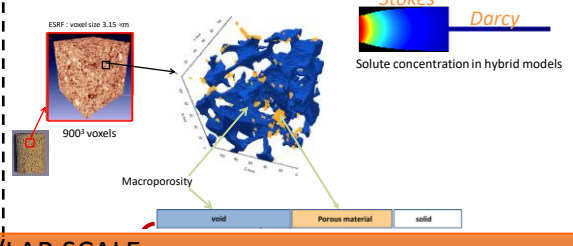
Modeling reactive transport processes in pore network models for karst applications

Dr. Roubinet Delphine, delphine.roubinet@umontpellier.fr, Dr. Linda Luquot, linda.luquot@umontpellier.fr, **Geosciences Montpellier**

MODELING TOOLS

Reactive transport processes in porous domains

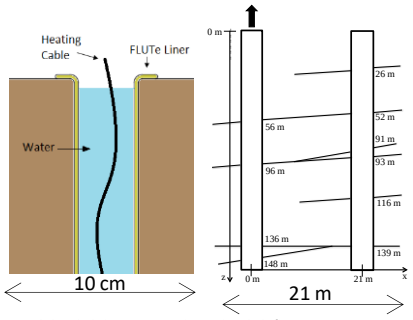
- Coupled models with fluid flow, transport, reactions
- Random walk approaches from pore- to Darcy-scale (from TDRW to CTRW)
- Stokes/Darcy hybrid approaches



Solute concentration in hybrid models

Borehole thermo-hydro-chemical characterization

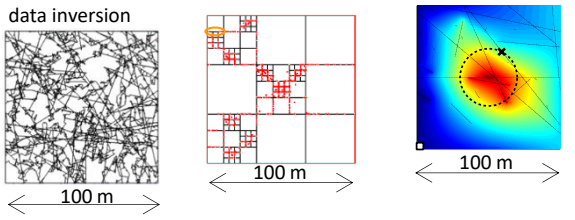
- Semi-analytical models for interpreting flowmeter experiments, and heat and tracer tests
- Particle-tracking approach for simulating chemical and heat tracer tests in fractured rocks



Single borehole heat tracer and cross-borehole flowmeter experiments

Thermo-hydro-chemical-electrical processes in fractured systems

- Fracture network generation
- Coupled fluid flow/transport and fluid flow/electrical processes
- Highly efficient numerical methods adapted to heterogeneous systems in the framework of sensitivity and risk analysis, and data inversion



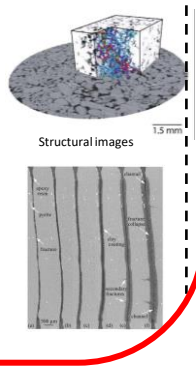
Fracture network, particle tracking simulation, and streaming potential distribution

MICRO/LAB SCALE — MACRO/FIELD SCALE

EXPERIMENTAL FACILITIES

- Flow-through reactive transport experiments in ambient and reservoir conditions
- Chemical analysis (IC, ICP-OES)
- Structural images (ESEM-EDS, XRMT)

ICARE laboratory facilities



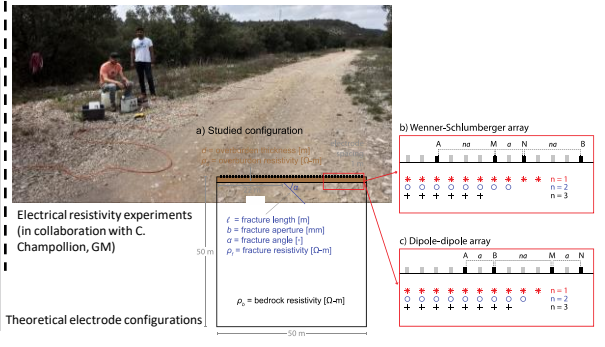
Structural images

- Field experiments and tool calibration at Lavalette site (3 boreholes – 100 m deep – cretaceous marly limestone)
- 35 borehole tools: logging, flowmeters, hydraulic and tracer tests, packers...

