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Bridging experimental analysis to reservoir models: a geochemical modelling approach for Carbon Capture Storage

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Geological storage of carbon dioxide in depleted gas reservoirs or deep saline aquifers is one of the techniques to reduce CO2 in atmosphere and mitigate the greenhouse effects on climate changes.

A Carbon Capture Storage (CCS) plan is composed of different steps (capture, transportation, injection, monitoring just to cite a few) and a comprehensive multidisciplinary investigation must be carried out to define site-specific storage capacity/efficiency, formation injectivity and monitoring, both in short and long terms.

Especially in studying subsurface processes, geological, hydrogeological, petrophysical, mineralogical and geochemical information must be integrated, to evaluate, and possibly predict/quantify, the effects of the dissolution-precipitation processes driven by CO_2injection and the consequent changes in petrophysical properties of the rocks.

In this framework, numerical modelling can play a role of primary importance especially if it can be supported by a complete set of experimental data. To this purpose, a workflow has been recently developed according to the following steps:

- Core description and sample selection, to assure representativeness for the storage complex
- Mineralogical, petrographic, petrophysical, gas and water chemical data acquisition
- Data elaboration and integration to propose a conceptual model
- Numerical simulations
- static models: geochemical validation
- dynamic: CO_2injection and reactive migration

Point 4 is the main focus of this work which aims at describing (i) the near wellbore migration of $CO_2$and its effects on injectivity, and (ii) the behavior of specific sedimentary lithologies once they have come into contact with CO_2. For this purpose, a sequence of models has been developed, with a growing degree of complexity. 0D pure geochemical models are used to investigate rock

reactivity (thermodynamic and kinetic) by taking advantage of the very low computational cost of these models.

The limitations of neglecting mass migration are then overcome by performing 1D cartesian models which are in turn also used to calibrate petrophysical parameters of more CPU-demanding 2D radial models set up for simulating CO_2injection at well scale.

The numerical investigation will be concluded by using a real 3D reservoir model to predict more realistically the dynamics of CO_2migration in the storage complex and its effects on the lithology and petrophysical properties. This last step represents the ideal link/bridge between experimental activity and reservoir models.

All the numerical simulations are carried-out with an Eni-internal software platform (e-muflot, Multiphase Flow and Transport) developed to represent reactive transport in dynamic reservoir models.