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In situ visualization of magma deformation at high temperature using time-lapse 3D tomography

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We use synchrotron based x-ray computed micro-tomography (sCT) to visualize, in situ, the microstructural evolution of magma samples 3 mm diameter with a resolution of 3 μm during heating and uniaxial compression at temperatures up to 1040 °C. The interaction between crystals, melt and gas bubbles is analysed in 4D (3D + time) during sample deformation. The ability to observe the changes of the microstructure as a function of time allow us to: a) study the effect of temperature in the ability of magma to fracture or deform; b) quantify bubble nucleation and growth rates during heating; c) study the relation between crystal displacement and volatile exsolution. We will show unique beautiful videos of how bubbles grow and coalescence, how samples and crystals within the sample fracture, heal and deform.

Our study establishes in situ sCT as a powerful tool to quantify and visualize with micro-scale resolution fast processes taking place in magma that are essential to understand ascent in a volcanic conduit and validate existing models for determining the explosivity of volcanic eruptions. Tracking simultaneously the time and spatial changes of magma microstructures is shown to be primordial to study disequilibrium processes between crystals, melt and gas phases.