

Cs sorption on glauconite sands: from batch sorption to transport predictions

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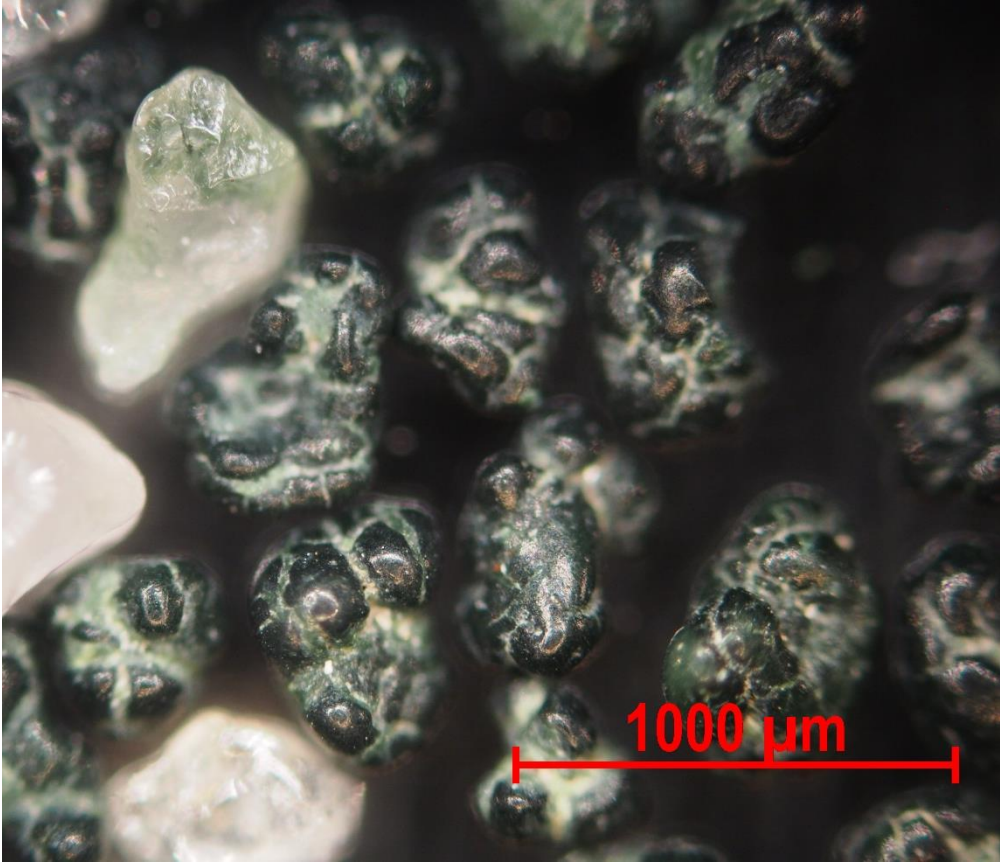
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Introduction

The Neogene-Paleogene glauconite sands are studied in the framework of the Belgian radioactive waste disposal. The sands are characterized by average glauconite contents of 20-30 wt%

