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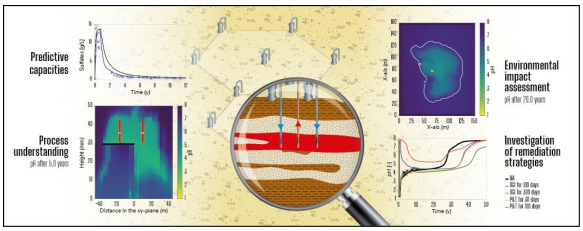

Reactive transport modelling as a toolbox to optimize uranium In Situ Recovery

DR. NICOLAS SEIGNEUR, PHD[1,2], MARINE BONNET[3] AND MICHAEL DESCOSTES[4]

[1]Mines Paris PSL
[2]Centre de Géosciences, MINES Paris, PSL University
[3]ORANO
[4]Orano Mining

More than 60% of worldwide uranium production is based on the In Situ Recovery mining technique. This exploitation method directly falls within the scope of the applications of reactive transport modelling to optimize uranium production and limit its associated environmental impact. We propose a modelling approach which is able to represent both the uranium recovery as well as the natural evolution of an aquifer impacted by an ISR test performed using sulfuric acid. The model is calibrated on short-term recovery data, as well as long-term data series obtained from monitoring wells surrounding an ISR exploitation. We present a multi-scale approach allowing to integrate laboratory-obtained information about the rock reactivity into large scale relevant simulations of exploitation.

The process-based approach of reactive transport modelling also allows to investigate the efficiency of several remediation strategies that can be considered in these contexts. In particular, we model the impact of Pump & Treat combined with reverse osmosis, as well as the circulation of non-impacted fluids through the reservoir with different operating strategies. These strategies are compared for a small-scale ISR pilot test in Mongolia. For this small-scale ISR pilot, monitored natural attenuation constitutes an interesting approach due to its faster pH recovery time with respect to Pump & Treat (5–10 years to pH ~ 6), whose efficiency can be improved by the addition of exchangeable cations. Circulation of unimpacted fluids can reduce pH recovery times if performed for periods longer than the ISR exploitation and/or deployed with a delay. Combined with an economic evaluation of their deployment, this modelling approach can help the mining operator select and design optimal remediation strategies from an environmental and economical standpoint.

In general, we show how reactive transport constitutes a powerful tool to optimize uranium ISR, both from an economic and environmental standpoint.