Research position (postdoc or research engineer)

Development of a deep learning model to optimize uranium in situ recovery

Context

Orano Mining and the Geosciences department of Mines Paris - PSL have collaborated to achieve a better understanding of the hydrogeochemical processes involved in the In Situ Recovery (ISR) of uranium. This mining technique, suited to confined and permeable aquifers, consists in the circulation of a leaching solution within the deposit through injection wells. The solution, which becomes progressively enriched due to the uranium dissolution, is then recovered through production wells. Uranium is then separated in a treatment facility. Nowadays, this technique represents 60% of uranium worldwide production.

HYTEC, a reactive transport simulator, allows to accurately simulate the processes involved in the uranium recovery. These simulations are currently used at the Katco mine (Kazakhstan) both for predicting uranium production (Lagneau et al., 2019 ; Collet et al. 2022) and the environmental footprint. Mining operators benefit thus from the predictive capacities of HYTEC to guide their exploitation. From this, they wish to use HYTEC to optimize the mining sequence for uranium recovery. However, the important computation times associated with HYTEC prevents them from performing a deep optimization. Hence, we wish to study the possibility of developping deep learning tools to overcome these limitations.

Proposed study

This study will be conducted in three stages.

1) Calibration of a neural network model

The first stage consists in developping an efficient neural network architecture based on simplified case (pair of injection-production wells). The model training will be based on the hydrogeochemical processes simulated with HYTEC. This model will have to be able to take into account the various operating conditions (solution composition, injection-production rates).

2) Upscaling

The second part will study the upscaling of the developed model to be used on a larger and more realistic geometry. We will start by investigating a production cell (one producer in the center of an hexagonal network of injection wells). Finally, the model will be operated on multiple cells (the production block) simultaneously.

3) Optimisation of the mining sequence

The last step will be to use the developed methodology on the block scale to improve the mining sequence to optimize uranium recovery.

Profile

Young PhD or engineer from a « Grande école » or university with experience in statistical/deep learning and possibly knowledge in reservoir engineering and hydrogeology. Past experiences with deep learning libraries (eg. PyTorch or Tensorflow) would be important assets. An aptitude for teamwork in a multidisciplinary framework, at the boundary between research and industry will be appreciated.

Research position (postdoc or research engineer)

Development of a deep learning model to optimize uranium in situ recovery

Practical informations

This project will be funded for 12 months as a collaboration between the Geosciences department of Mines Paris - PSL and Orano Mining. This contract may start from May 2023. Work will be conducted partly in the Orano office (Chatillon, France) and Geosciences department (Fontainebleau, France). A trip to the Katco mine in Kazakhstan likely.

Contacts

- Mines Paris - PSL : Mike Pereira (mike.pereira@minesparis.psl.eu), Nicolas Seigneur (nicolas.seigneur@minesparis.psl.eu), Irina Sin (irina.sin@minesparis.psl.eu), Vincent Lagneau (vincent.lagneau@minesparis.psl.eu)
- Orano : Sébastien Hocquet (sebastien.hocquet@orano.group)

References

- Collet, A., Regnault, O., Ozhogin, A., Imantayeva, A., & Garnier, L. (2022). Three-dimensional reactive transport simulation of Uranium in situ recovery: Large-scale well field applications in Shu Saryssu Bassin, Tortkuduk deposit (Kazakhstan). *Hydrometallurgy*, *211*, 105873.
- 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.