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Garnetite formation along fluid pathways in subducting oceanic sediments from Lago di Cignana, Western Alps

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Fluids play a key role in many geological processes in a wide range of scales. The microstructural and petrological expression of fluid-rock interaction processes is never obvious and becomes more complex when reducing the scale of observation. One of the major challenges derives from partial replacement of minerals by dissolution-precipitation leaving gaps in the rock history record. Finding the records of such processes can help in understanding and reconstructing the processes of fluid flow, mineral dissolution and related bulk volume changes in rocks.

The UHPM Lago di Cignana Unit (Zermatt-Saas Zone, Western Alps) has been intensively studied for being one of the few localities where coesite- and diamond-bearing oceanic lithosphere has been exhumed. Here, 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, so any process occurring during subduction is mostly recorded in garnet. Here we combine a petrological study of both major and trace elements combined with microstructural analysis based on electron backscatter diffraction to understand the effect of fluids on this system and how this has affected both lithologies.

Dissolution features in garnets are ubiquitous, occurring both as dissolution interfaces within single garnet crystals as well as intergranular pressure solution. We link the localization of fluid flow to increased dissolution of the rock matrix, leading to the relative enrichment in residual garnet along the fluid pathways. As dissolution of the matrix progresses, intergranular pressure solution of garnet takes over as main deformation mechanism in the residual garnetite lenses. At the garnetite rim, new garnet growth occurred, allowing us to constrain P-T conditions for the majority of this fluid event using quartz-in-garnet elastic geobarometry. These results provide an insight into the behaviour of fluid flow and on the rheological properties of subducting sediments at HP to UHP conditions.

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