Effect of microvariability on electrical rock properties: investigations based on microstructure simulations

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Abstract

In petrophysics, physical rock properties are typically established through laboratory measurements of individual samples. These measurements predominantly relate to the specific sample and can be challenging to associate with the rock as a whole since the physical attributes are heavily reliant on the microstructure, which can vary significantly in different areas. Thus, the obtained values have limited applicability to the entirety of the original rock mass. To examine the dependence of petrophysical measurements based on the variable microstructure, we generate sets of random microstructure representations for a sample, taking into account macroscopic parameters such as porosity and mean grain size. We show that the methodology can adequately mimic the physical behavior of real rocks, showing consistent emulation of the dependence of electrical conductivity on connected porosity according to Archie's law across different types of pore space (micro-fracture, inter-granular, and vuggy, oomoldic pore space). Furthermore, properties such as the internal surface area and its fractal dimension as well as the electrical tortuosity are accessible for the random microstructures and show reasonable behavior. Finally, the possibilities, challenges and meshing strategies for extending the methodology to 3D microstructures are discussed.

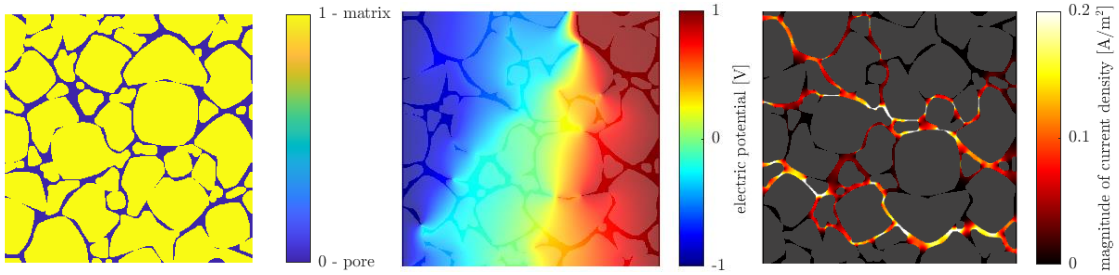

Figure 1: Example 1001x1001 microstructure mimicking a sandstone (left), simulation results in terms of electric potential (center) and current density (right).

Reference / more information

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