

# **Reaction pathways during fluid-rock interactions: the role of fluid composition**

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In nature, fluids permeate through nominally solid rocks along fractures, grain boundaries, and pores. Once the fluid comes into contact with the rock-forming minerals, these will enter an enhanced disequilibrium state initiating mineral dissolution and mineral-fluid reactions that may result in precipitation, replacement reactions, element mobilization and mass transport, ore deposit formation and changes in stress distribution.

We performed a series of laboratory experiments to investigate the effects of various solutions on two types of monomineralic rocks over time under simulated hydrothermal conditions. The rocks were Carrara Marble, composed of calcite grains, and anorthosite, consisting of plagioclase grains. The solid material was prepared as approx. 3 mm-scale cubes and placed in Teflon containers with 2 ml of solution in sealed hydrothermal metal cylinders at 200° C. Results show that the composition of the solution has a significant impact on the location of any potential replacement reaction. We observed that the reaction either occurred along the grain boundaries while leaving the outer part of the cube in contact with the bulk fluid relatively unaffected, or it began along the faces of the cube while leaving the grain boundaries almost intact, or a combination of both. To compare experimental samples with a natural scenario, a rock in contact with the bulk fluid inside the container of the hydrothermal experiment might be equivalent to bodies of rocks near wide open fractures filled by fluids.

Here we discuss which factors might control reaction pathways by analyzing the experimental samples using SEM, Electron Microprobe, ICP-OES and Raman Spectroscopy. Additionally, we compare our experimental results with PhreeqC simulations of the same systems to explore the effects of reaction rates, fluid concentration, and the width of the interface boundary fluid layer, where supersaturation of a product phase can be achieved. This study provides insights into understanding mineral-fluid reaction pathways in rocks as well as the potential for controlling reaction pathways for various designed material applications, and could be used as a proxy for determining fluid composition in natural geological processes.