Dating fluid infiltration and deformation in the ultramafic oceanic lithosphere by perovskite geochronology

Francesca Piccoli[1], Daniela Rubatto[1], Maria Ovtcharova[2], Jörg Hermann[1], Marcel Guillong[3], Alberto Vitale Brovarone[4]

[1]Institute of Geological Sciences, Universität Bern, Bern, Switzerland
[2]Department of Mineralogy, University of Geneva, Geneva, Switzerland
[3]Department of Earth Sciences, ETH, Zurich, Switzerland
[4]Dipartimento di Scienze Biologiche, Geologiche e Ambientali (BiGeA), Alma Mater Studiorum Universit. di Bologna, Bologna, Italy

Hydrated ultramafic rocks (*i.e.*, serpentinites) are stable over a large range of *P-T* conditions during subduction and are thus potentially capable of recording prograde and retrograde structures. Dating deformation and metamorphic reactions in ultramafic rocks such as serpentinites is notoriously difficult because of the lack of suitable minerals for geochronology. Carbonated ultramafic rocks (*i.e.*, ophicarbonates) form by peridotite serpentinization and carbonation at seafloor. Their metamorphic evolution is linked to that of serpentinites, hence dating deformation in metamorphic ophicarbonates may elucidate the *P-T-t* history of the subducted ultramafic lithosphere. A potential, yet unexplored, suitable mineral for geochronology in ophicarbonates is perovskite ($CaTiO_3$). Perovskite has a metamorphic and metasomatic origin and U-Pb dating can thus provide age constraints on fluid-related processes and deformation. We present trace element and geochronological study of perovskite in ophicarbonate rocks from two Alpine metamorphic terranes, Val Malenco (Central Alps) and Lanzo Massif (Western Alps). Trace element data of perovskite in blackwalls from the Zermatt-Saas unit will be also presented.

In the Lanzo Massif, perovskite is found in shear bands associated with metamorphic clinopyroxene, andradite garnet, and antigorite, replacing carbonate. The age of perovskite in this sample (49.4 ±1 Ma) indicates that deformation and devolatilization driven by fluid infiltration occurred near peak metamorphic conditions. Moreover, we observed immobile behaviour of Th and U during metasomatism, suggesting that the fluids equilibrated with the ophicarbonates were reduced. Trace element data for all sample localities show that perovskite composition broadly reflects that of the protolith, suggesting that at this metamorphic conditions, metamorphic fluids cannot significantly mobilized trace elements.

Perovskite from Val Malenco is found in calcite veins cutting across serpentinites. The perovskite age of ca. 50 Ma coincides with the decompression phase and the activity of the Lunghin-Mortirolo movement zone, a regional-scale shear zone that separates weakly deformed rocks in the hangingwall from ductile Alpine deformation in the footwall.

Altogether, the obtained results show that metamorphic perovskite geochronology gives geologically meaningful ages and is thus a viable tool to date deformation and fluid flow in the subducted oceanic lithosphere.