Geophysical Research Abstracts
Vol. 14, EGU2012-5331, 2012
EGU General Assembly 2012

Lithium-chronometric constraints on duration and kinetics of fluid-rock interaction

T. John (1), Y. Podladchikov (2), R. Dohmen (3), N. Gussone (1), R. Klemd (4), T Magna (1,5)

(1) Institut für Mineralogie, Universität Münster, Germany (timm.john@uni-muenster.de), (2) Institut de Géophysique, University of Lausanne, Switzerland, (3) Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, Germany, (4) GeoZentrum Nordbayern, Universität Erlangen Germany, (5) Czech Geological Survey, Czech Republic

Direct investigations on fluid flow in crystalline rocks are not possible and due to the dm- to m-sized dimensions of the flow structures also not recordable in-situ by geophysical methods. Consequently, we have to rely on samples that have been exhumed long after (i.e. millions of years) the fluid-rock interaction took place. Obtaining time constraints on fast processes that have occurred a long time ago is a difficult task as most radiogenic chronometers provide absolute age constraints with percent-level precision, but fluid flow may last only a few thousands of years or less, which is well below the resolution of conventional geological clocks. Lithium chronometry, with Li being one of the fastest-diffusing elements, is currently the tool of choice to obtain information on the duration of fluid flow and fluid-rock interaction.
We applied the Li chronometry on a fossil high-pressure fluid pathway and its associated reaction selvage formed at ~70 km depth during subduction of a coherent oceanic slab. Formation of the vein and its reaction selvage was caused by fluid infiltration under peak metamorphic conditions. In reaction selvages such as that investigated here, the advective component of the element transport is focused into fracture-related porosity, e.g., in vein structures. Consequently, for such a fluid-dominated system, element transport within unfractured rock adjacent to a fluid conduit is solely diffusive and can be treated as having resulted from bulk diffusion. Element transport occurs exclusively within the fluid, thus the through fluid-filled interconnected porosity and exchange with minerals occurs through dissolution-precipitation reactions constrained by local thermodynamic equilibrium.

The results of the Li-diffusion modelling are:

1. Timescales for mineral reactions are estimated to be at least 20 times shorter than the duration of the fluid-rock interaction, indicating that any kinetic corrections to estimates of the duration of the diffusion are negligible. Local thermodynamic equilibrium is indeed a valid assumption for fluid-mediated processes at high fluid-rock ratios.

2. The model set up allows us to be also predictive for the formation of reactive porosity and we found that a transient, reaction-induced porosity increase of ~10-times the background value developed.

3. Fluids can travel through subducting slabs along major conduits in pulses with durations of less than ~200 years. Thus, the fluids produced by dehydration of rocks are mobilized in short-lived, channelized fluid-flow events.