Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29232

A mineralogical and geochemical approach to evaluate the redox capacity of basaltic glass and crystals via experiments

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The levels of greenhouse gases, particularly CO2, rise globally. To tackle this problem, scientists and engineers have been exploring carbon capture and storage (CCS) technology to reduce CO2 concentrations in the atmosphere. Mineral carbonation is a promising CCS technique that involves CO2 reacting with Ca-Mg-Fe bearing basaltic rocks to store it in the rocks as carbonate minerals. The CarbFix project in Iceland is an excellent demonstration of this approach. However, much remains to be discovered about the intricate physicochemical connections between water, dissolved ions, and crystal growth in complex multicomponent systems at the atomic and nanoscale. These factors are vital for the successful deployment of CCS in basaltic reservoirs.

This research explores the use of supercritical CO2, which is achieved by exceeding the critical temperature and pressure of 30.97 °C and 73.773 bar, respectively. In this state, CO2 exhibits the properties of both a gas and a liquid. The study presents the results of an experiment conducted on basaltic crystals and glasses under varying temperatures (between 100 and 200 ºC) and pressures (64 to 79 bar) to investigate the reaction between CO2 (sc), water, crystals (mainly forsterite) and basaltic glass. The results highlight the partial dissolution of mineralogical phases and the formation of new alteration phases, in addition to the precipitation of carbonates containing Ca, Mg, and Fe. A comparison will be made between the obtained carbonation to the findings of Aaberg [1] study, in which synthetic forsterite was reacted with CO2. Furthermore, the composition of the post-reaction gases will be analyzed to evaluate the redox conditions occurring in water-CO2-basaltic glass and water-CO2-basaltic crystal reactions.