Geophysical Research Abstracts
Vol. 21, EGU2019-6894, 2019
EGU General Assembly 2019

Multistage fluid-rock interactions between mafic and felsic rocks in subducted crust

Thomas Bovay (1), Daniela Rubatto (2), Pierre Lanari (3), and Jörg Hermann (4)

(1) Universität Bern, Institut für Geologie, Bern, Switzerland (thomas.bovay@geo.unibe.ch), (2) Universität Bern, Institut für Geologie, Bern, Switzerland (daniela.rubatto@geo.unibe.ch), (3) Universität Bern, Institut für Geologie, Bern, Switzerland (pierre.lanari@geo.unibe.ch), (4) Universität Bern, Institut für Geologie, Bern, Switzerland (joerg.hermann@geo.unibe.ch)

Dehydration reactions during prograde metamorphism provide the source of fluids responsible for element transfer between crust and mantle in subduction zones. Advances in thermodynamic modelling and experiments provide now a detailed framework on fluid production in single rock types. However, little is known about the interaction of fluids between multiple rock types of contrasting composition. To address this problem we investigated an association of mica-schists, chloritoid-schists, garnet-schists wrapping eclogitic boudins (Teodul Gletscher Unit) that are embedded within the Zermatt Saas ophiolites (Western Alps), which all reached eclogitic facies metamorphism during Alpine convergence. A multidisciplinary approach has been applied to constrain fluid-rock interactions from seafloor alteration through subduction and exhumation.

The bulk rock chemistry of the mafic rocks displays high CaO concentration (15.9-22.4 wt%) and low Na2O (0.3-0.5 wt%) and MgO (4.3-11.3 wt%) concentration. These major chemical variations are typical for alteration process occurring at the seafloor by interaction with seawater prior to subduction. The composition of the schists is strongly depleted in CaO and enriched in NaO with respect to the typical Zermatt Saas ophiolite metasediments. These trends suggest a fluid-mediated exchange between mafic and felsic rocks during seafloor alteration.

Geothermobarometry on phengite and garnet from to the mica-schists constrains the metamorphic path of the tectonic unit, and indicate a peak metamorphism at 560 °C and 22 kbar. Rutile inclusions in garnet from the garnet-schists show a limited range of Zr content (23 to 38 ppm) regardless of the inclusion location. Zr-in-rutile thermometry yields temperatures ranging from 520 to 550 °C at 22 kbar.

Garnet is present in every lithology and evidence of a multi-phase history is revealed by quantitative mapping of major elements. In every type of schists a sharp chemical zoning from a Fe-rich core to a Fe-Ca-rich rim is observed. The spectacular textural relationships between the two garnet compositions suggest fluid-assisted fracture filling of the core by a new garnet generation, rim-core replacement and merging of distinct grains during rim growth. Moreover, garnet porphyroblasts from the garnet-schist display a unique Fe-Ca-rich core surrounded by a patchy Fe enrichment of the mantle zone. Trace element analyses show a depletion of HREE from core to rim with a marked Eu anomaly in the core. In situ oxygen isotope analyses show a dramatic drop in δ18O from 12 ‰ in the core to 4 ‰ in the rim. The significant variation in δ18O is coherent with the chemical zoning of the major elements and is a good evidence for open system behaviour. Garnet of the eclogitic boudins are Fe-Ca-rich in composition and sometimes show relict of replacement textures; however the δ18O value is relatively homogeneous across the garnet crystals between 1 and 2 ‰ in line with deep sea floor alteration of the protolith. The combined data suggest that fluid liberated by the breakdown of lawsonite in the eclogites interacts with the adjacent garnet schists, triggering complex dissolution and precipitation reactions that are not predicted from modelling of a single rock type.