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PhD Proposal

Study and optimization of uranium extraction by In Situ Recovery in a consolidated and fractured sandstone context.

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Keywords

Reactive transport, hytec, uranium in situ recovery, fractured reservoir

Context

Orano Mining and MINES Paris PSL are collaborating on research projects aimed at improving the understanding and hydrogeochemical simulation of mining operations using in situ recovery (ISR). This technique involves injecting a lixiviant solution (such as sulfuric acid) through a series of injection wells and recovering the metal-enriched solutions via production wells. The metal is then separated in a processing plant. This technique, which offers a major economic advantage, currently accounts for nearly 60% of global uranium production. The reactive transport software HYTEC (developed at the Geosciences Center of MINES Paris PSL) enables efficient simulation of the processes at play in the well field, in 3D, at the scale of a production block. These simulations are currently being used at the Katco mine in Kazakhstan for both uranium production (Lagneau et al. 2019, Collet et al. 2022) and for predicting its environmental footprint (Escario Perez et al. 2022, Seigneur et al. 2024, Doucmak et al. 2025).

ISR is currently used primarily in unconsolidated sand formations, which allow for easy fluid circulation and uniform sweep, making high recovery rates possible. In the context of a nuclear resurgence that forecasts growing uranium demand, diversifying supply sources may prove strategic. In this regard, the high-grade deposits of the Athabasca Basin (Canada) represent an opportunity. However, these deposits, located in fractured consolidated sandstone, do not exhibit the typical properties of formations usually targeted for ISR (such as permeability, confinement, etc.).

Objectives and methodology

We aim to investigate whether ISR is a viable technique for these deposits, from both economic and environmental perspectives. This feasibility will be assessed using numerical simulation tools with the Hytec software. The work will be carried out in several stages:

- Calibration of the model to reproduce hydrogeological characterizations (tracer tests, geophysical surveys, etc.) in situ (properties of the fractured medium, etc.) and geochemical characterizations;
- Modeling of in situ reactive tracer tests;
- Exploration of potential improvements to optimize the extraction process.

Required Skills

Master's degree or Engineering degree with experience in geology/hydrogeology, geochemistry, reservoir modeling, or environmental sciences."

Practical informations

The 36-month CIFRE PhD is funded by Orano Mining. The work will take place partly at Orano's premises (Paris, Châtillon) and at the Geosciences Center of Mines Paris PSL (Fontainebleau). The research will have international visibility through publications and participation in scientific conferences.

References

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