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Research position (postdoc or research engineer)

Contacts
- MINES Paris PSL : Vincent Lagneau (vincent.lagneau@minesparis.psl.eu), Nicolas Seigneur (nicolas.seigneur@minesparis.psl.eu)
- Orano : Sébastien Hocquet (sebastien.hocquet@orano.group)

Keywords
Reactive transport, pore-scale modelling, uranium in situ recovery, hytec

Context
Orano has been a major contributor to the uranium production by in situ recovery (ISR) since the 1980s, through projects in the USA, then Kazakhstan and currently in Mongolia and Uzbekistan. Orano mining has been collaborating for several years with the Geosciences department of Mines Paris PSL to improve their quantitative understanding of the processes which occur in the ISR reservoir. This is achieved is through coupled hydrogeochemical simulations using Hytec, allowing to predict and optimize the uranium recovery.

Generally, ISR requires specific reservoir properties. A sufficient permeability is necessary to allow the injection and circulation of leaching solutions. Second, the ore needs to be confined by impermeable layers. Due to its reduced costs, the ISR applicability for uranium production is being considered for a wider range of geological contexts. Given its relatively low permeability, the Imouraren ore in Niger had never been considered suited to ISR exploitation. However, the lower grades areas, for which the economical evaluation of traditional technique is uncertain, could prove to be favorable to an adapted ISR exploitation.

Objectives
Within the feasibility assessment studies, Orano Mining and the Geosciences department wish to develop predictive hydrogeochemical simulations of the ore behavior during the ISR exploitation. These simulations, which include the fluid circulation between the technological wells and the reactivity of the ore minerals (including uranium), need to contribute to the predictive understanding of the system and thus, strengthen its economical evaluation.

Model calibration will be performed based on mineralogical and elemental analysis, cells circulation tests within cells performed by Orano

as well as hydrogeological tracer tests. In addition, a new experimental campaign of a dynamic leaching tests followed through microtomographig images (Patrice Creux, UPPA/LFCR in Pau) will provide detailed additional pore-scale information to understand the coupled hydrodynamic and geochemical behavior of the ore material down to the pore-scale.

Proposed work

Laboratory scale (~10 cm)
Experimental analysis of dynamic leaching tests (sample composition and leachate analyses) and calibration of a geochemical model and 1D column reactive transport model. Evaluation of the sample variability will be a key factor for later upscaling approaches.

Analyses of the experimental results from the LFCR in order to build a 3D representative elementary volume. A closer analysis of the relevant pore-scale hydrogeochemical processes (double porosity model, mineral exclusion, surface (de)passivation, …) will be performed to constrain the 3D model.

Implications for the Imouraren project
This works will be part of the decision process towards the conception of a potential ISR pilot on the Nigerian site. To this end, the work will also consist in designing such pilot (design of the production cells, position of monitoring piezometers, …). This high-industrial-stake work will be performed in collaboration with the Geosciences department (Mines Paris PSL) and several teams (exploration, R&D, hydrogeology, …) from the industrial Partners (Orano). The technical and scientific novelty of the proposed approach should allow one or several publications.

Profile
Young PhD or engineer with interest in coupled hydrogeochemical simulation (reactive transport). Past experience in modelling, hydrogeology or geochemistry would be an appreciated asset.

Practical information
This project will be funded for one year as a collaboration between the Geosciences department of Mines Paris PSL and Orano Mining. Work will be conducted partly in the Orano office (Chatillon 92) and Geosciences department (Fontainebleau 77) and will include some trips to Pau.