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Development of a micromodel design algorithm for heterogeneous reservoir rocks

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The utilization of microchips to study fluid flow processes in porous media has gained high popularity in recent years. The silicon structures between two glass plates allow the visual observation of various processes (e.g., EOR and microbiology during underground hydrogen storage) and assess their suitability for large-scale applications. Nowadays, a wide field of designs ranging from artificial structures to structures based on µ-CT images is available. The representation of pore space geometry for a specific rock is critical, which led to good workflows for designing pore structures from µ-CT images in the past. However, many displacement mechanisms are also influenced by heterogeneities of rock core samples on the macro scale. Applying existing micromodel design algorithms on strongly heterogeneous rocks often leads to a poor outcome. Relatively large areas with inaccessible or dead pores could be created, making experimental execution more difficult. This study extends an existing procedure by adding certain steps to improve the representation of pore geometry on the microchip. Using the Efros Freeman image stitching algorithm, the mask based on µ-CT images is homogenized to make optimal use of the area of the microchip. A gradient map is created based on the petrophysical parameters, which locally transforms the homogeneous mask into high and low permeable/porous zones. The low permeable domains compose circular shapes with a transition zone into the high permeable region. The petrophysical properties of the chip were fitted using pore-scale simulation in an iterative process to the rock sample.
In general, this algorithm is useful for the development of heterogeneous structures for micromodels. The resulting design combines a high level of pore space representation with the suitability for execution of complex flow experiments with a focus on visual investigations in porous media.

Participation

In-Person

References

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Primary author: Mr HOGEWEG, Sebastian (Clausthal University of Technology)

Co-authors: Dr GAOL, Calvin Lumban (Clausthal University of Technology); Dr HAGEMANN, Birger (Clausthal University of Technology); Prof. GANZER, Leonhard (Clausthal University of Technology)

Presenter: Mr HOGEWEG, Sebastian (Clausthal University of Technology)

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