In sedimentary basins, natural formation waters contain natural dissolved CO$_2$. Its occurrence is interpreted as resulting from diagenetic water-rock interactions. When considering the injection of CO$_2$ in geological formations in massive volumes, this will induce a shift in the natural equilibrium. Some minerals can be altered, whereas some can precipitate. One of the question is to know which kind of host rocks are more favorable for carbonates to precipitate, a likely product of injected CO$_2$. Another objective is to optimize the predictions for the safety and capacity of certain reservoirs or aquifers to indeed keep the CO$_2$ dissolved in the water or hydrocarbons, or in situ as a permanent mineral phase.

In the aim of looking at ways of storing carbon dioxide in geological structures such as depleted oil fields, or in saline aquifers which may hold large reserves of dissolved CO$_2$, some single mineral dissolution experiments and geochemical modeling will be presented that aim at understanding chemical reactions between acidified water and rocks on a micro scale. These experiments are directed to better constrain chemical information such as equilibrium constants or dissolution rates for specific mineral dissolution and precipitation on single mineral or simple mineral systems, to later scale up to typical depleted petroleum reservoirs conditions, which are host rocks for hydrocarbons and gas constituted of a many minerals of various sizes and reactivities.

Some of the results will present data from laboratory experiments which involve calcite plugs 21 mm long by 9 mm wide, consisting of natural entroquites from a Paris Basin limestone formation. Flow-through experiments were conducted at ambient temperature and consist in percolating water with 1 bar of p CO$_2$ in a dissolved form through a calcite plug, after equilibrating it with water. A careful monitoring of the experiment, that is the chemistry of main aqueous species Ca, Mg, K, Na, Cl, C and pH was done. The flow rate varied in the experiment, and results show that it had a considerable impact on the chemistry of the effluent's waters. Computer simulations such as DIAPHORE which are 1D reaction-transport models were used to simulate the experimental data. Results show a good correlation between experimental and numerical models, but the experiment shows variations with some parameters that the model does not yet constrain very well. For example, because the continuous injection of enriched CO$_2$ water keeps the system far from equilibrium, this induces an important role to the petrophysical features of the mineral such as the grain size, and the effective reactive geometrical surface which is prompt to react with acidified water. This reactive surface depends on the geometry of the mineral surface and largely on the porosity. In complex mineral systems, it can be shown also that the thermodynamic equilibrium constants have great influence on the reactivity of certain minerals.

Results will show the importance of running dissolution and precipitation experiments of simple mineral systems in order to adjust kinetics and thermodynamics constants, to be used in more complex natural systems. When and if depleted petroleum reservoirs are selected for pilot injection studies for CO$_2$ permanent sequestration, different conditions need to be tested (water chemistry with brines, temperatures, higher
pressure and higher p CO₂). Furthermore, for the sake of providing good modeling results and insuring safety guidelines for acid gas injection in underground structures, all these things need to be taken into consideration and sought out in terms of carbon balance, petrophysical changes (static or dynamic) resulting from mineral dissolution or precipitation.

These geochemical efforts are thus preliminary and mandatory steps towards an upscale effort to the reservoir engineering models and to the basin models which ultimately should be necessary for pilot studies.