Borehole tools

Lavalette site

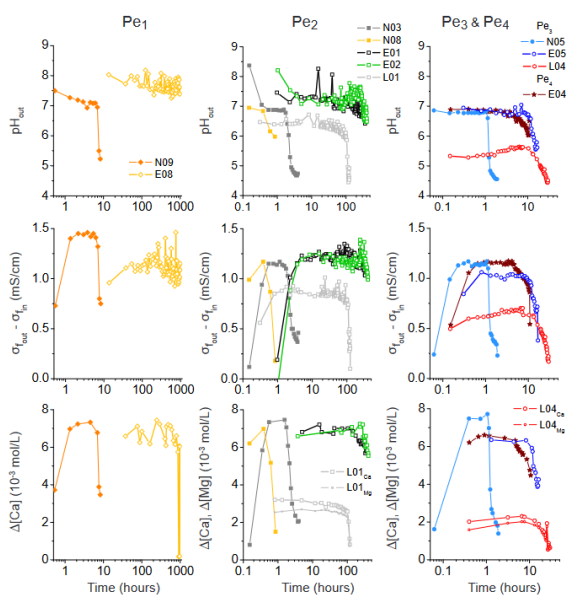
- Large-scale hydro-thermo-chemical tomography in wells
- Borehole and surface geoelectrical experiments (electrical resistivity, streaming potential...)

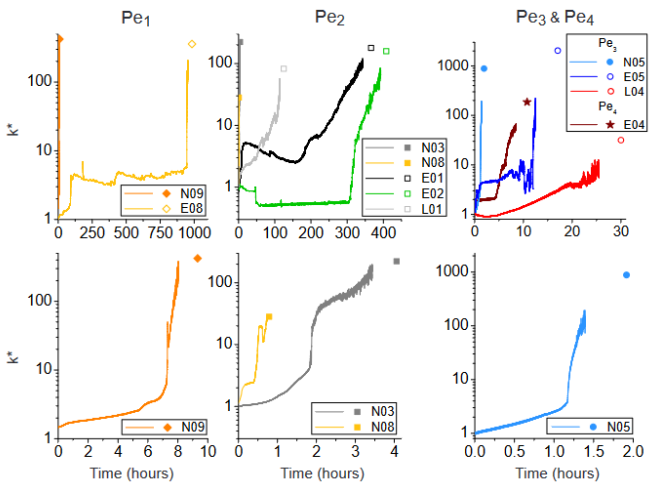


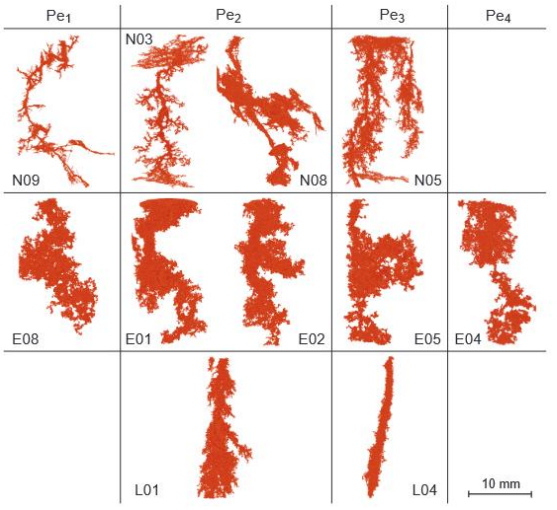
Electrical resistivity experiments (in collaboration with C. Champollion, GM)

Theoretical electrode configurations

Flow through experiments through natural core samples and developpment of 3D pore network models







Evolution of the pH at the outlet of the experiments (pH_{out}, first row), the differences in fluid conductivity (σf , second row) and calcium and magnesium concentrations between the outlet and inlet of the percolating experiments (Δ[Ca] and Δ[Mg], third row), with Péclet numbers Pe_1= 0.09 (first column, diamonds), Pe_2= 0.65 (second column, squares), Pe_3= 1.97 (third column, circles) and Pe_4= 5.26 (third column, stars). Samples labels with N stand for Normandie chalk, E for Euville crinoidal limestone and L for Lexos dolomite.

Evolution of the normalized rock permeability k∗ [-] during the percolating experiments, where k∗ is defined as the permeability of the sample along the experiment normalized by its initial permeability. The dot represents the final value of permeability.

Graphics are displayed according to Péclet numbers, in colums (Pe_1, Pe_2 and Pe_3 & Pe_4). Due to the large differences in experiments duration, a zoom of Normandie values is displayed on the second row.

Main path conduits of each sample depending on the four Péclet numbers (in columns) and the rock type (in rows). The samples are all displayed with the acid injection above them. The scale in the bottom right applies to all the samples

Leger, M., Luquot, L. and Roubinet D., Role of mineralogical, structural and hydrodynamic rock properties in conduits formation in three distinct carbonate rock types, Chemical Geology, 607, 121008. doi : 10.1016/j.chemgeo.2022.121008 (2022)