Geophysical Research Abstracts
Vol. 19, EGU2017-14592, 2017
EGU General Assembly 2017

The role of an evolving porosity in fluid-rock interaction – a synthesis of insights gained in six years of in-situ 4D microtomography experiments

Florian Fusseis
University of Edinburgh, Edinburgh, United Kingdom (florian.fusseis@ed.ac.uk)

Effective fluid rock interaction relies on permeable pore space for fluid to move in. In dynamic (tectono-)metamorphic environments, pore space will be transient and subject to continuous modification. As a consequence, transport properties of rocks evolve throughout their metamorphic history, which complicates the interpretation of fossilised traces of fluid-rock interaction in natural rock samples. Thankfully, a large body of processes involved in fluid-rock interaction occur on time scales accessible in experiments, and over the past decades significant insights were gained in many now classical laboratory investigations. Until recently though, fluid-rock interaction could not be observed directly, and processes and rates were inferred through indirect measurements or post-mortem analyses. Studies that utilise x-rays or neutrons to continuously image fluid-mediated processes inside experimental vessels allow, on the one hand, to quantify their rates but also to assess and characterise transient porosity on the grain scale.

In this presentation, I will synthesize the findings from several collaborative experimental studies that documented and quantified fluid-rock interaction in 4-dimensional x-ray microtomographic datasets. Most of these experiments were conducted in bespoke x-ray transparent vessels built in Edinburgh and all of them involved a dynamically evolving porosity as a key element of the studied processes. The latter are 1) the dehydration of gypsum single crystals and alabaster, 2) the carbonation of olivine aggregates, 3) pressure solution in polycrystalline salt, and 4) the dolomitisation of various carbonates. The microtomographic time series data enabled the direct observation of the above processes on the grain scale and were used to quantify their advance using sophisticated image analytical workflows.

Each of the studies characterised porosity formation or alteration by a particular mechanism relevant to geological scenarios and it became apparent from the experiments that the spatio-temporal advancement of both pore formation and the associated reactions were substantially different in each case. I will show that in particular the geometrical appearance, size distribution, overall volume and interconnectivity varied in both, in space and time. It seems difficult to ignore these complexities in the investigation of fluid-rock interaction, particularly where fluid transport pathways, or the geometry and distribution of reactive surfaces are relevant. However, I will also demonstrate how time-resolved in-situ imaging experiments provide a way to explore the role of dynamic porosity in fluid rock interaction and give us a key to reliably quantify reaction rates from volumetric estimates, provided that rigorous protocols are followed in image analysis. In the near future, this will allow considering dynamic rock transport properties as integral components in the interpretation of fluid-mediated metamorphic processes.