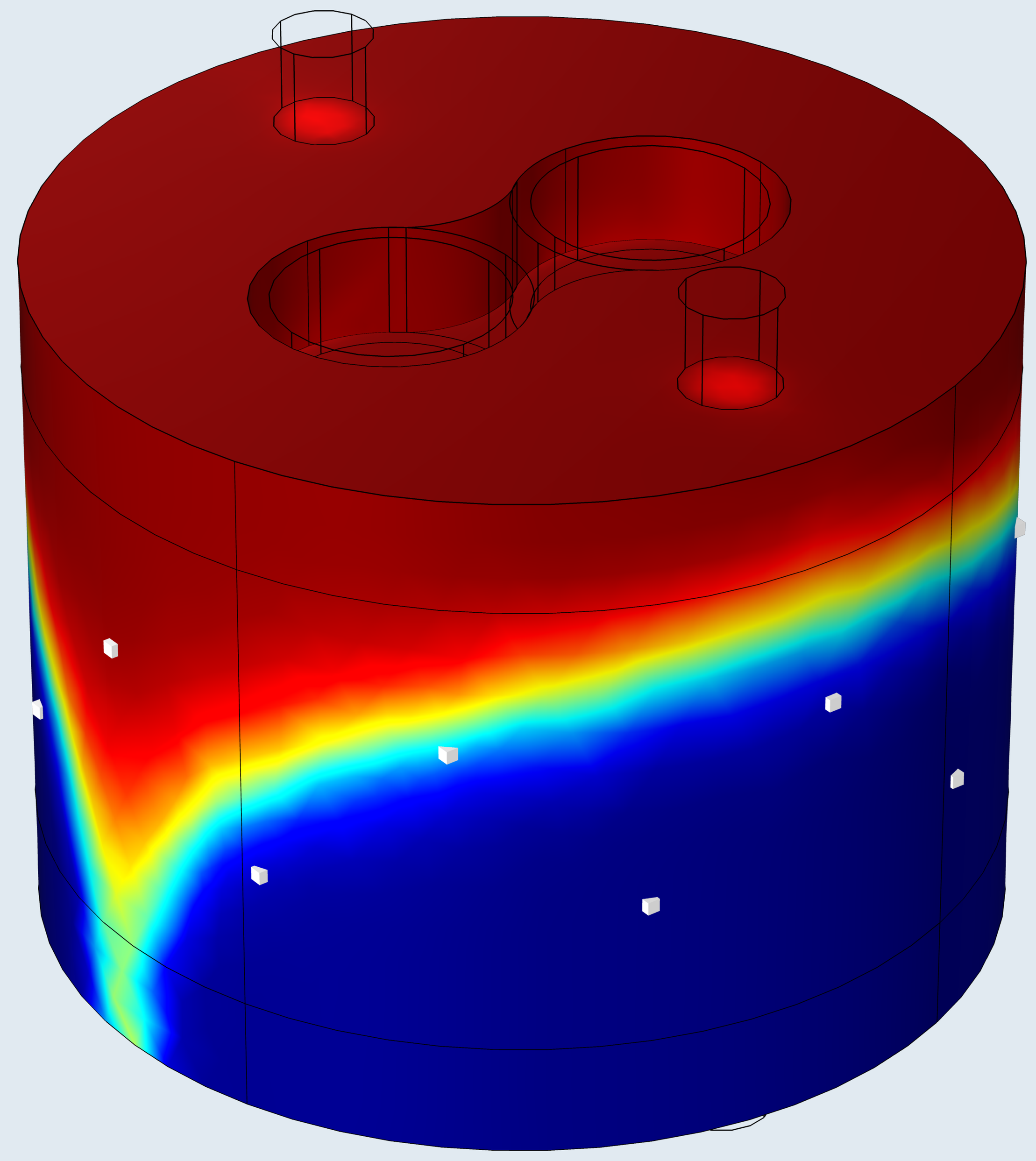

A FEM Study for the Design of an Advanced Oedometer for GHM Tests

Electrical Resistivity Tomography (ERT) is a non-evasive method to monitor the composition of pore fluid. COMSOL Multiphysics® was used to define an appropriate experimental protocol of electrical measurements for ERT in the advanced oedometer.

