Reaction-induced porosity and implications for element mobility

CHRISTINE V. PUTNIS[1,2], JÖRN HÖVELMANN[3], FRANÇOIS RENARD[4], ENCARNACIÓN RUIZ-AGUDO[5]

[1]Institut für Mineralogie, University of Münster, Germany, [2] Department of Chemistry, Curtin University, Perth, Australia, [3]German Research Centre for Geosciences (GFZ), Potsdam, Germany, [4] PGP, Department of Geosciences, University of Oslo, Norway, [5] Department of Mineralogy and Petrology, University of Granada, Spain

Aqueous fluids, that are ubiquitous in the crust of the Earth, will move through possible pathways in rocks. Rocks characteristically have low permeability but fractures and mineral grain boundaries can provide fast fluid pathways. However, porosity within minerals forms when a mineral is out of equilibrium with an aqueous fluid and reactions take place in an attempt to reach a new equilibrium. Commonly, dissolution at a mineral-fluid interface initiates one or several coupled reactions involving dissolution and precipitation[1,2]. In pseudomorphic volume-deficit reactions, a new phase forms while porosity is created, and thereby reactive fluid flow through the originally solid mineral is enhanced. These coupled dissolution-precipitation replacement reactions therefore will constrain the mobility of elements carried by the fluid. Such reactions are common during metamorphism, metasomatism, and weathering. Elements present in the parent mineral are released to the fluid and therefore mobilized for transport elsewhere.

Porosity formation has been shown in a number of systems, such as during albitisation of feldspars[3] and replacement of carbonates by apatite phases[4]. Examples from in situ AFM experiments will be presented. This mechanism has been shown as a means of carbon and phosphorus sequestration and for the removal of toxic elements from ground waters, such as Se and As.

References: [1]Ruiz-Agudo E. et al. (2014) Chem. Geol., 383, 132. [2]Putnis C.V. and Ruiz-Agudo E. (2013) Elements, 9, 177. [3]Hövelmann J. et al. (2009) Contrib. Min. and Pet. 159, 43. [4]Pedrosa E.T. et al. (2016) Chem. Geol., 425, 1-11.