

Estimation of reactive surface area using a combined method of laboratory analyses and digital image processing

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Fluid-rock interactions play an important role in the engineering processes such as chemical stimulation of enhanced geothermal systems and carbon capture, utilization, and storage. However, these interactions highly depend on the accessible reactive surface area of the minerals that are generally poorly constrained for natural geologic samples. In particular, quantifying surface area of each reacting mineral within whole rock samples is challenging due to the heterogeneous distribution of minerals and pore space. In this study, detailed laboratory analyses were performed on sandstone samples from deep geothermal sites in Lithuania. We measure specific surface area of whole rock samples using a gas adsorption method (so-called B.E.T.) with N_2 at a temperature of 77.3K. We also quantify their porosity and pore size distribution by a Helium gas pycnometer and a Hg porosimetry, respectively. Rock compositions are determined by a combination of X-ray fluorescence (XRF) and quantitative scanning electron microscopy (SEM) - Energy-dispersive X-ray spectroscopy (EDS), which are later geometrically mapped on images of two-dimensional SEM- Backscattered electrons (BSE) with a resolution of $1.2 \mu\text{m}$ and three-dimensional micro-CT with a resolution of $10.3 \mu\text{m}$ to produce a digital mineral map for further constraining the accessibility of reactive minerals. Moreover, we attempt to link the whole rock porosity, pore size distribution, and B.E.T. specific surface area with the digital mineral maps. We anticipate these necessary analyses to provide in-depth understanding of fluid sample chemistry from later hydrothermal reactive flow-through experiments on whole rock samples at elevated pressure and temperature.