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The application of Synchrotron radiation based microtomography in (structural) geology

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Synchrotron radiation based tomography (SRT) is a well established, yet still improving technique to image the internal microstructure of a wide range of materials in three dimensions. It benefits from the very high photon flux provided by synchrotron sources, which is collimated in a very small, coherent photon beam covering a continuous energy spectrum of up to 100 keV. Imaging techniques such as absorption contrast, absorption edge and phase contrast tomography as well as automated sample loading render the method very flexible for addressing a large number of scientific questions concerning rock microstructure. With different end stations for micro- and nanotomography achieving spatial resolutions of several hundred down to a few tens of nanometers, SRT provides three-dimensional microstructural data that bridge a critical gap towards the nanoscale. In combination with high-speed cameras even dense rock samples can be imaged in fractions of seconds, leading the way to time-resolved studies in 3D.

Beyond the stunning three-dimensional insights that SRT data provide into rock microstructure, such data allow a quantitative and time-dependent characterisation of rock properties. On the way to such a characterisation, the quantitative analyses of three- and four-dimensional SRT data may pose a significant challenge for the user. The analyses are demanding in terms of the necessary hardware and software, and the procedure involves a number of possible technical pitfalls and analytical error sources. However, mastering these challenges means opening a new approach to experimental as well as computational rock mechanics and microstructural geology. Increasingly, these approaches are included in the multi-scale characterisation of rocks and their mechanical properties.

This presentation aims at reviewing the potential of Synchrotron radiation based microtomography for research applications in structural geology and experimental rock mechanics. Besides outlining the technical capabilities of the latest generation of microtomography beam lines at the Advanced Photon Source (USA), we will present our workflow for the analysis of large time-resolved tomographic datasets. We will conclude with an outlook on a next generation of in-situ studies on fluid-rock interaction and rock deformation.

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