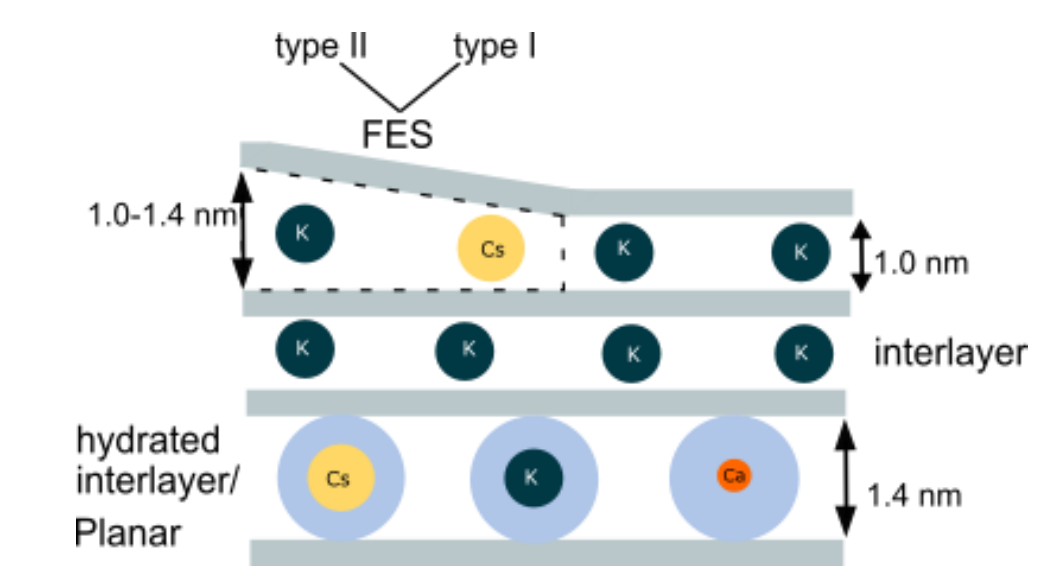


Glauconite has a radiocaesium interception potential that is comparable to illite, suggesting that glauconite containing sands may be an effective geological barrier for radiocaesium. However, glauconite is present as coarse pellets (~0.5 mm diameter) and considerable sorption non-equilibrium may occur during reactive transport in these permeable sands.

Objectives

The **aim** of this study is to use the trace caesium (Cs) **sorption potentials** and **site characterisation** of the glauconite sands in agitated batch suspensions **to predict reactive transport** at variable flow rates and compare the results with **column experiments** under variable flow rates.

