Geophysical Research Abstracts
Vol. 20, EGU2018-4499, 2018
EGU General Assembly 2018

Can short-term heat tracing experiments predict the long-term behavior of ATES systems ?

Thomas Hermans (1), Frédéric Nguyen (2), Tanguy Robert (2), Nolwenn Lesparre (2), and Jef Caers (3)

(1) Ghent University, Faculty of Sciences, Department of Geology, Ghent, Belgium (thomas.hermans@ugent.be), (2) Liege University, Faculty of Applied Sciences, Urban and Environmental Engineering, Liege, Belgium, (3) Stanford University, Department of Geological Sciences

In theory, aquifer thermal energy storage (ATES) systems can recover in winter the heat stored in the aquifer during summer to increase the energy efficiency of the system. In practice, the energy efficiency is often lower than expected from simulations due to spatial heterogeneity of hydraulic properties or non-favorable hydrogeological conditions. In many cases, the lack of available data leads the modeler to consider homogeneous layered conceptual models to forecast the long-term behavior of geothermal systems. Ignoring spatial heterogeneity bears the risk of misleading decisions based on the prediction of those models. The proper design of ATES systems should always consider the uncertainty about subsurface parameters. In practice, in-situ tests such as push/pull tests, heat storage experiments, heat tracer tests or other specific tests can be performed to gain knowledge on subsurface parameters. One question remains: are these tests sufficiently informative to predict with realistic uncertainty the behavior of the reservoirs for long-term use?

In this contribution, we investigate how we can predict the long-term behavior of ATES systems using short-term heat tracing and storage experiments. We combine field experiments with a probabilistic modeling approach called Bayesian Evidential Learning (BEL) to gain knowledge on the information content of our data sets. BEL relies on a set of surrogate models of the subsurface representing prior uncertainty. It uses a global sensitivity analysis to identify sensitive parameters for long-term heat storage and short-term experimental data and can validate the use of short-term heat tracing experiments to generate informative data sets. In addition, we show that the approach can be used to directly estimate the uncertainty range of the prediction from the observed experimental data, without explicit inverse modeling. The methodology therefore allows us to tests experimental hypothesis that can be further validated with field data. We use the approach to compare the information content of different data acquisition schemes: tracing vs. storage/push-pull experiments, standard vs. multi-cycle experiments, very-short vs. long experiments, single-hole vs. multi-borehole and geophysical measurements. Finally, we illustrate the proposed framework with field data.