Geophysical Research Abstracts
Vol. 21, EGU2019-6726, 2019
EGU General Assembly 2019

Geochemistry of calcite veins in the Troodos Pillow Lavas and their implications for the timing and environmental conditions of fracturing, fluid circulation, and vein mineral growth

Dennis Quandt (1), Peter Micheuz (1), Walter Kurz (1), Tobias Kluge (2), Ronny Boch (3), Dorothee Hippler (3), Kurt Krenn (1), and Christoph Hauzenberger (1)

(1) Institute of Earth Sciences, NAWI Graz Geocenter, University of Graz, Graz, Austria (dennis.quandt@uni-graz.at), (2) Institute of Environmental Physics, University of Heidelberg, Heidelberg, Germany, (3) Institute of Applied Geosciences, NAWI Graz Geocenter, Graz University of Technology, Graz, Austria

The Late-Cretaceous Troodos supra-subduction zone ophiolite, Cyprus, exposes well-preserved and heavily veined pillow lavas. These veins provide insights into paleo-fluid circulation through oceanic crust. Based on rare earth elements, δ13C, δ18O, 87Sr/86Sr, Δ47 (clumped) isotopic compositions, and microtextures of calcite veins we discuss the physicochemical environment and temporal framework of vein formation and demonstrate that distinct geochemical signatures of the observed vein types are related to their specific growth mechanisms.
Predominantly seawater-like rare earth element patterns, clumped isotope temperatures <40 °C and corresponding parental fluid δ18O compositions in the range of seawater (-2 to +2 ‰ SMOW) suggest low-temperature vein calcite precipitation from seawater. 87Sr/86Sr ratios of seawater-derived blocky calcite veins associated with host rock brecciation as well as syntaxial crack and sealing calcite veins intersect the Sr isotope seawater curve between 92 and 82 Ma and indicate mineralization of hydro- and extensional fractures during this time interval. Few blocky calcite veins host well-preserved primary aqueous two-phase (liquid and vapor) high-temperature fluid inclusions but lack any intersection with the Sr isotope seawater curve. Simple 87Sr/86Sr balance calculations and high precipitation temperatures (up to 220 °C), however, point to formation during pillow lava magmatism (92-75 Ma) in order to supply sufficient heat. These high-temperature blocky calcites developed a Mn-controlled growth zonation in which the bimodal distribution of primary and decrepitated fluid inclusions, oxygen isotopic compositions, and rare earth element characteristics indicates alternating flow of magmatic fluid and seawater probably along a detachment fault.
Pronounced veining between 92 and ca. 82 Ma, only postdated by antitaxial veins whose calcite fibers grew independently of fracturing and advective fluid flow, implies sealing of the oceanic crust within ca. 10 Ma after its initial formation at 92 Ma. Varying parental fluid δ18O compositions, slightly negative δ13C, and low Y/Ho ratios of antitaxial veins suggest precipitation from variably modified seawater at low temperatures. Therefore, formation ages may be younger than 87Sr/86Sr intersections (75-34 Ma) and might overlap with Troodos microplate rotation (ca. 83-50 Ma) or uplift ($\leq$28 Ma).
This study demonstrates that the combination of vein microtextures and indicative geochemical analyses can be essential in order to understand the diverse physicochemical conditions of vein formation. Low-temperature blocky and late-stage calcites precipitated within seawater-filled fractures where fluid-rock interaction modified slightly the seawater composition due to long fluid residence times. Fast crack and sealing in contrast prevented extensive fluid-rock interaction and resulted in seawater signatures of syntaxial veins. Antitaxial veins may have acquired their distinct isotopic and rare earth element characteristics during diffusion and calcite fiber growth.