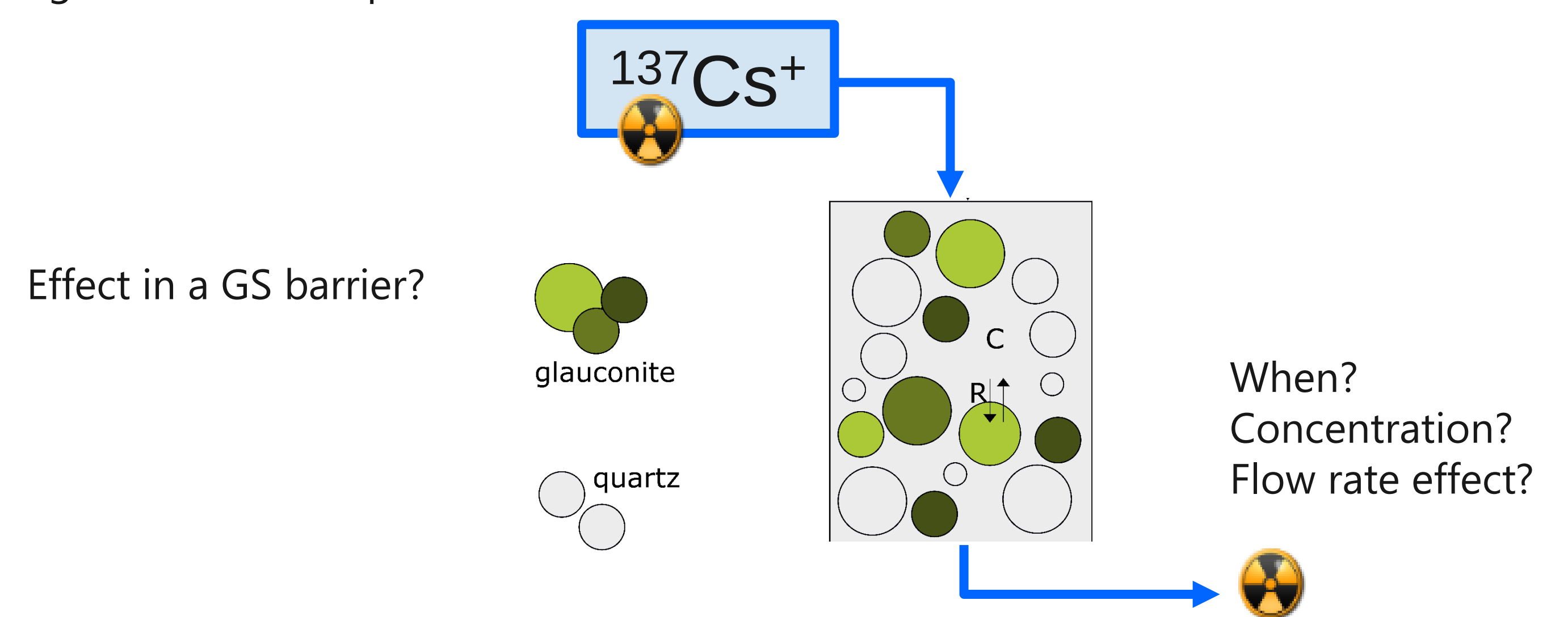
Concept



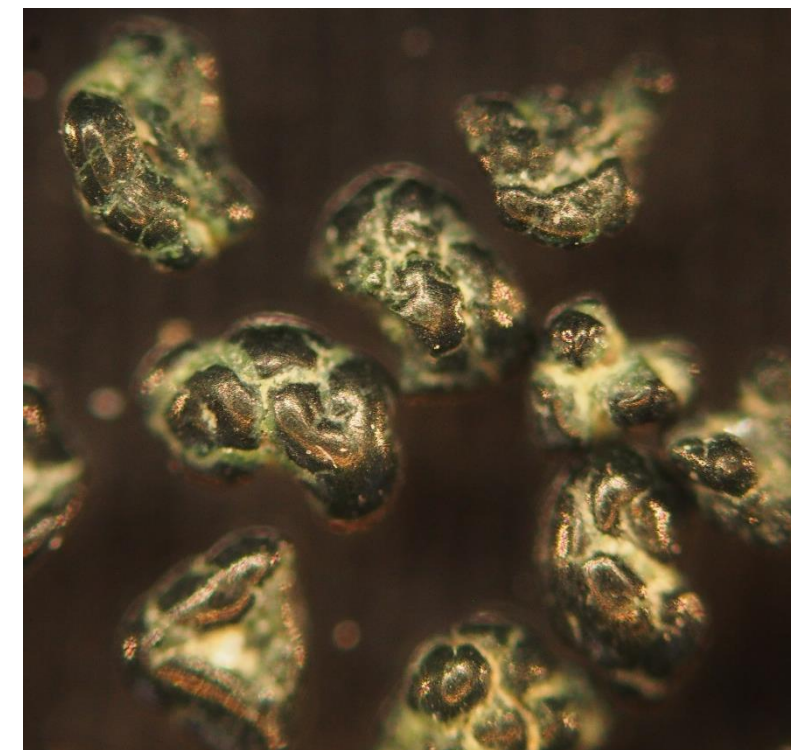
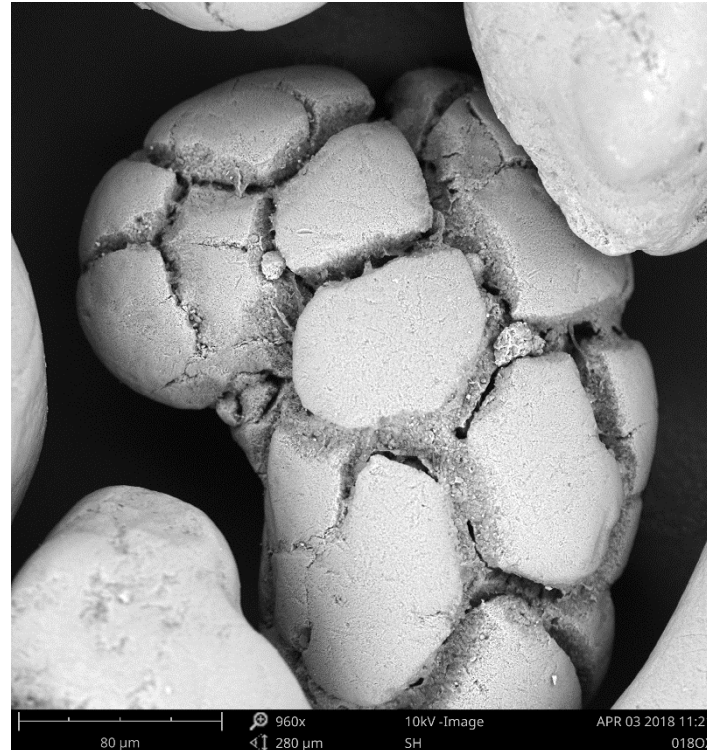
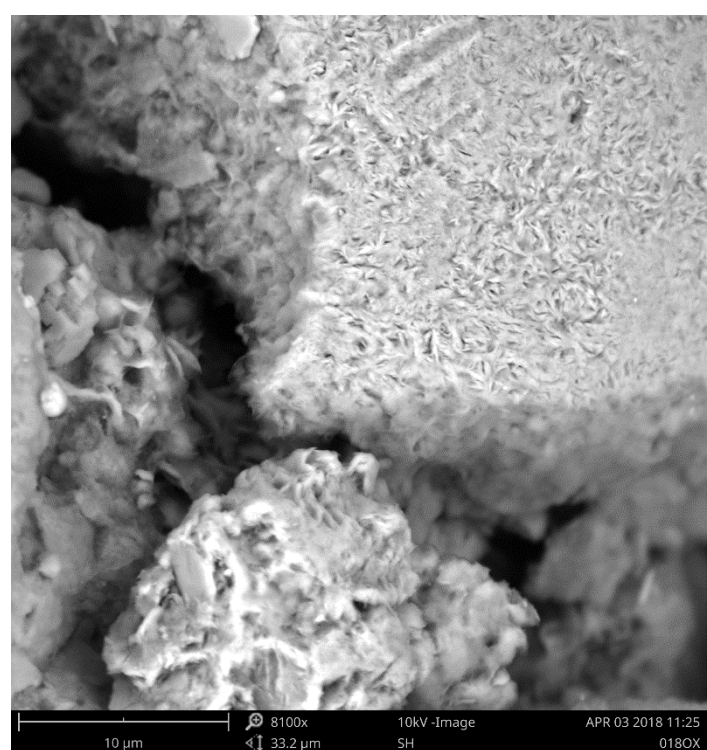
Highly selective sorption on selective Frayed edge sites (FES)

FES only 0.2 % of the total cation exchange capacity

High sorption potentials with equilibration times of > 30 days in agitated batch suspensions



