

Fluid assisted mineral replacement processes

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Replacement of one mineral by a more stable one is a widespread phenomenon in various geological environments and processes. Within the frame of Forschergruppe FOR 741 ('Nanoscale processes and geomaterials properties') we focus on replacement reactions in the presence of a fluid. One main mechanism controlling these replacement reactions is fluid-assisted dissolution and material transport along grain and interphase boundaries followed by reprecipitation of the product phase. Reaction-related volume changes and the development of porosity and microcracks in the product phase may also play an important role. Two different model examples for fluid-assisted replacement processes are studied and compared: (1) the alteration of plagioclase to sodalite, as observed in metasomatic rocks, and (2) the fluid-assisted replacement of plagioclase by albite, which is a widely recognized phenomenon, reported from a number of rock types. Both examples are suitable for studying the behaviour of trace elements during mineral replacement processes. In order to construct a replacement model, we combine microscopic observations and chemical analyses of natural minerals and rock samples, for which the PTX conditions of the respective replacement reaction are well defined, with investigations by hydrothermal experiments. High-resolution microanalytical techniques (e.g. SEM, TEM, LA-ICPMS, and electron-backscatter diffraction) provide detailed information about the 3-dimensional geometry of the reaction front and the possible lattice preferred orientations or lattice deformation of the educt and product phases. The study contributes to a better understanding of the geological meaning of replacement textures and trace element and isotope signatures of the product phases. Future research plans are to expand the experimental research to other model systems of fluid-mineral interaction. Of special interest is the development of metastable amorphous material at the reaction interface, as observed in most of our experiments, and the determination of its internal structure and general role in fluid-assisted mineral replacement processes.