EGU21-7938
https://doi.org/10.5194/egusphere-egu21-7938
EGU General Assembly 2021
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Petrogeochemical tools for simulating fluid-rock interaction processes in high-pressure metamorphic terrains

Pierre Lanari[1], Thomas Bovay[1], Daniela Rubatto[1], Hugo Dominguez[1], Thorsten Markmann[1], Nicolas Riel[2], and Alice Vho[1]

[1]University of Bern, Institute of Geological Sciences, Bern, Switzerland (pierre.lanari@geo.unibe.ch)
[2]University Mainz,Institute of Geosciences Johannes Gutenberg, Mainz, Germany

Petrological models based on equilibrium thermodynamics have proven critical in assessing how mineral assemblages evolve with pressure (*P*) and temperature (*T*) conditions. Still, they remain limited for the investigation and simulation of fluid-rock interaction processes in open systems. The interaction between a reacting aqueous fluid and a (already water-saturated) rock at eclogite facies conditions, for example, can have no or very limited effects on the mineral assemblage—beyond eventually triggering re-equilibration. Therefore, pervasive fluid flows that are not associated to intense metasomatism cannot be modeled using phase diagrams and often remain hardly noticeable even to experienced petrologists. Unlike major and minor elements used for thermodynamic modeling, stable isotopes (e.g. oxygen) are known to be more sensitive for recording interaction with a fluid in isotopic disequilibrium.

In order to extend the existing modeling capabilities, an integrated modeling framework was developed applicable to multi-rock open systems combining thermodynamic and oxygen isotope fractionation modeling based on internally consistent databases (Vho et al. 2019, 2020). The petrological model quantifies the effect of dehydration reactions on the bulk $\delta^{18}O$ of a rock during prograde metamorphism and can simulate different degrees of fluid-rock interaction with the surrounding rocks. This approach, in combination with the measurement of isotopic composition in key minerals, can be used for characterizing the behavior of open vs closed systems in natural settings and quantify the degree of fluid-rock interaction. Estimation of integrated fluid fluxes across geologic units of the Western Alps then allows permeability changes to be quantified along with the metamorphic conditions under which these changes occurred. Such results open the door to the dynamic simulation of reactive fluid flows in high-pressure environmentthat are controlled by the compaction pressure of the rock matrix.

This project has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (grant agreement No 850530).

References:

- Vho, A., Lanari, P., Rubatto, D. (2019). An internally-consistent database for oxygen isotope fractionation between minerals. Journal of Petrology, 60, 2101–2129

- Vho, A., Lanari, P., Rubatto, D., Herman, J. (2020). Tracing fluid transfers in subduction zones: an integrated thermodynamic and δ18O fractionation modelling. Solid Earth, 11, 307-328