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Using correlation functions to describe complex multi-phase porous media structures

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Multi-scale flow and transport modelling relies on multi-scale image/property fusion techniques. Previusly we have rigorously addressed binary porous media description and stochastic reconstruction problems. However, numerous porous media have more than two, usually solids and pores, phases, e.g., clays, organic, heavy minerals and such. In this contribution we develop efficient approaches to utilize correlation functions to describe such muti-phase soil and rock structures using large sets of cluster, linear and probability functions, including cross-correlations. The approach is tested on numerous 3D images, which were segmented into 3 and more relevant phases. It is shown that multi-phase correlation functions are potentially a very powerful tool to describe any type of porous media at hand and this study also provides a basis for multi-phase stochastic reconstruction techniques, necessary for multi-phase image fusion to obtain large 3D images of hierarchical porous media based on, for example, macro and micro X-ray tomography scans and FIB/BIB-SEM and SEM.
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