MS42-O2 "Stop-and-go" in-situ tomography of dynamic processes – gas hydrate formation in sedimentary matrices

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Investigations of dynamic processes followed with in-situ tomography methods have proven to be challenging due to a typical tradeoff between the quality and resolution of reconstructions and acquisitions time. This ill compromise is particularly troublesome for rapid processes like crystallization, dissolution and coarsening where sub-µm pixel resolution details are frequently of crucial importance for physical properties or reactivity kinetics. Here, we report on a well-working solution to this issue in form of a "stop-and-go" synchrotron-based X-ray CT method that combines benefits of sub-µm resolution with complex environments of in-situ experimental cells under elevated gas pressure. The method has been successfully used to mimic the nucleation and growth processes of natural hydrate in various sedimentary matrices at simulated marine conditions (Figure 1). Xenon gas was employed to enhance the density contrast between gas hydrate and the fluid phases involved. The nucleation sites are easily identified with a sub-µm pixel resolution and the various growth patterns are clearly established. These micro-structural findings are highly relevant for future efforts of quantitative rock physics modeling of gas hydrates and ultimately correct detection and quantification of this new source of hydrocarbons. The "stop-and-go" CT method is complemented by a newly developed synchrotron-based method [1] which allowed us to determine the crystallite size distributions (CSD) during the growth and post-formation coarsening of the gas hydrate using the identical pressure cell. Understanding the complex morphologic changes may eventually permit the determination of the formation age of gas hydrates deposits [2, 3], which are largely unknown at present.

[1] Neher et al., A new fast method to derive Crystallite Size Distributions (CSD) from 2D X-ray diffraction data (this conference) [2] Klapp et al., (2007), GRL, 34 : L13608, DOI:10.1029/2006GL029134 [3] Chaouachi et al., In-situ determination of the evolution of the crystallite size distributions of GH-bearing sediments using two-dimensional X-ray diffraction (this conference)

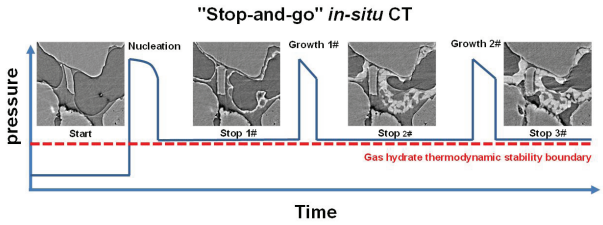

Figure 1. The "stop-and-go" experimental procedure: (1) The initial micro structure (start). (2) The reaction starts by pressurizing the cell (nucleation). (3) The reaction is "paused" by lowering pressure (Stop#1). The procedure can be repeated to study the further stages of the growth.

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