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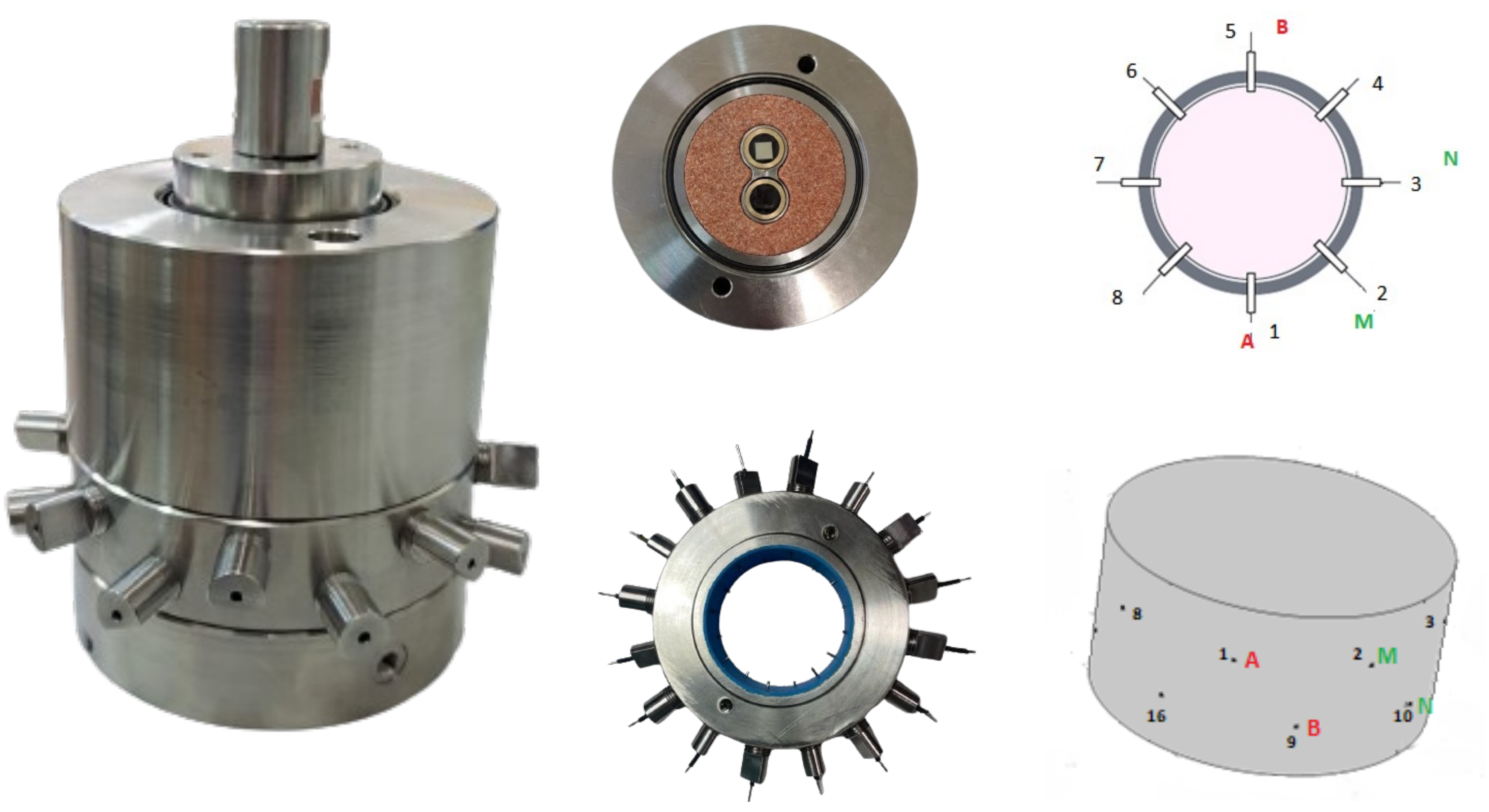
Introduction

An advanced oedometer was designed to study the Geochemo-Hydro-Mechanical behaviour of clays that are used to secure dissolved and non-aqueous contaminants (McCartney et al., 2016). As the behaviour of such materials is largely influenced by physico-chemical interactions with the wetting pore fluid, robust integration of multi-physics modeling and experiments is required.

