High volumes of mineral dissolution by localized fluid pulses in UHPM metasediments of Lago di Cignana, Western Alps

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Fluids play key roles in many geological processes across wide ranges of spatial and temporal scales. A major challenge in establishing the impacts of fluids is that partial replacement of minerals by dissolution-precipitation produces gaps in the rock record. Finding the records of such processes can help in understanding and reconstructing the processes of fluid flow, mineral dissolution and related volume changes.

The ultra-high pressure metamorphic (UHPM) Lago di Cignana Unit (Zermatt-Saas Zone, Western Alps) has been intensively studied because it is a piece of exhumed coesite- and diamond-bearing oceanic lithosphere. In this unit, schistose quartzite hosts coesite-bearing garnet and contains lenses of garnetite, which previously have been attributed to local bulk-compositional differences. Almost the entire quartzite consists of a retrograde mineral assemblage, and therefore processes occurring during subduction are best recorded in garnet.

A combined microstructural and petrological study of the garnetite lenses and their host rock reveals evidence for compaction by dissolution during subduction, partially driven by intergranular pressure solution. As the host rock matrix is removed, garnet is preferentially preserved and concentrated into garnetite. Garnet-garnet contacts then result in pressure solution and grain boundary migration. Different garnet densities and microstructures in the garnetite, alongside dissolution-reprecipitation structures in host rock garnet, suggest a complex process driven by fluid pulses. Linking garnet composition and structures to P-T through barometry on inclusions reveals an evolving fluid pathway during prograde to peak metamorphism, resulting in significant mass removal by pressure solution in metasediments subducted to UHPM conditions.

The occurrence of pressure solution and mass removal at UHPM conditions in combination with the large amounts of fluids produced by slab dehydration suggests that dissolution may play a significant role in metasediments during subduction.

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