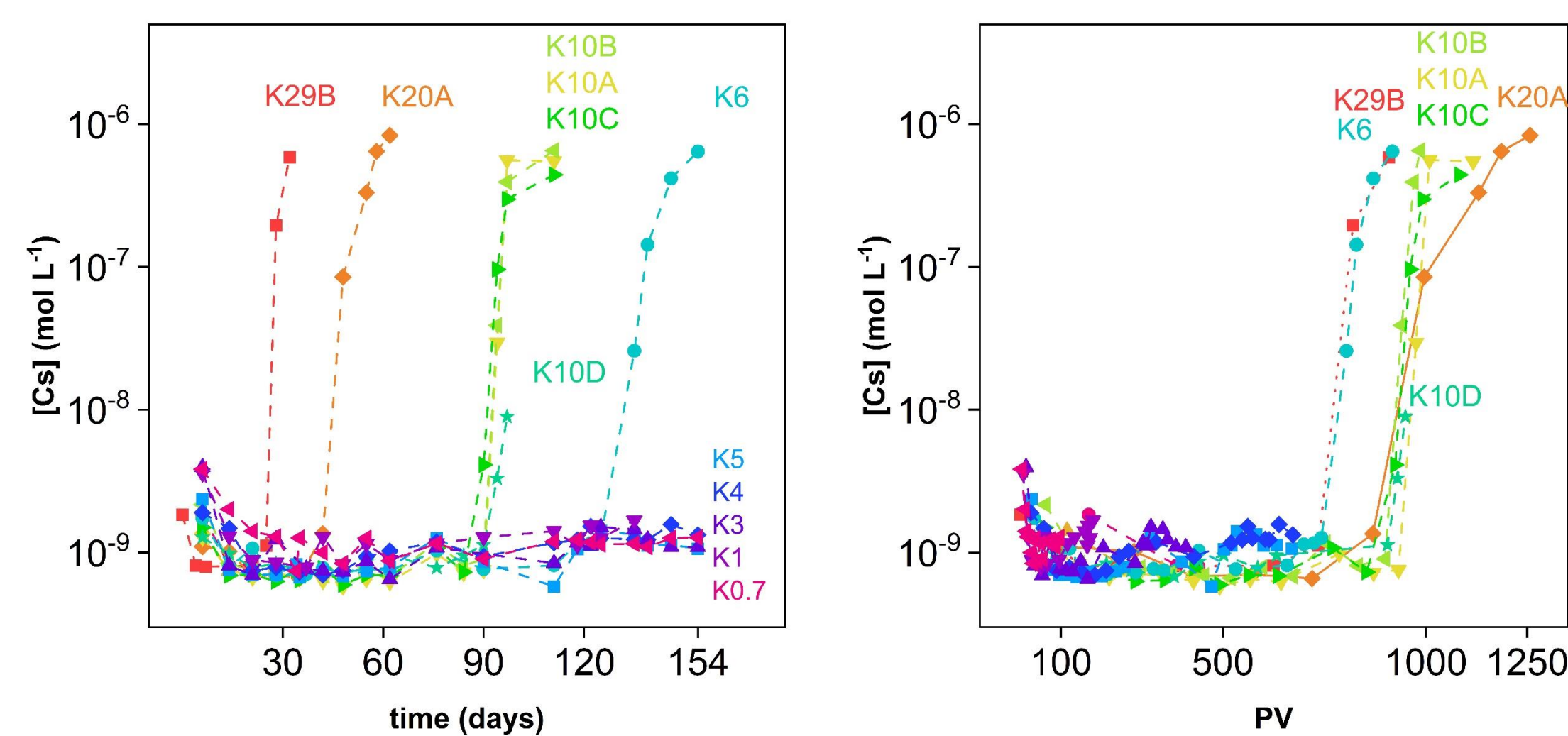
Glauconite sands have a high clay content, however present mostly as silt-sand sized pellets – different sorption dynamics – high associated permeability



