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Laboratory and synchrotron x-ray tomography: experiments in more than just pretty pictures

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In the last decade, developments in x-ray tomography have allowed dramatic increases in our ability to image geological materials with higher temporal, spatial, phase and spectroscopic resolution. These advances have been paralleled by better access to quantitative image processing computing methods, and therefore we can now track both textural and compositional evolution through time and space, and define time dependant mechanical properties non-destructively; looking inside the rocks we study. Here I will present a series of case studies from both laboratory and synchrotron x-ray tomography (and associated imaging modalities) that highlight the state-of-the-art capabilities.

Across all geological and environmental disciplines, there are fundamental challenges at all temporal spatial scales that can only be addressed through a combination of in situ experiments and numerical modelling. However, these experiments can be extremely challenging to design, perform and interpret in an accurate and scaled manner. I will present data from recent experiments to capture pore scale processes during flow in porous media and validate computation fluid dynamics models; and from high temperature magmatic deformation experiments to develop our understanding of bulk rheological behaviour by determining the crystal- and bubble-scale interactions that control them.

I will highlight the opportunities and challenges presented by such experiments, and discuss both the future direction of x-ray imaging across the geosciences, and the challenges in systematically and rigorously processing and presenting data from dynamically changing samples and very large data sets.