

Reaction path controlled by acid supply, hydrothermal alteration in CO₂-H₂O-forsterite system

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Carbon cycle is heavily imbalanced by industrial CO₂ emissions. One of carbon capture storage (CCS) scenarios is reaction between CO₂ rich fluid and mafic/ultramafic rocks, which are abundant in divalent cations as Mg, Fe²⁺. Such released ions during rock alteration form various carbonates with carbon species in the fluid. Moreover such carbonate scaling and others are commonly linked to geothermal energy utilization. Batch type experiments were conducted between the interaction of olivine and CO₂-rich solution at 150°C. The experiments were carried out using forsterite (Fo93), solution with CO₂ concentration of 5-20 mmol/kg for up to 4 weeks and the solution composition and secondary mineralogy monitored. Initially forsterite dissolved leading to pH increase (H⁺ consumption) and Mg, Fe and Si release to solution. Upon further reaction secondary phases started to form as ferroan magnesite (Fe-Mg carbonate), chrysotile and brucite. This resulted in decrease of CO₂ concentration and eventually increase of the pH to >8. The results were compared with kinetic reaction modelling to further gain insight into the water-rock mechanism and to evaluate if simple reactions can be accurately simulated. The results indicate that reaction path and mass movement can be modelled, this is heavily relying on the primary mineral reactive surface area and initial secondary mineral formation or nucleation.