING STABLE ISOTOPES AND MAJOR ION HYDROCHEMISTRY

Context and objectives

Steep headwater catchments are extremely dynamic hydrogeological systems. Their response to climate change is likely to be complex and non-linear, not least due to the interactions and feedbacks between hydrogeology and geomorphology, soils and vegetation. Thus, future predictions demand the application of complex physically-based and spatially-distributed models which incorporate all important processes. However, the development of such models is non-trivial, and requiring sound a priori conceptual understanding. Dedicated field campaigns are invaluable in this regard. As such, the objective of this project is to determine spatio-temporal patterns in water sources, flow pathways and residence times using a combination of classical hydrochemistry solution and stable isotope ratios in an alpine watershed.

Research approach and methodology

Oxygen and hydrogen isotopes are the only true tracers of water molecules. Water cycle processes cause variation in the ratios of $^{18}O/^{16}O$ and $^{2}H/^{1}H$, which can be indicative of recharge conditions and groundwater mixing. Unfortunately, unambiguous inferences are rarely possible from isotope data alone, and so a suite of isotopic, chemical, geological and hydrogeological data are normally needed. Accordingly, solute species and their concentrations will also be determined; variability relative to rain water arises as a consequence of rock-water interactions, and is therefore dependant on flow pathways and residence times. A recently completed 3D geological model, as well as in situ groundwater level measurements, can also be brought to bear in the interpretation phase. Mixing models could also prove useful. The study site, the Vallon de Nant, Vaud, is a natural reserve and is therefore relatively unaffected by anthropogenic activity. This, along with the beauty and diversity of the landscape (meadows, forests, moraines and a small glacier) and existing instrumentation make it an ideal research site. Finally, there is a possibility for this study to be extended, if the student desires, to include the development of high-resolution Snow Water Equivalent maps. These maps would be highly complementary to the both hydrochemical analyses and modelling work alike; snowmelt is a presently a key constituent of annual stream discharge, is a major influence of groundwater recharge, and moreover is highly sensitive to climatic change.

Partners and collaboration

The project will be supervised Profs. P. Brunner and D. Hunkeler. The datasets developed shall feed into the development of the hydrogeological models currently under construction as part of the IntegrAlp project (http://wp.unil.ch/integralp/); an interdisciplinary collaboration with the University of Lausanne. The student will have the opportunity to attend project meetings and interact with scientists beyond the discipline of hydrogeology. Particular insight will be gained into the coordination of large scientific projects, including the need to ensure that data collected delivers maximum benefit across multiple disciplines.

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