Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18546

Investigating the complexity of mantle wedge hydration using automated thermodynamic modeling of fluid-rock interactions

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Fluid-rock interactions are one of the most important processes on Earth and play an important role in many metamorphic systems, especially during external fluid infiltration. In particular, hydration of the mantle wedge is known to be an extremely important factor controlling various aspects of the subduction zone evolution such as seismicity, thermal structure, and mantle melting. Nevertheless, it was recently pointed out that the hydration of the forearc mantle of subduction zones may be less common than previously suggested [1], possibly in contradiction with geophysical evidences from seismic imaging. Here we ran over 550000 computations of infiltration to study the impact of 1) complex ionic fluids relative to conventional molecular fluids, 2) different fluid sources, i.e., pure H_2O or ionic fluid equilibrated with a) hydrated mantle, b) sediments or c) MORB, 3) the impact of variable Ol-Opx-Cpx proportions and 4) the impact of fluid-rock ratios, all at relevant P-T conditions along both cold and hot subduction zones.

The results clearly demonstrate the impact of the fluid source and the starting composition of the infiltrated peridotite on the stabilization of hydrous phases. Antigorite precipitation is strongly affected by the starting peridotite composition. All hydrous phases vary widely between fluid sources, e.g., at low-T, brucite precipitation change by an order of magnitude at the same P-T condition. Changes in pH and f_{O2} in the peridotite ternary exhibit complex patterns and are responsible to large changes in the fluid speciation at the end of the infiltration. Additionally, depending on the P-T conditions, different fluid-rock ratios can either decrease or increase the amount of antigorite precipitation.

These results clearly show the complexity of fluid-rock interaction processes in the subduction zone and warrant the use of simple fluid formulation to model such processes.

[1] Abers, van Keken & Hacker (2017), *Nature Geosciences* **10**, 333–337.

This work is part of project that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 864045).