Conceptualizing a 4D laboratory X-ray CT dataset of stone weathering

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Time-lapse and dynamic X-ray computed tomography (µCT) create a large amount of 3D datasets to study specific processes. Here, we show a conceptual way to visualize the course of such process on a single, reference 3D dataset. Therefore, we define the time step where a voxel in the 3D dataset changes (defined here as flip point), and rebuilt a new 3D dataset containing this time step information in its pixel value. As such, a 3D representation can be made of the 4D process (Fig. 1).

We test this tool on a continuous time-lapse dataset of limestone weathering and the formation of a gypsum crust [1]. Scans were acquired with a TESCAN UniTOM^{HR} (custom configuration). The raw data was processed using the batch reconstruction module and the flip point detection tool in the XRE Acquila 4D toolkit.

The limestone sample is exposed to a closed atmosphere above a $H_2SO_{3(aq)}$ solution during the course of 4 days whilst being continuously scanned with µCT. The development of a gypsum crusts coincides with the dissolution of calcite matrix and is a continuous process in time. Here, application of the flip point detection creates a single 3D dataset consisting of time-step labelled voxels representing either calcite dissolution or gypsum precipitation. Therefore the kinetics of the process can be studied by analysis of the newly built flip point volume (Fig. 1).

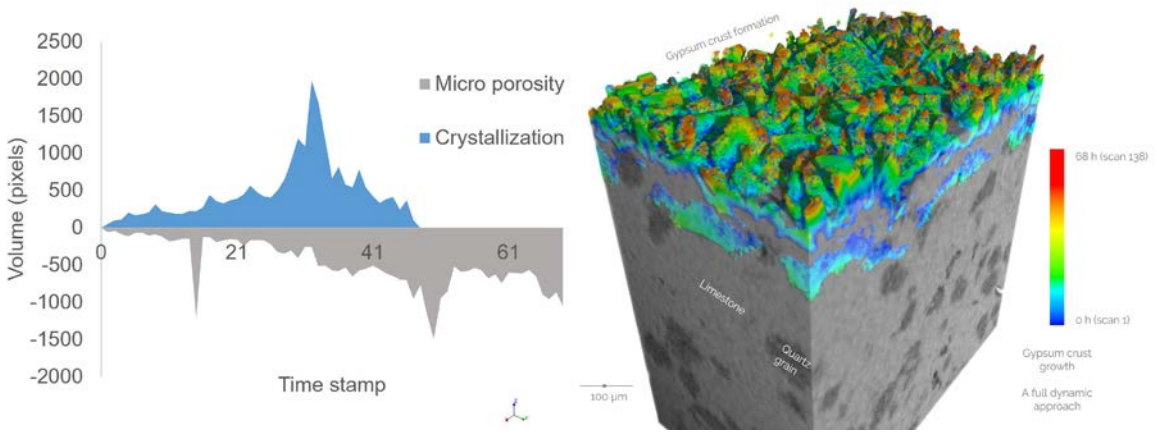

Figure 1: Representation of the kinetics of crystallization and dissolution (micro porosity) in function of time (left) and 4D time colour coded representation (right).

References

[1] T. De Kock, T., J. Van Stappen, J., G. Fronteau, M.A. Boone, W. De Boever, F. Dagrain, G. Silversmit, L. Vincze, V. Cnudde, Talanta **162**: 193-202 (2017).