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Mineralogical and chemical changes of carbonate rocks under SC CO_2 exposure. Experimental and numerical tests.

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The focus of this research is a qualitative and quantitative study of mineralogical, chemical and petrophysical (porosity) changes in carbonate rock samples after injection of supercritical (SC) CO_2. The studied rocks were sampled in the western Basque-Cantabrian Basin, North Spain, and consist of vuggy carbonates ("Carniolas") of the Puerto de la Palombera formation (Hettangian).
Samples are exposed to (a) SC CO_2 rich brine and (b) dry SC CO_2 under similar experimental conditions (P $\approx$75 bar, T $\approx$ 35 °C, 970 h exposure time and no CO_2 flow). Mineralogical and pore space study is completed by optical microscopy, scanning electron microscopy and optical image analysis before and after the experiment. X-ray fluorescence analyses are performed to refine the mineralogical information and to obtain whole rock geochemical composition. The determination of brine composition before and after the experiment completes the analytical programme. Numerical modelling is applied to validate the experimental observations.
Mineralogical and chemical results indicate that the carbonate rocks exposed to supercritical CO_2 in dry conditions do not suffer significant changes. The injection of supercritical CO_2-rich brine, however, induces chemical and physical changes in the rock due to the high reactivity of calcite at the low pH conditions produced by the acidified brine. Secondary minerals (gypsum and illite) precipitated during the CO_2-rich brine experiment. Numerical modelling indicates that illite precipitation may continue during a long period which can be an important issue in term of CO_2 injectivity.
These results can be used to characterize the behaviour of carbonate rocks under conditions similar to the vicinity of a CO_2 injection well. Experimental and numerical analysis facilitated a detailed characterization of the CO_2-carbonate rock interactions at laboratory scale. The procedure carried out could be applied to similar experimental injection tests.