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Trace-element migration during crystal-plastic deformation in UHP rutile: dislocations in low-angle boundaries as high-diffusivity pathways.

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The trace-element composition of rutile is commonly used to constrain P - T - t conditions for a wide range of metamorphic systems. Recent studies have highlighted the importance of micro- and nanostructures in the redistribution of trace elements in rutile via high-diffusivity pathways and dislocation-impurity associations. In this contribution, we investigate the effect of crystal-plastic deformation of rutile on its composition by combining microstructural and petrological analyses with atom probe tomography. The studied sample is from an omphacite vein of the ultrahigh-pressure metamorphic Lago di Cignana unit, Western Alps, Italy. Zr-in-rutile thermometry and inclusions of quartz in rutile and of coesite in omphacite constrain rutile deformation to around the prograde HP-UHP boundary at 500–550 °C. Crystal-plastic deformation of a large rutile grain resulted in low-angle boundaries that generate a total misorientation of ~25°. Dislocations constituting the low-angle boundary are enriched in common (Fe, Zr) and uncommon trace elements (Ca). The Ca is interpreted to be derived from the grain exterior, suggesting diffusion of trace elements along the dislocation cores. The potential for dislocation microstructures to act as fast diffusion pathways must be evaluated when applying traditional geochemical analyses as compositional disturbances caused by the presence of dislocation might lead to erroneous interpretations.