Numerical investigation on the impact of thermo-osmosis on fluid pressurisation and barrier integrity in Boom clay

A case study of the ATLAS in-situ full-scale heating experiment

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INTRODUCTION

Existing literature suggests the importance of the thermo-osmosis (TO) for an accurate simulation of pore pressure evolution in heater tests for nuclear waste disposal in clay rock [1]. The consensus regarding the extent of its physical impact is limited. Uncertainty of parameters describing the host rock further adds to the complexity of this consideration.

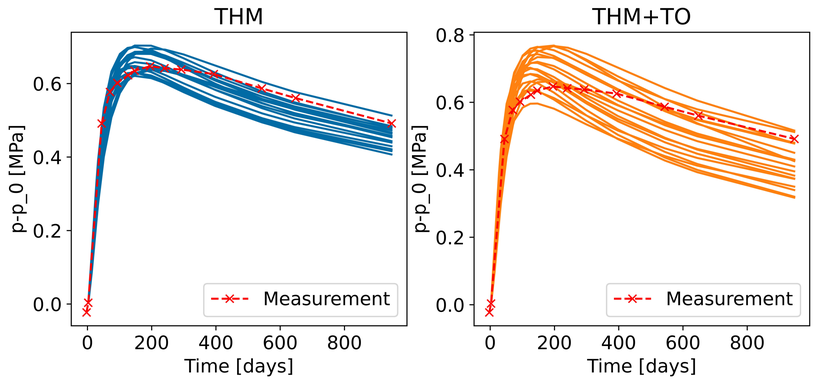
This study will use the ATLAS in-situ full-scale heating experiment from the HADES underground research laboratory in Mol, Belgium [2], to investigate the impact of TO on the thermal pressurisation in Boom Clay.

METHODS

- ATLAS experiment was simulated using an inelastic thermo-hydro-mechanical (THM) model in OpenGeoSys. [3]
- All parameters assumed to be isotropic.
- Parameters screened using One-Variable-At-Time technique.
- Four parameters with the highest significance selected for next step - parameter study - Young's modulus, thermal expansivity, intrinsic permeability and Poisson's ratio.
- Parameter space was explored using Latin Hypercube Sampling and 2-level-full-factorial experiment design.

RESULTS

- Two physical processes compared: THM and THM+TO (including TO-coefficient in parameter space). All figures in this section show the 19 best results.

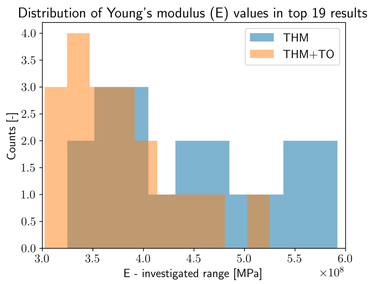


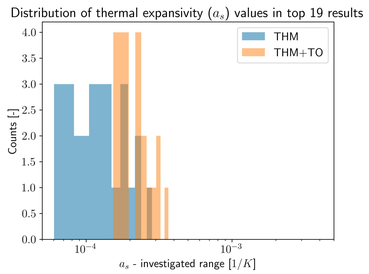
TO impact:

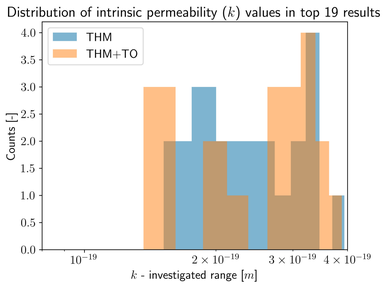
- wider spread
- stepper slope

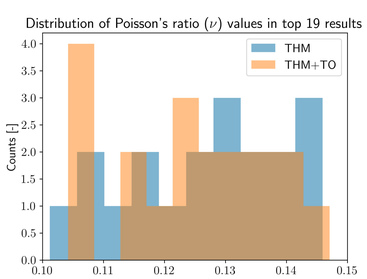
of the pressure curves.

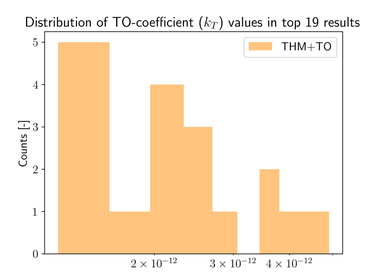
- Following figures show the results of the parameter study.







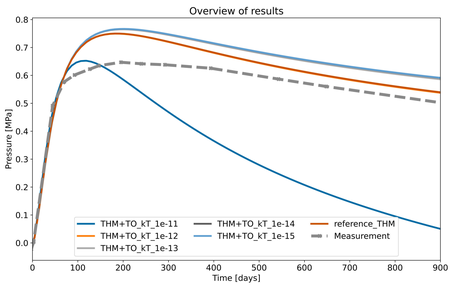




The distribution of best parameter choices, without converging to optimal values. It may mean that the global optimum is outside tested parameter space.

CONCLUSIONS

Introducing TO into simulation has a great impact on the pressurisation, and the distribution of the highest impact parameter values. Therefore the correct parametrization of TO needs further investigation. One example of the pressure variation induced by the impact the TO-coefficient is shown in the figure below.



OUTLOOK

- Proxy can help explore parameter space and find global optimum but may introduce more uncertainty.
- The next objective is quantitative estimation of TO's importance depending on parameterisation.
- Research goal is to express impact of TO in statistical framework.

BIBLIOGRAPHY

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