The oedometer allows to monitor the mechanical response of clay samples exposed and flushed with acid solutions and non-aqueous fluids. An insight on the local changes in soil microstructure and pore fluid composition is obtained through maps of electrical conductivity, by means of Electrical Resistivity Tomography (Comina et al., 2008).

COMSOL Multiphysics® was used to optimize the protocols of electrical measurements, based on quadrupoles where 2 electrodes inject current and other 2 measure the electrical potential drop. Several quadrupoles are used to obtain a single data set for any ERT inversion.



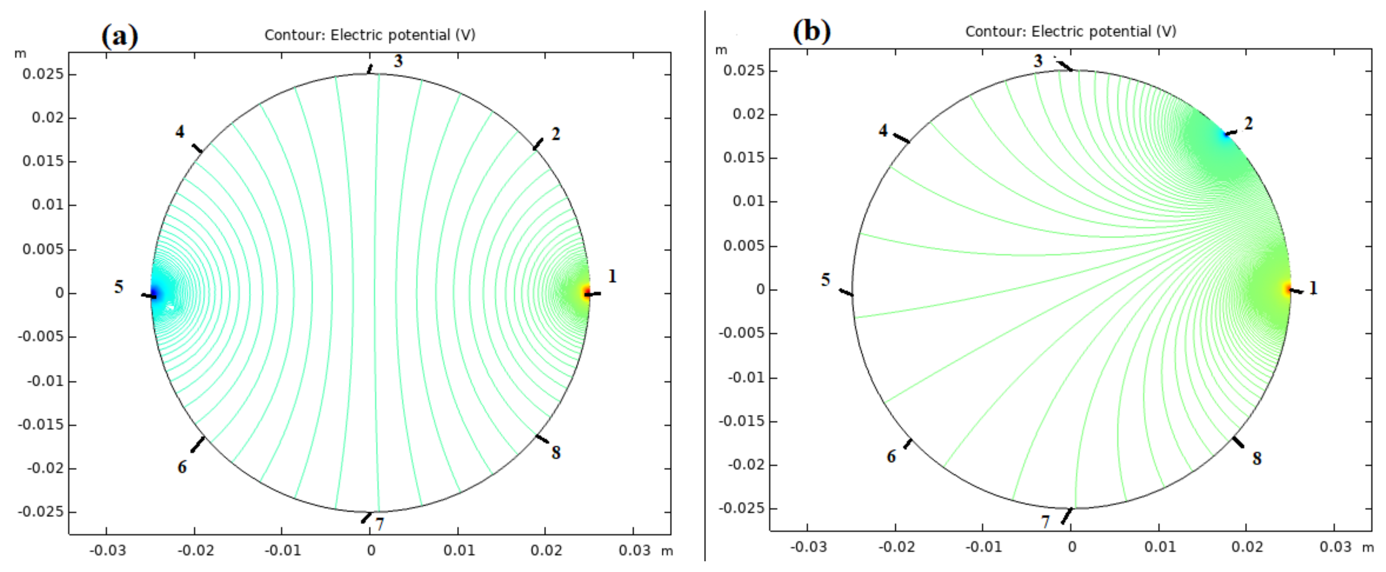
Overview of the advanced oedometer along with its base and ring. In the last column the two protocol of measurement are presented.

