Geophysical Research Abstracts
Vol. 18, EGU2016-13824, 2016
EGU General Assembly 2016

Dynamics of barite growth in porous media quantified by in situ synchrotron X-ray tomography

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Current models used to formulate mineral sequestration strategies of dissolved contaminants in the bedrock often neglect the effect of confinement and the variation of reactive surface area with time. In this work, in situ synchrotron X-ray micro-tomography is used to quantify barite growth rates in a micro-porous structure as a function of time during 13.5 hours with a resolution of 1 μm. Additionally, the 3D porous network at different time frames are used to simulate the flow velocities and calculate the permeability evolution during the experiment. The kinetics of barite growth under porous confinement is compared with the kinetics of barite growth on free surfaces in the same fluid composition. Results are discussed in terms of surface area normalization and the evolution of flow velocities as crystals fill the porous structure.

During the initial hours the growth rate measured in porous media is similar to the growth rate on free surfaces. However, as the thinner flow paths clog the growth rate progressively decreases, which is correlated to a decrease of local flow velocity. The largest pores remain open, enabling growth to continue throughout the structure. Quantifying the dynamics of mineral precipitation kinetics in situ in 4D, has revealed the importance of using a time dependent reactive surface area and accounting for the local properties of the porous network, when formulating predictive models of mineral precipitation in porous media.