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The effect of low temperature deformation on the trace element distribution in calcite veins and implications for carbonate geochronology

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In the last decade, *in-situ* U-Pb geochronology via Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS) has been established as the most important dating method for calcite. However, the heterogeneous distribution of U in individual calcite crystals renders dating very challenging. This is because finding zones of sufficiently high U concentrations that can provide precise constraints on timing of calcite precipitation is an inefficient process of ‘’hit or miss’’. Second, it can be difficult to identify regions that retain geochemically unaltered primary calcite cement. Thus, to improve the most important geochronological tool for the *in-situ* dating of calcite, there is a need to understand why or where calcite sequesters U and to fingerprint the mobilization mechanisms that modify the U concentration after formation. To determine where specific trace elements sit within calcite and how they are affected by post-recrystallization deformation processes, this project applies cutting-edge Synchrotron X-Ray Fluorescence Microscopy (XFM), Electron Backscatter Diffraction (EBSD), and LA-ICP-MS to calcite veins from the Middle and Upper Jurassic carbonates and marls (metamorphic temperatures of about 85°C) from the Neogene Molasse Basin in central northern Switzerland. The combination of these techniques allows a direct comparison of high-resolution trace elements maps and with the crystal lattice structure of calcite. We show two main textural types of trace element distributions within syntaxial calcite veins: 1) concentric crystal growth zonations, perhaps recording changes in the fluid chemistry over time, and 2) complex complete overprint of the initial growth zonation upon secondary fluid infiltration and trace element replacement. In the latter case, EBSD and LA-ICP-MS reveal that fractures and median lines probably served as pathways for secondary fluid infiltration. In the studied case, the secondary fluids caused depletion in U content in the cracked vein center. In-situ U-Pb analyses on this vein would therefore only yield precise ages of the rim of the vein, which would date the oldest calcite precipitation stage. The results of this project give valuable insights in the complexity of fluid overprint during multi-staged deformation cycles in the modification of trace elements in calcite, further motivating the need for better understanding the U-Pb system in calcite.