Flow in saturated bentonite under elevated temperatures

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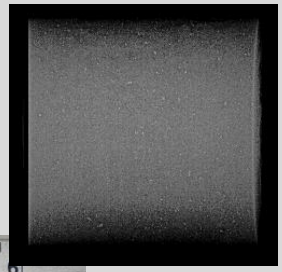
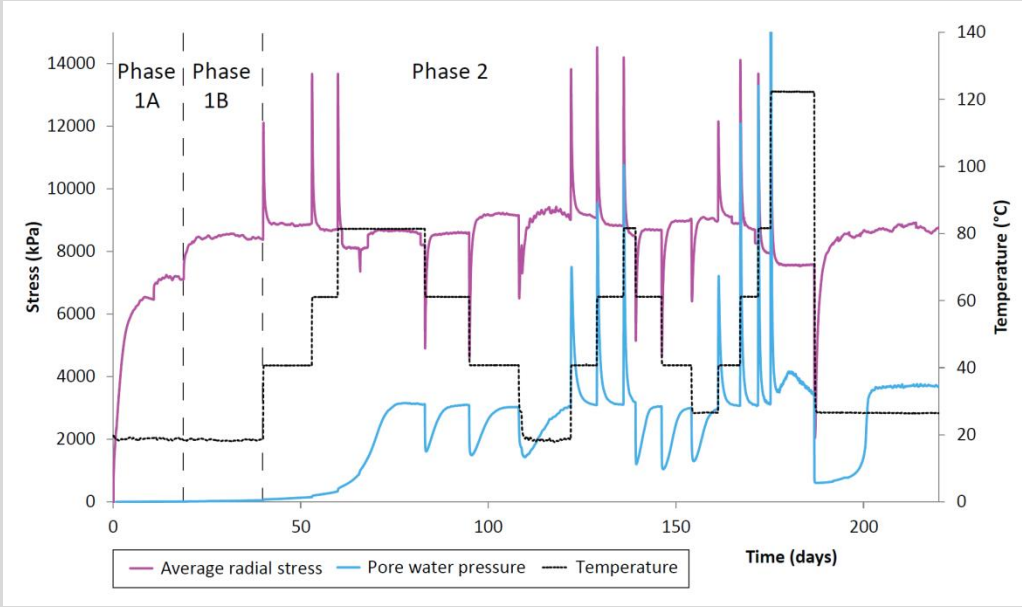
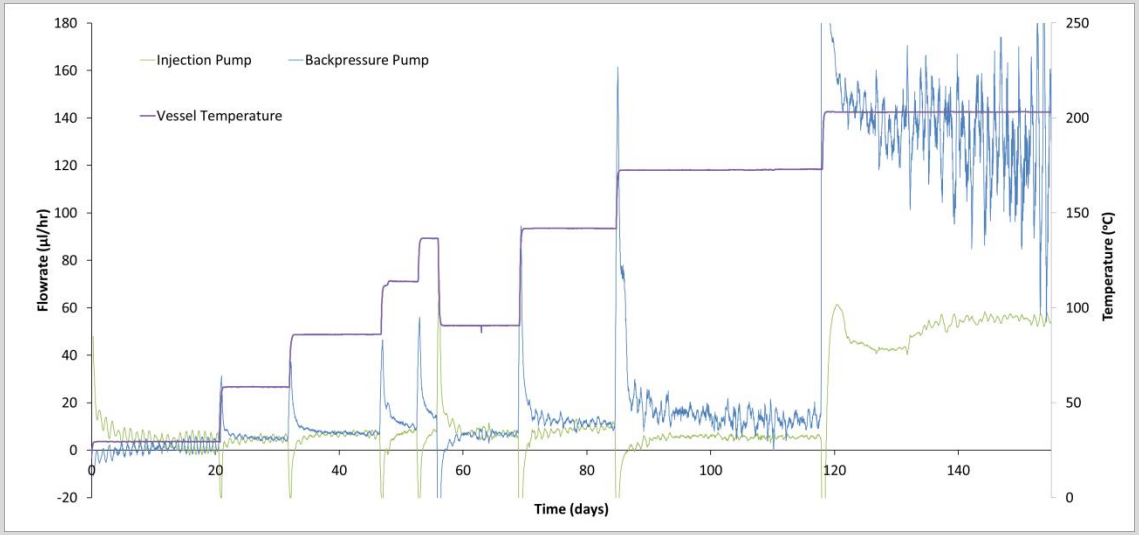
Laboratory experiments – stress and porewater



