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Fault and fluid systems in supra-subduction zones: The Troodos ophiolite

Dennis Quandt, Peter Micheuz, Walter Kurz, and Kurt Krenn
Institute of Earth Sciences, NAWI Graz Geocentre, University of Graz, Austria (dennis.quandt@uni-graz.at)

The Troodos massif on the island of Cyprus represents a well-preserved and complete supra-subduction zone (SSZ) ophiolite. It includes an extrusive sequence that is subdivided into Upper (UPL) and Lower Pillow Lavas (LPL). These volcanic rocks contain mineralized fractures (veins) and vesicles that record fluid availability probably related to slab dehydration and deformation subsequent to a period of subduction initiation in the framework of a SSZ setting. Here, we present electron microprobe element mappings and cathodoluminescence studies of vein minerals as well as analyses of fluid inclusions entrapped in zeolite, calcite and quartz from veins and vesicles of the Pillow Lavas of the Troodos ophiolite.
Two different zeolite type assemblages, interpreted as alteration products of compositional varying volcanic glasses, occur: (1) Na-zeolites analcime and natrolite from the UPL that require lower formation temperatures, higher Na/Ca ratios and pH values than (2) Ca-zeolites heulandite and mordenite from the LPL which indicate temporal or spatial varying fluid compositions and conditions. Calcite represents a late stage phase in incompletely sealed blocky type (1) assemblage and in syntaxial quartz veins. Additionally, calcite occurs as major phase in syntaxial and blocky veins of UPL and LPL. These syntaxial quartz and calcite veins are assumed to be related to tectonic extension. Chalcedony is associated with quartz and occurs in typical veins and vesicles of the LPL. In addition, the presence of neptunian dykes in veins suggests that seawater penetrated fractures throughout the extrusive sequence. Thus, circulation in an open system via advective transport is favored while diffusion in a closed system is a subordinate, local and late stage phenomenon.
Calcite veins and quartz vesicles contain primary, partly re-equilibrated two phase (liquid, vapor) fluid inclusions. The chemical system of all studied inclusions in both host minerals is restricted to aqueous chemistry with salinities below 5 mass% based on last melting of ice between -3 and -0.8° C. Homogenization around 100-200° C occurs always to the liquid phase indicative for a pressure dominated fluid origin. Well preserved zonation textures in blocky calcite veins consisting of partly decrepitated but also re-equilibrated large fluid inclusions are related to Mn-rich areas. This fluid inclusion generation shows also homogenization to the liquid phase and points to minimum temperature conditions for formation of Mn-enriched areas of about 220° C. Calcite microstructures within the veins are characterized by type I and II twins as well as undulatory extinction and subgrain boundaries indicative for deformation temperatures of approximately 200-250° C, with differential stresses of about 50 MPa.
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