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Experimental determination of carbonation rate in Portland cement at 25°C and relatively high CO_2 partial pressure

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The aim of this work is to study the alteration of Portland class G Cement at ambient temperature under a relatively high CO_2 partial pressure through suitably designed laboratory experiments, in which cement hydration and carbonation are taken into account separately.
First, the hydration process was carried out for 28 days to identify and quantify the hydrated solid phases formed. After the completion of hydration, accompanied by partial carbonation under atmospheric conditions, the carbonation process was investigated in a stirred micro-reactor (Parr instrument) with crushed cement samples under 10 bar or more of pure CO_2(g) and MilliQ water adopting different reaction times.
The reaction time was varied to constrain the reaction kinetics of the carbonation process and to investigate the evolution of secondary solid phases. Chemical and mineralogical analyses (calcimetry, chemical composition, SEM and X-ray Powder Diffraction) were carried out to characterize the secondary minerals formed during cement hydration and carbonation. Water analyses were also performed at the end of each experimental run to measure the concentrations of relevant solutes. The specific surface area of hydrated cement was measured by means of the BET method to obtain the rates of cement carbonation.
Experimental outcomes were simulated by means of the PhreeqC software package. The obtained results are of interest to understand the comparatively fast cement alteration in CO_2 production wells with damaged casing.