Geophysical Research Abstracts
Vol. 15, EGU2013-5336, 2013
EGU General Assembly 2013

Experimental study of the caprock / cement interface under CO_2 geological storage conditions

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In the framework of CO_2 geological storage, one of the critical point leading to possible massive CO_2 leakages is the behavior of the interfaces crossed by the injection well. The lack of relevant data on the behavior of these interfaces (rock/well materials) in the presence of CO_2 under high pressure and temperature conditions led to the development of a new experimental model called "Sandwich". These batch experiments consisted in putting a caprock (Callovo-Oxfordian claystone of the Paris Basin) in contact with cement (Portland class G) in the presence of supercritical CO_2 with or without aqueous solution. The new experimental device was designed in order to follow the evolution of a clayey caprock, a Portland cement and their interface submitted to the acidic attack of carbonic acid through a study of the initial and final states. This model should help to document the behavior of interfaces in the proximal zone at the injection site.

After one month of ageing at 80°C under 100 bar of CO_2 pressure, the caprock, the cement and the interface between caprock and cement are investigated thanks to SEM, cathodoluminescence and Raman spectrometry. The main results reveal i) the influence of the presence of an aqueous solution since the carbonation mechanisms are quite different under dry and wet atmospheres, ii) the good cohesion of the different interfaces despite the carbonation of the cement, iii) the precipitation of different carbonate phases, which relates the changes in the chemistry of the solution to time, iv) the enrichment of silica in the cement phase submitted to the action of CO_2 putting into evidence new mechanisms of in situ silica re-condensation, v) the very good behavior of the caprock despite the alkaline flux from cement and the acidic attack from the dissolved CO_2. These experimental results will be compared to those obtained by geochemical simulations performed with PHREEQC.

This study was financially supported by the French agency ANR (ANR-08-PCO_2-006).