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Multimodal, multiscale chemical and structural imaging of vein-formation processes

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Veins are opening-mode fractures in rocks filled with minerals crystallised from a fluid injected during the cracking process. They occur throughout the entire lithosphere of our planet and constitute important fast fluid pathways in otherwise dense, impermeable rock1. In addition, veins trap precious ores such as gold and are routinely targeted by the resource industry2,3. Moreover, microstructure and mineral texture of vein-forming minerals serve as invaluable recorders of the tectonic history of rock evolution, the state of stress and temperature during emplacement as well as fluid chemistry and fluid-rock interaction1,4-6. Hence, micro- and nano-analytical methods hold the key to understanding the physics and chemistry of vein-formation processes.

Here, we show how selected applications of Synchrotron XFM, ptychography, and SAXS/WAXS unveil quantitative micro- and nano-textures of calcite veins, which are invisible to conventional imaging techniques. The Synchrotron's unique ability to map trace chemistry and structures over more than four orders of magnitude in length scale inspires unprecedented insights into the multi-scale physics of coupled chemical, mechanical, hydraulic and thermal processes in rocks and other reactive, porous solids. This multi-physics, multi-scale coupling constitutes one of the principal research challenges in the Earth and Material Sciences7,8.

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