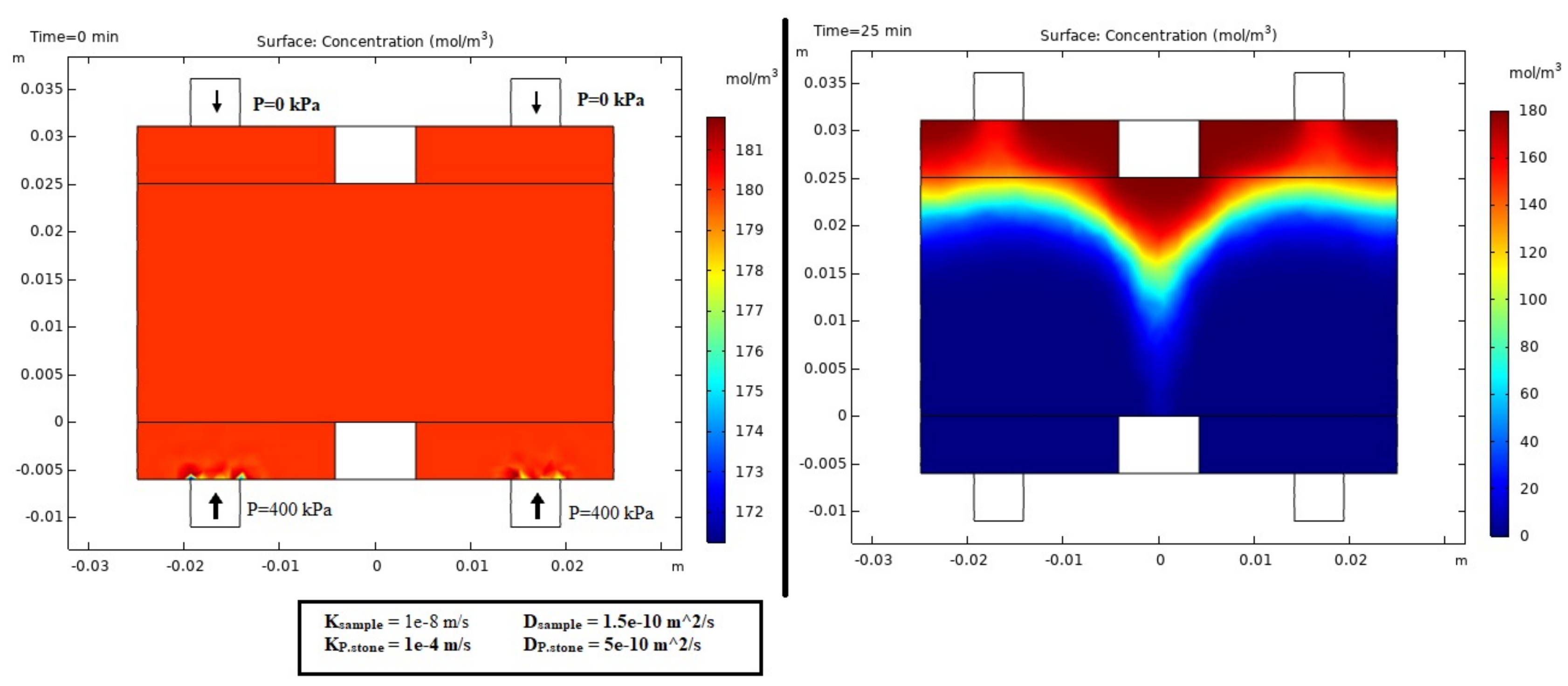
Methodology

To design the most appropriate experimental protocol, numerical analyses were performed in COMSOL®. Simulations of flushing tests, where distilled water is forced into an initially brine-saturated sample, were run accounting for water Darcian flow and advection/diffusion of chemical species using the Darcy's Law(dl) and Transport of Diluted Species (tds) physics. Maps of the electrical conductivity of the soil at different times were predicted based on the electrolyte concentration using Archie's law. The Electric Currents (ec) physics was then used to investigate the electrical potential fields associated to 314 different electrodes quadruples.

Results

The position and combination of some quadruples were such that the measuring electrodes lay almost on the same potential line and were excluded from the inversion data. These allowed us to determine which of them can be used, in real tests, for reliable reconstructions and which would provide less meaningful information.





Change in salt concentration over time when distilled water is flushed through clayey sample. The two figures on the left-hand side are electric potential lines at the level of electrodes. (a)when the current is injected in electrodes 1-5 the potential measuring electrodes 3-7, lay on the same potential line. (b)no such condition was encountered when current is injected in 1-2.

REFERENCES

1. C. Comina, S. Foti, G. Musso, & E. Romero 2008. "EIT oedometer – an advanced cell to monitor spatial and time variability in soil". *Geotechnical Testing Journal*, ASTM, 31 (5): 404-412.
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