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Variation of the representative elementary volume (REV) in heterogeneous rocks with changing CT image resolution

Thursday, 2 June 2022 09:10 (15 minutes)

The two paradigms of digital rock physics, chemistry, and biology are imaging and computation (Sadeghnejad et al. 2021). An unbiased characterization of rocks not only requires a sample with a sufficient volume (i.e., representative elementary volume, REV) to account for sample heterogeneity but also requires a high-resolution image with enough pore-scale details (Lin et al. 2019, Jackson et al. 2020). However, imaging at the highest resolution is expensive; therefore, there should be an optimum resolution wherein the accuracy of the pore-scale studies can be guaranteed.

REV can be computed both deterministically or statistically. Deterministic REV's can be computed by finding a field-of-view (FOV) in which the property of interest (e.g., porosity, permeability, tortuosity) no further fluctuates. However, a statistical REV is defined as the representative volume below which the statistics (e.g., mean, standard deviation, coefficient of variation) for a quantity of interest vary with the scale. Different properties may have different REV's. Moreover, from one porous medium to another or depending on the overall dimensions of the problem, the REV size will typically vary among different scale ranges (Hommel et al. 2018).

Berea sandstone samples of 10–15 mm length and 4 mm diameter were drilled from one sample block. The samples were scanned in various resolutions by utilizing X-ray microtomography (μ XCT) and an X-ray synchrotron light source. The grey value images were segmented by applying a random forest classifier. Rock properties (including porosity, permeability, tortuosity, Minkowski measures) were computed on FOVs of varying size by applying the commercial GeoDict software package (Math2Market, Kaiserslautern, Germany) and coding in Python. In this study we aim to analyse whether REV's for properties with high computational costs (i.e., permeability) might be replaced with REV's of other properties (e.g., surface area, Minkowski measures), which have lower computational demands. Furthermore, an analysis of deterministic and statistical REV's revealed different REV sizes for the computed parameters and a dependence of REV size on the spatial resolution.

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Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Online

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