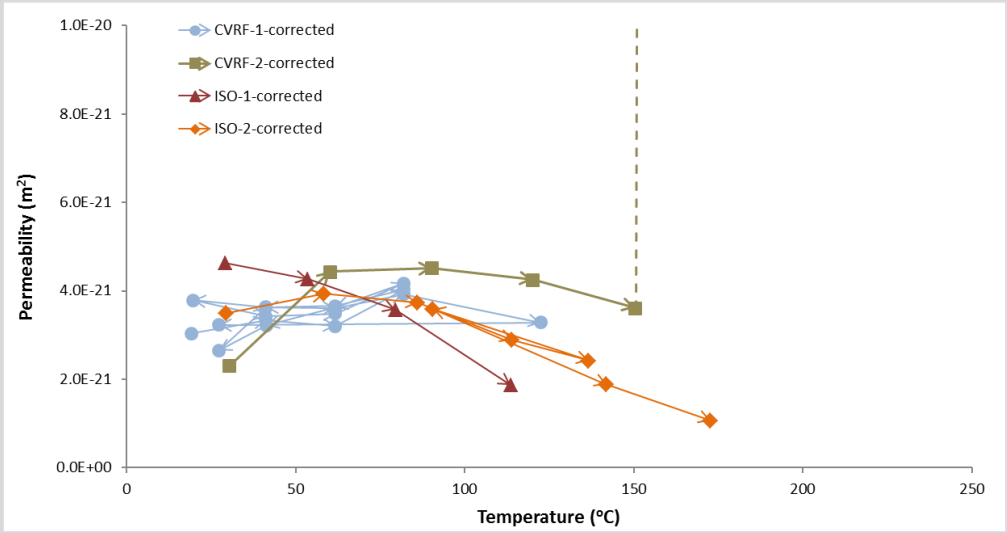


- Each temperature increment induced a sharp increase in total stress that gradually relaxed to a well-defined asymptote.
- Up to ~120°C, there was a positive correlation between the maximum total stress value and the temperature step.
- In test 1 the asymptotic average radial stress value decreased for each temperature increase up to 120°C.
- In test 2 above 150°C both axial and radial load cells showed a decrease in total stress value.
- Bentonite experienced a thermally induced consolidation, reducing the ease with which fluid migrated through the sample.

Laboratory experiments – thermal influence on permeability



- Isotropic test flowrate data
- Spikes in outflow accompany increases in temperature, that decay to a constant outflow value
- Decreases in temperature correspond with spikes in inflow



- Above 60-80°C, the permeability decreases as the temperature increases
- Effect more pronounced in the isotropic tests
- Complicated by thermal compliance of the constant volume pressure vessel

- Strong coupling between the bentonite and the THM behaviour
- Expect this to be exacerbated for gas flow
- Cation exchange facilitated through corrosion of steel or alteration of the bentonite affects the bentonite behaviour
- De-ionised water is used in the experiments to date. The use of synthetic ground water may demonstrate a stronger THMC coupling

Summary

- The effect of temperature on gas permeability is an important consideration
  - Preliminary gas flow testing started
  - Too early to draw conclusions
  - Gas is likely to be strongly THM sensitive

Publications:

- Daniels, K. A., Harrington, J. F., Zihms, S., and Wiseall, A. Bentonite permeability at elevated temperature. *Geosciences, submitted*.
- Zihms, S., and Harrington, J. F., 2015. Thermal cycling: impact on bentonite permeability. *Mineralogical Magazine,* **79** (6), 1543–1550.