



PhD position:

Effect of acidic conditions on confinement properties of porous media rich in analcime

Research area: environmental geochemistry, confinement properties of natural porous material.

Context and problematic : Analcime is a hydrated tectosilicate, belonging to the zeolite family; a mineralogical group used in many applications, such as water and air depollution and catalysis due to their mesoporous structure leading then to high specific surface area and cationic exchange capacity, and wide range of pore size distribution. **Analcime is one of the main constituents of the « Abinky » geological formation which** separates two sandstones aquifers: the « Teloua » above and the « Tchirézrine 2 » below. The « Tchirézrine 2 » is composed of Uranium bearing phases, and is currently envisaged by ORANO group for a potential extraction of U by in-situ acidic leaching using H_2SO_4 . In this context, before all potential exploitation of the « Tchirézrine 2 », ORANO have **to propose different scenario of reactive transport models to assess the effect of acid injection in the « Tchirézrine 2 » on the confinement properties on the « Abinky » formation.** Such properties will be directly dependent on the hydrodynamic, mineralogical and geochemical properties of this formation rich in analcime. Preliminary results obtained by ORANO have shown that **the main transport process** in this geological formation **will be diffusion.** However, there is no data in literature concerning the **confinement properties of materials rich in analcimes** for anions (as SO_4^{2-}) and cations (as H^+ , uranyl, major cations) especially by considering acidic gradients and the large range of chemical composition (e.g., salinity) inherent of natural waters. Then, no data exists also concerning **the possible anionic exclusion and potential adsorption of cations** occurring at the analcime/solution interface as a function of pore water composition and petrophysical properties of the porous media, as well as on the stability of materials rich in analcime in acidic conditions ($2 < pH < 4$).

Working plan of the PhD: To answer to these questions, the work of the PhD position will consists to obtain: (1) a mineralogical and petrographical characterization of materials rich in analcime sampled on site and provided by ORANO ; (2) the ion-exchange properties towards major cations (Na^+ , Ca^{2+} , Mg^{2+} and K^+) and H^+ , as well as the stability in acidic conditions, of the analcimous cement characterized in task 1 ; (3) the acquisition of diffusion parameters for water tracer (HDO) and ions (SO_4^{2-} , UO_2^{2+} and major cations) in porous media constituted of particles used in task 2 and compacted at different total porosities for different porewater chemical compositions to assess anionic exclusion and adsorption properties ; (4) the effect of pH gradient on diffusion properties of the porous material investigated; (5) scenario of reactive transport model constrained by data obtained in tasks 1 and 2 to interpret the whole experimental data set obtained in tasks 3 and 4.

Funding and place of work: this position is funded by 50% by the **Graduate School « Intree »** (Interfaces for aeronautic, energy and environment; training formation « **Investissements d'avenir** ») conducted by Poitiers University and 50% by **ORANO company**, and will be held **in the University of Poitiers at the IC2MP Institute** (team E2, HydrASA) under the supervision of Emmanuel Tertre and Sophie Billon (IC2MP) and Michael Descostes (ORANO Company). Furthermore, the PhD student fellow will be required to undertake regular visits at ORANO Company (Paris).

Available techniques and equipment in the IC2MP laboratory include an experimental diffusion set-up, XRD, IR spectroscopy, SEM-EDS, alpha/beta autoradiography, rock porosity PMMA method, ICP MS-OES, ion-chromatography, Raman spectroscopy.

Required profile: Applicants should have a **Master or an Engineer degree** in a field related to **Earth Science** and/or **Physico-Chemistry of Materials**, with a strong interest in characterization and experimental activities. The candidate is expected to be proficient in English

Duration: PhD of **36 months**. Expected date of employment: **1 October 2021**.

Remuneration: 1 769 euros gross monthly.

How apply: The application file should contain a detailed CV, copies of the university or engineer school marks (Master level), a motivation letter for this proposal and letters of two referees. Application will be sent to emmanuel.tertre@univ-poitiers.fr and sophie.billon@univ-poitiers.fr.

Application deadline: no later than **May 1st 2021**.

Relevant references linked to the scientific project:

- Billon S. & Patrier P. (2019). Diagenetic and hydrothermal history of the host rock of the Imouraren uranium. *J. African Earth Sci.*, 160, 103637.
- de Boissezon H., ... & Descostes M. (2020). Modelling the U and ²²⁶Ra mobility during and after an acidic In Situ Recovery test. *J. Contam. Hydrology* 235, 103711.
- Robin V., Tertre E., ... & Descostes M. (2015). Ion exchange reactions of major inorganic cations on beidellite. *Appl. Geochem.*, 59, 74-84.
- Tertre E., S. Savoye... et al. (2018). Diffusion of water through the dual porosity swelling clay mineral vermiculite. *Environ. Sci. Technol.*, 52, 1899-1907.