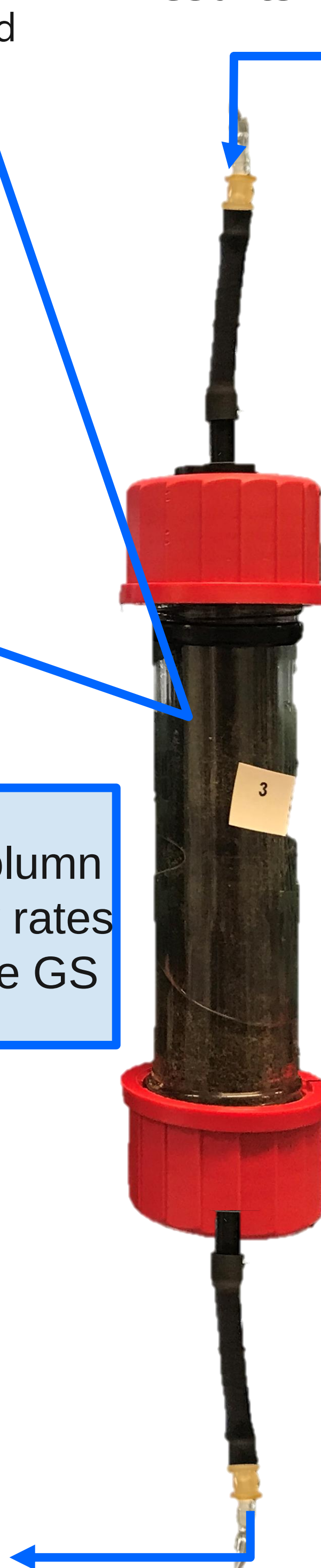
Clay platelets visible with SEM
Migration of Cs⁺ in the pellet is limited by diffusion

Cs Column experiments

No breakthrough in first pore volumes (PV)
Breakthrough at about 900 PV
Only at the highest flow rate earlier breakthrough

