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The CO2-Vadose Project: Geophysical and geochemical monitoring of CO2 migration in a carbonate reservoir in the vadose zone. Experimental design and the baselines

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The main challenge of the geologic carbon sequestration (GCS) near-surface monitoring community is how to detect small CO2 seepage fluxes and anomalous concentra- tions in the presence of relatively large natural background fluxes caused by biological processes (e.g., Oldenburg et al. 2003; Lewicki et al. 2005, 2007; Leuning et al. 2008; Cortis et al. 2008).
The CO2-Vadose Project aims at developing a facility around a room of a former underground limestone quarry to perform experimental releases of CO2 under controlled conditions in order to study its migration along the vadose zone and to test near-surface detection techniques.
Preliminary modelling carried out with the research code COORES^{TM} coupled with the geochemistry reactor ARXIM permitted to model the extend of the CO2 plume at chosen release rate, the concentrations and flow rates expected at chosen depth, the timing of the migration and of the sampling strategy. Parameters for the model were derived from preliminary investigations on the studied site and further petrophysical characterizations (porosity, permeability, capillary pressure versus water-gaz saturation, etc...).
Based on the results furnished by the preliminary modelling, an array of detection and monitoring tools was deployed. They allow the regular monitoring of water and gas compositions and fluxes, as well as their samplings, thanks to TDRs and SP (water content), lysimeter (water composition), infrared analyser (CO2 concentrations), flux chamber (CO2 fluxes), radom (radon concentrations), micro-GC (CO2, O2, N2 and CH4 concentrations). Micro-climatic parameters were also recorded by a weather station at the site surface (precipitation, barometric pressure, temperature, relative humidity, wind speed, sunniness) and around the injection room (barometric pressure, temperature). These tools will be used for the establishment of the baselines, for the comprehension of the CO2 migration in the vadose zone during the future gas injection in the selected quarry room. Besides, δ13C CO2, total organic carbon, mineral carbon, as well as the compositions in He, Ne, Ar and Kr, were periodically determined to establish the composition of the CO2 + trace compounds to be injected in the future.