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Postdoctoral research position (12 months)

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Keywords
Reactive transport, Hytec, Athabasca Basin, Metallogenesis, Uranium, Earthbeat, THMC simulations.

Contexte
Among the various energy transition scenarios, the use of nuclear power for electricity production represents an attractive solution. As a result, global demand for uranium is expected to increase significantly in the coming decades. To boost production and diversify supply sources, new deposits must be developed. The uranium deposits of the Athabasca Basin (Canada) are among the richest in the world. A better understanding of their metallogenesis represents an opportunity both for exploration and for the mining of these deposits.

The ANR *Earthbeat* project, led by Fabrice Golfier (Université de Lorraine, GeoRessources laboratory), focuses on the coupled thermo-hydro-mechanical-chemical processes that interacted to form these fault-hosted hydrothermal deposits. Current knowledge suggests that these systems are characterized by cyclic hydrothermal pulses that increase the permeability of geological formations, subsequently allowing resource accumulation and the formation of giant deposits. This project brings together researchers from GeoRessources (Université de Lorraine), BRGM, Université Côte d'Azur, Université Clermont Auvergne, Orano Mining, and the Centre de Géosciences (Mines Paris PSL).

Objectives and Work Description

The objective of this 12-month postdoctoral position is to constrain the reactivity of the system—from the scale of the fault gouge and the damage zone up to the deposit scale. Reactive transport simulations will be carried out using **Hytec** to identify zones of dissolution and precipitation. These simulations will be conducted in close collaboration with other teams involved in the project to better constrain the geometry and boundary conditions of this complex system.

The first part of the work will focus on the fault zone, to understand the processes affecting the fractured system (quartz dissolution, silicon migration, precipitation of

secondary minerals) leading to a reduction in permeability. The goal of this first phase is to estimate changes in mineralogy and permeability at the fault scale.

The second part of the work will aim to combine the previous results with those of other work packages within the project to move toward the deposit scale (upscaling from the fault and its surroundings to the deposit). The objective will be to reproduce the main and general observations of the system. From an industrial perspective, this second phase should provide quantitative analyses to help identify the parameters and processes that control the variability of the Athabasca Basin deposits.

Profile

The candidate should hold a PhD and have demonstrated expertise in one or more of the following areas: geochemistry, sedimentology, reservoir engineering, reactive transport, and geology.

Practical Information

This 12-month postdoctoral position will take place primarily at the *Centre de Géosciences* of *Mines Paris PSL*, located in Fontainebleau. Travel may be required to collaborate with the various members of the Earthbeat project.

References

- Lagneau, V., Regnault, O., & Descostes, M. (2019). Industrial deployment of reactive transport simulation: an application to uranium in situ recovery. *Reviews in Mineralogy and Geochemistry*, *85*(1), 499-528.
- Noiriel, C., Seigneur, N., Le Guern, P., & Lagneau, V. (2021). Geometry and mineral heterogeneity controls on precipitation in fractures: An X-ray micro-tomography and reactive transport modeling study. *Advances in Water Resources*, *152*, 103916.
- Seigneur, N., Mayer, K. U., & Steefel, C. I. (2019). Reactive transport in evolving porous media. *Reviews in Mineralogy and Geochemistry*, *85*(1), 197-238.
- Eldursi, K., Scholtes, L., Conin, M., Golfier, F., Mercadier, J., Ledru, P., ... & Chemillac, R. (2021, April). The role of fault intersection in fluid flow patterns and the formation of world-class unconformity-related uranium deposits, Athabasca Basin, North Canada. In *EGU General Assembly Conference Abstracts* (pp. EGU21-7257).
- Martz, P., Mercadier, J., Cathelineau, M., Boiron, M. C., Quirt, D., Doney, A., ... & Ledru, P. (2019). Formation of U-rich mineralizing fluids through basinal brine migration within basement-hosted shear zones: A large-scale study of the fluid chemistry around the unconformity-related Cigar Lake U deposit (Saskatchewan, Canada). *Chemical Geology*, *508*, 116-143.

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