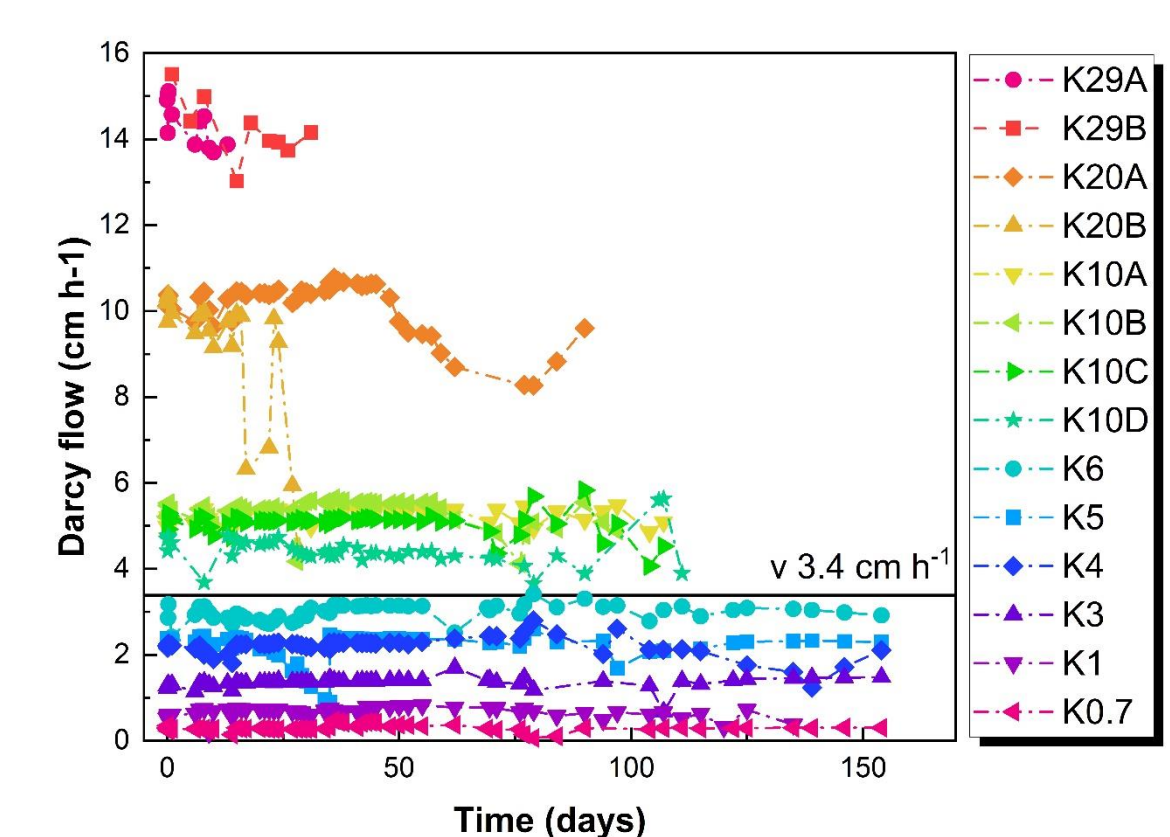


Results

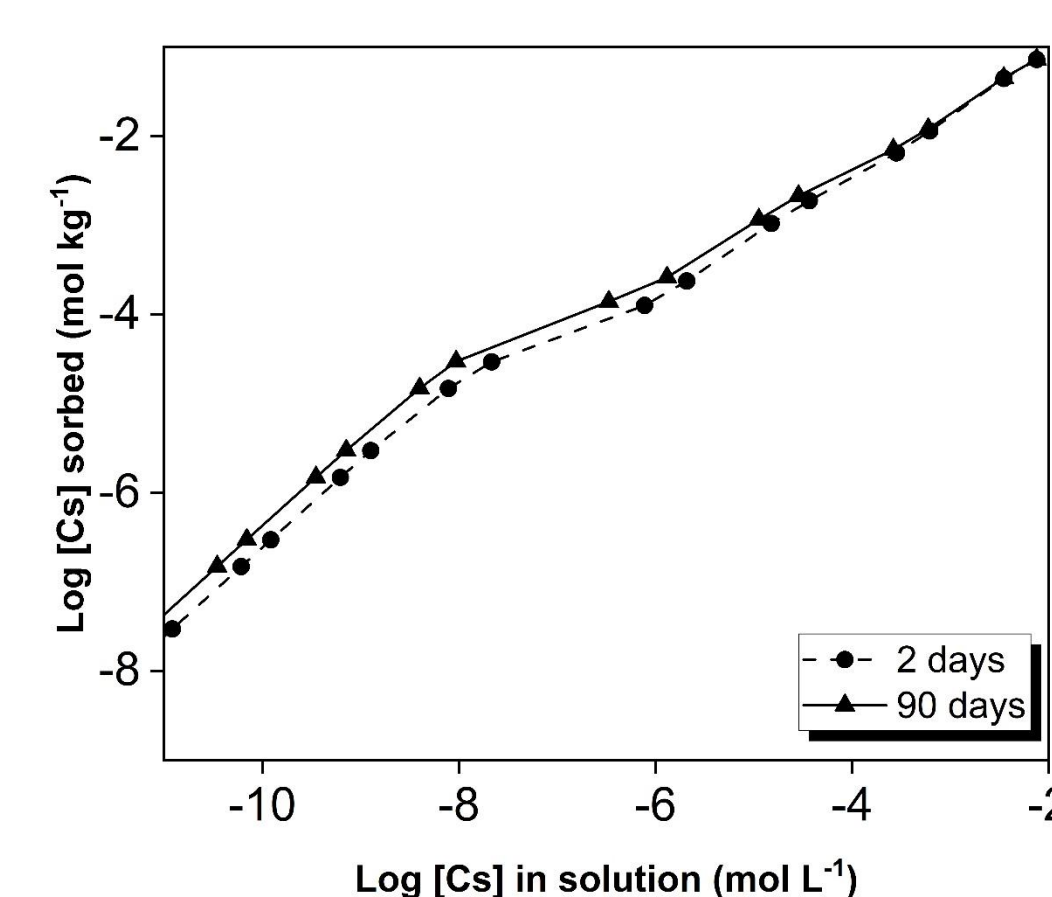


10⁻⁶ M
137Cs⁺

Flow rates



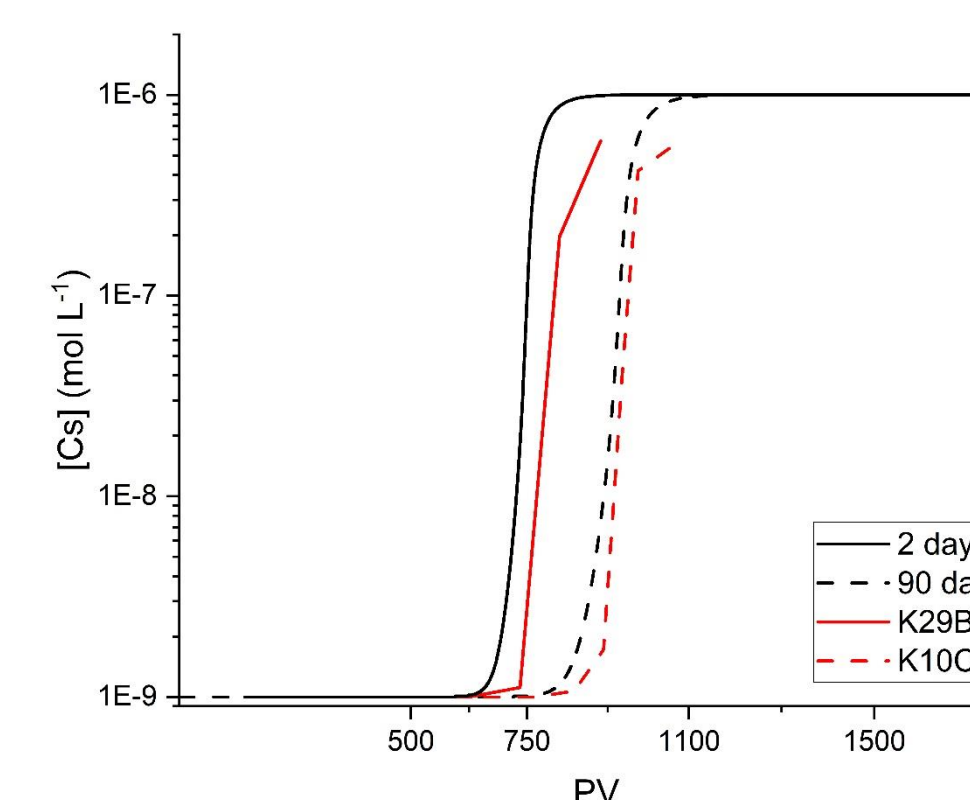
Predictive transport: input parameters HP1



PhreeqC component
Sorption isotherm – site characterisation
3 site model (capacity & selectivity)
Based on cation exchange
Takes into account competing cations

+ HYDRUS component – saturated flow with advection-dispersion equations for solute transport

Model prediction versus experimental results



Good correspondence between **prediction** and **experimental results**

Local equilibrium assumption is **valid**
Only in unrealistically high flow rates early break through

Conclusions

Cs⁺ **sorption** on highly permeable glauconite sands is **sufficiently fast** to delay breakthrough with flow rates below 2.4 m d⁻¹ and **equilibrium flow** applies. The reactive transport model can **accurately predict** breakthrough. Only in high flow rate, unrealistic for the Neogene and Paleogene formations the local equilibrium assumption is not valid.

References

- Bruneel, Y., Van Laer, L., Brassinnes, S., Smolders, E., 2020. Radiocaesium sorption on natural glauconite sands is unexpectedly as strong as on Boom Clay. Science of the Total Environment 720, 137392.
- Bruneel, Y., Van Laer, L., Brassinnes, S., Smolders, E., 2021. Characterisation of the highly selective caesium sorption on glauconite rich sands of contrasting geological formations. Applied Geochemistry, 128, 104926.
- Bruneel, Y., Van Laer, L., Brassinnes, S., Smolders, E., 2021. The sorption of caesium to glauconite sands obeys local equilibrium at environmentally relevant water flow rates, Applied Geochemistry, 133, 105073