

Perfluoroalkyl substances transport and retention in soils: a combined modeling and nuclear resonance imaging study

Applications are invited for a three-year PhD position at the interface between reactive transport in porous media and magnetic resonance imaging (MRI) at IFSTTAR (EE Laboratory, Nantes, France) and INRA (EMMAH laboratory, Avignon, France).

Context. Perfluoroalkyl substances (PFASs) refer to a family of chemicals that have been used in a wide number of industrial, agricultural and household applications since the end of the forties. However, most of these substances are toxic, persistent in the environment and bioaccumulative. They have been detected in most environmental compartments, including soils, surface waters, alluvial aquifers and groundwater.

Soils act as a filter by delaying the arrival of PFAS plumes to aquifers. However, on the long term, PFASs retained in the soil act as sources of PFASs to these aquifers. To date, the adsorption and release mechanisms of PFASs on soil constituents are not completely elucidated, and models able to predict the transport of PFASs in the soil – and consequently PFAS arrival in aquifers – are not available.

Job description. This PhD proposal aims at improving the understanding and description of PFAS-soil interactions, and at incorporating this knowledge into PFAS transport models.

It will build on a pioneering approach developed by the project leaders that uses fluorine nuclear magnetic resonance (^{19}F NMR) to record simultaneously and non-destructively quantitative time-lapse information on the presence of PFAS in different compartments of the soil.⁽¹⁾

This approach will be adapted to monitor PFAS transport experiments in soil columns. It will help discriminating various PFAS transport models based on different retention mechanisms and provide a unique way to improve our understanding of PFAS fate in soils.

The PhD student will:

- perform column scale PFAS transport experiments in increasingly complex porous media (ranging from quartz sand to unsaturated and undisturbed soil cores),
- monitor the dynamics of PFAS transport and retention directly inside the porous media using the new fluorine magnetic resonance imaging tools,
- use these new MRI data to identify the kinetics of PFAS adsorption onto the porous media constituents, their release, and their convective and dispersive transport,
- compare the MRI data to the outputs of a solute transport model that will be adapted from the models currently available within the VSoil modeling platform⁽²⁾ developed at INRA.

Requirements. We seek candidates who demonstrate willingness and ability to study solute transport in complex porous media both on an experimental and modeling point of view. Previous experience with modeling would be highly appreciated. Previous experience with NMR or MRI is not mandatory. A successful candidate with no previous NMR MRI experience will be trained in these techniques and become a knowledgeable user. The candidates should hold a master degree in physics, fluid mechanics, physical chemistry, environmental sciences, computational sciences, or applied mathematics with excellent grades. Good oral and written command of English or French is required.

About EE and EMMAH labs. The successful candidate will share his time between the EE and EMMAH laboratories. EE⁽³⁾ is a laboratory of the 'French Institute of Science and Technology for Transport, Development and Networks' (IFSTTAR). It is located in Nantes, one-hour drive east of the Atlantic Ocean. EMMAH⁽⁴⁾ is a joint research laboratory of the 'National Institute for Agricultural Research' (INRA) and University of Avignon. It offers a friendly and effective working environment settled in Provence, one-hour drive north of the Mediterranean sea.

How to apply: Applications should include a resume and a copy of master degree grades, as well as contact information for one or two references and should be sent as soon as possible to:

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⁽¹⁾ <https://pubs.acs.org/doi/10.1021/acs.est.6b05671>

⁽²⁾ <https://www6.inra.fr/vsoil>

⁽³⁾ <https://www.ee.ifsttar.fr/>

⁽⁴⁾ https://www6.paca.inra.fr/emmah_eng/