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Impact of nanopores in clay on accessibility and connected porosity in sandstone samples

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Imaging is a valuable tool to identify and characterize the spatial distribution of minerals in rock samples. Scanning electron microscope (SEM) can capture microscale features, and when equipped with energy dispersive spectroscopy (EDS), can be utilized to identify minerals; however, it is limited to only two-dimensional images. X-ray computed tomography (X-ray CT) can be used to capture pore-grain structure in 3D, although lab-scale X-ray CT instruments are limited in resolution. The 2D SEM and 3D X-ray CT images can be combined to get various mineral properties including, mineral volume fraction, accessibility, porosity, pore connectivity, mineral surface areas etc. and these can be utilized to conduct reactive transport simulation. However, the regular SEM and X-ray CT fails to capture the nanoscale pores in clays. In this study seven sandstone samples with varying amounts of clays are imaged using 2D SEM and 3D X-ray CT at Auburn University. Additionally, focused ion beam-scanning electron microscopy (FIB-SEM) images are captured on the clay-rich areas of the polished samples to understand the nanopore connectivity within clays. Mineral abundances are determined by counting mineral pixels of same the color in the segmented 2D images while mineral accessibilities are calculated by counting interfacial pixels between associated mineral and adjacent pore. Moreover, the 3D X-ray images are processed to determine the connected surface area. Three types of accessibility are considered: the first approach accounts for all the pore space, the second approach considers only the connected macropores and the third approach includes connected porosity considering nanopores in clays. Finally, reactive transport simulations is carried out using the accessible mineral surface area calculated from the three approaches and the corresponding simulated evolution of minerals and reaction rates compared.

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Participation

Online

Primary authors: SALEK, Md Fahim (Auburn University); Mr QIN, Fanqi; BECKINGHAM, Lauren (Auburn University)

Presenter: SALEK, Md Fahim (Auburn University)

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