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Effects of trace gas components in carbon capture and storage: geochemical experiments and simulation of laboratory-scale brine-rock-CO_2-trace gas interaction

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In the research activities on geological storage of carbon dioxide many studies mainly focus on the impact of pure CO_2 gas on the storage formations. However, flue gas streams of power plants not only contain CO_2, but also number of trace gases such as O_2, N_2, Ar, NO_X, SO_X, CO, H_2, H_2S, COS and CH_4. These trace gases may not only interact with pipeline material, but can also trigger short-term and long-term changes within the subsurface storage lithology. The chemical reactivity of each of these compounds has to be evaluated and their interactions with each other have to be understood, especially since some of them are far more reactive than CO_2. Within the project COORAL (= CO_2 Purity for Capture and Storage) we concentrate on geochemical investigations to determine reaction pathways and kinetics of different mineral phases typical for potential German storage formations as influenced by the presence of trace gases within the flue gas stream. Quantitative measurements of these reactions are relatively well described for pure CO_2 systems but are so far not well described for multi-component mixtures. We combine laboratory experiments (batch and flow-through) with numerical simulations applying the geochemical simulators PHREEQC and ChemApp, which will be coupled to GeoSys/RockFlow for coupled thermo-hydro-mechanical-chemical (THMC) process simulations. Calculations and experiments are performed for temperatures up to 200°C and pressures up to 50 MPa. The aim of the study is to determine optimal maximum concentration levels of trace gases in flue gas streams to be used in geological CO_2 storage.