Post-Doctoral position on the characterization of transport and biogeochemical processes in the critical zone
University of Rennes, France

Location : University of Rennes 1, France

Institute : Geosciences Rennes – Observatoire des Sciences de l'Univers de Rennes

Supervision : **Tanguy Le Borgne** tanguy.leborgne@univ-rennes1.fr
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Duration: 2 years

Starting date: 1st of May 2018

Deadline for application: 1st of March 2018

Keywords: hydrology, groundwater, biogeochemistry, tracer experiments

Profile and Skills required: PhD in Earth/environmental sciences, hydrology, biogeochemistry, or a related field. The candidate should have a strong background in physical and biochemical hydrology together with a solid publication record. The candidates will be expected to play a full role in the timely write-up and publication of the results, including participation in national and international conferences.

Research context:

Transport processes play a major role in the dynamics of hydrological systems by bringing in together reactants that trigger biogeochemical processes, by sustaining fluid-mineral reactions, and by transporting contaminants across continental landscapes. Understanding transport processes in coupled surface and subsurface environments and their impact on biogeochemical cycles is one of the goals of critical zone observatories that have been recently setup across the world (http://www.czen.org/). In this context, significant progress has been obtained in developing reactive transport models for the critical zone (see recent review of Li et al., 2017). However, only few experimental data document the dynamics of reactive transport process in situ. For this purpose, the University of Rennes and CNRS has developed a mobile laboratory designed to host a suite of high frequency chemical analysis instruments allowing a continuous monitoring of the evolution of dissolved chemical species and dissolved gases during reactive transport experiments (see

https://www.critex.fr/critex-tools/wp7-deep-waters/task-7-3-tracer-test/ and https://www.critex.fr/critex-tools/wp8-tracing-methods/task-8-1-gas-tracing/). The on-board instruments include *in situ* mass spectrometer (MIMS), gas chromatography for dissolved gas measurements (Chatton et al., 2017) and continuous flux measurements for major ions determination. Tracer experiments will be run either in rivers or in boreholes. In boreholes, precise injections will be performed with a double inflatable packer fully equipped with multi-parameter sensors. Subsurface experiments will be performed at highly instrumented hydrogeological observatories (http://hplus.ore.fr/en/). River experiments will be performed in critical zone observatories that have been recently equipped with rivers laboratories (https://www.critex.fr/critex-tools/wp4-high-frequency-geochemistry/) monitoring continuously chemical concentrations at high frequency. (Floury et al., 2017).

Project description:

The objective of this postdoctoral project is to design and perform reactive tracer tests in highly instrumented observatories to address currently open questions about reactive transport processes in the critical zone. We will consider a range of reactions, including redox reactions, such as denitrification and iron-oxidation, possibly coupled with microbiological processes. The objective will be to compare field scale reaction rates to batch reaction rates, to assess the impact of flow rates and mixing processes on reaction rates, and to quantify the effect of subsurface reactive processes on river chemistry. Tracer breakthrough curves will be interpreted using reactive transport models developed by the Rennes team (https://reactivefronts-erc.univ-rennes1.fr/).

Scientific environment:

The project will benefit from an interdisciplinary environment through close collaborations between the geosciences, physics and ecology departments in Rennes. The postdoc will integrate the Rennes hydrogeology group, which is one of the leading groups in this field in Europe, with numerous international collaborations and cutting edge experimental and computational facilities. The Rennes group is coordinating the H+ network of hydrogeological sites in France (http://hplus.ore.fr/en/), ENIGMA training network in Europe (https://enigma-itn.eu/) and OZCAR observatory in France.

Contact details and application:

Related publications:

Roques, C., Aquilina, L., Boisson, A., Vergnaud-Ayraud, V., Labasque, T., Longuevergne, L., ... & Bour, O. (2018). Autotrophic denitrification supported by biotite dissolution in crystalline aquifers:(2) transient mixing and denitrification dynamic during long-term pumping. Science of the Total Environment, 619, 491-503.

Li, L., Maher, K., Navarre-Sitchler, A., Druhan, J., Meile, C., Lawrence, C., ... & Jin, L. (2017). Expanding the role of reactive transport models in critical zone processes. Earth-Science Reviews, 165, 280-301.

Shakas, A., Linde, N., Baron, L., Selker, J., Gerard, M. F., Lavenant, N., ... & Le Borgne, T. (2017). Neutrally buoyant tracers in hydrogeophysics: Field demonstration in fractured rock. Geophysical Research Letters, 44(8), 3663-3671.

Klepikova, M. V. T. Le Borgne, O. Bour, M. Dentz, R. Hochreutener, and N. Lavenant (2016) Heat as a tracer for understanding transport processes in fractured media: theory and field assessment from multi-scale thermal push-pull tracer tests, Water Resour. Res., 52(7), 5442-5457.

Chatton, E., Labasque, T., De La Bernardie, J., Guihéneuf, N., Bour, O., & Aquilina, L. (2016). Field continuous measurement of dissolved gases with a CF-MIMS: Applications to the physics and biogeochemistry of groundwater flow. Environmental science & technology, 51(2), 846-854.

Floury, P., Gaillardet J ., Gayer E., Bouche J, Tallec G., Ansart P., Koch F., Gorge C., Blanchouin A,

and Roubaty J. L.(2017). The potamochemical symphony: new progress in the high-frequency acquisition of stream chemical data. Hydrol. Earth Syst. Sci., 21, 6153-6165.

Shakas A., N. Linde, L. Baron, O. Bochet, O. Bour, T. Le Borgne (2016) Hydrogeophysical characterization of transport processes in fractured rock by combining push-pull and single-hole ground penetrating radar experiments Water Resour. Res. Vol. 52, 2, pp 938-953

Jamin, P., P. Goderniaux, O. Bour, T. Le Borgne, A. Englert, L. Longuevergne, S. Brouyeres (2015) Contribution of the finite volume point dilution method for measurement of groundwater fluxes in a fractured aquifer J. of Contamin. Hydrol. Vol. 182 pp 244-255

Kang, P. K., T. Le Borgne, M. Dentz, O. Bour, and R. Juanes (2015), Impact of velocity correlation and distribution on transport in fractured media: Field evidence and theoretical model, Water Resour. Res., 51, 940–959

Roques, C., O. Bour, L. Aquilina, B. Dewandel, S. Leray, J.H. Schroetter, L. Longuevergne, T. Le Borgne, R. Hochreutener, T. Labasque, N. Lavenant, V. Vergnaud-Ayraud (2014) Hydrological behavior of a deep sub-vertical fault in crystalline basement and relationships with surrounding reservoirs, J. of Hydrol. 509 (2014) 42–54

Boisson, A., P. de Anna, O. Bour, T. Le Borgne, T. Labasque, L. Aquilina (2013) Reaction chain modeling of denitrification reactions during a push–pull test. J. of Contam. Hydrol., 148, 1–11