



Lawsonite-rich veins and layers as records of fluid flow and element cycling in subducted oceanic crust

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Lawsonite is an abundant hydrous mineral in subducted oceanic crust and sediments and is an important carrier of water (~ 11 wt.%) and trace elements (REE, U, Th, Sr, Pb) into the mantle. Despite its widespread stability at the high-pressure/low-temperature conditions of subduction, it is rarely preserved in the geologic record, particularly in eclogite. Therefore, scarce fresh lawsonite eclogites in which the composition of lawsonite can be directly determined are important geochemical archives of fluid-mediated processes during subduction. Of particular interest are lawsonite-rich veins and layers that may represent former fluid pathways and that may record element mobility related to fluid-rock interaction during subduction and/or incipient exhumation.

In the Sivrihisar (Turkey) subduction complex, lawsonite-rich veins and layers (~30% to nearly 100% lawsonite) are preserved along mafic pod margins, where lawsonite eclogite has been partially transformed to lawsonite blueschist. To understand the petrogenesis of these lawsonite-rich assemblages, we conducted a petrographic and geochemical study of a representative lawsonite-rich layer hosted at the margin of a meter-scale lawsonite eclogite pod. Bulk rock and mineral major and trace element analyses were conducted along a transect consisting of the lawsonite-rich layer (Lws + Grt + Ph), its glaucophane-rich margin (Gln + Grt + Lws + Ph + Rt), and the lawsonite eclogite host at varying distances from the lawsonite-rich layer (~ 1 – 2 cm away and > 10 cm away).

Bulk rock geochemistry indicates that the lawsonite eclogite protolith was MORB that experienced interactions with (meta)sedimentary rocks before or during the crystallization of high-pressure phases such as lawsonite and rutile. Integrated major and trace element composition and zoning in garnet and thermobarometric results, including Zr-in-rutile thermometry, indicate that the lawsonite + garnet + phengite layer and its associated glaucophane-rich margin formed at or near peak eclogite-facies metamorphism (2.4 ± 0.1 GPa, 550°C) as a result of fluid-mediated processes that scavenged P, Sr, Pb, Y, Mn, HFSE, and REE from the eclogite immediately adjacent to the vein (~ 1 – 2 cm away). Mass balance calculations also suggest the addition of LILE and transition metals to the pod margin; these elements were likely supplied from a source external to the mafic pod, such as serpentinites. Fluid-rock interaction along the eclogite pod margin may have also driven changes in fO_2 , as omphacite, glaucophane, lawsonite, and phengite from the pod margin record core-to-rim increases in Fe³⁺. We propose that the transformation of eclogite to blueschist along the pod margin occurred as a result of changes in the bulk chemistry imparted during fluid-rock interactions.