Geophysical Research Abstracts
Vol. 19, EGU2017-16415, 2017
EGU General Assembly 2017

Numerical modelling of hydration reactions

Johannes C. Vrijmoed and Timm John
Freie Universität Berlin, Mineralogy and Petrology, Department of Earth Sciences, Berlin, Germany
(j.c.vrijmoed@fu-berlin.de)

Mineral reactions are generally accompanied by volume changes. Observations in rocks and thin section indicate that this often occurred by replacement reactions involving a fluid phase. Frequently, the volume of the original rock or mineral seems to be conserved. If the density of the solid reaction products is higher than the reactants, the associated solid volume decrease generates space for a fluid phase. In other words, porosity is created. The opposite is true for an increase in solid volume during reaction, which leads to a porosity reduction. This slows down and may even stop the reaction if it needs fluid as a reactant. Understanding the progress of reactions and their rates is important because reaction generally changes geophysical and rock mechanical properties which will therefore affect geodynamical processes and seismic properties.

We studied the case of hydration of eclogite to blueschist in a subduction zone setting. Eclogitized pillow basalt structures from the Tian-Shan orogeny are transformed to blueschist on the rims of the pillow (van der Straaten et al., 2008). Fluid pathways existed between the pillow structures. The preferred hypothesis of blueschist formation is to supply the fluid for hydration from the pillow margins progressing inward.

Using numerical modelling we simulate this coupled reaction-diffusion process. Porosity and fluid pressure evolution are coupled to local thermodynamic equilibrium and density changes. The first rim of blueschist that forms around the eclogite pillow increases volume to such a degree that the system is clogged and the reaction stops. Nevertheless, the field evidence suggests the blueschist formation continued. To prevent the system from clogging, a high incoming pore fluid pressure on the pillow boundaries is needed along with removal of mass from the system to accommodate the volume changes.

The only other possibility is to form blueschist from any remaining fluid stored in the core of the pillow structures for example as a remnant from the eclogitization (dehydration) reaction. In this case, a low pore fluid pressure on the pillow boundary relative to the core is required to form blueschist, which could be related to a drop in ambient pressure during exhumation. Fluid is then flowing out from the pillow towards the rims. This hypothesis has the advantage that clogging of the system is prevented and no high fluid pressure on the boundary is required. However, it is complicated by the fact that there may not be enough excess fluid present in the eclogite pillow if most of it left the system during the prograde metamorphism.

van der Straaten, F., Schenk, V., John, T., and Gao, J., 2008, Blueschist-facies rehydration of eclogites (Tian Shan, NW-China): Implications for fluid-rock interaction in the subduction channel: Chemical Geology, v. 255, p. 195-219.