



Contribution ID: 409

Type: **Poster (+) Presentation**

Multiscale pore network modeling of a carbonate rock sample using micro-CT and SEM images

Wednesday, 2 June 2021 09:00 (1 hour)

Accurate representation of the pore space is of utmost importance in the modeling of flow and transport in porous media. The challenge arises in heterogeneous rocks particularly with wide pore size distributions where the ratio of smaller pores to the sample size is very small. This is obvious, for instance, in the pore-level images of most carbonates where there is a trade-off between resolution and image size. This broad distribution of pore sizes often causes smaller elements, called micro-pores and throats, to be overlooked. However, they can largely affect the flow and electrical properties in porous media.

Modern 3D imaging techniques allow characterizing porous rock samples at different scales, by using computed tomography and electron microscopes.

However, for heterogeneous porous samples such as carbonates, with simple mineralogy but very complex pore space, extracting accurate petrophysical properties and simulating fluid flow is challenging.

Yet global methods, including LBM or PNM simulations, are not predictive unless they take into account the heterogeneity of the pore space by computing local properties at each scale and upscaling them using appropriate algorithms.

The goal of this study is to simulate multiphase flows as accurately as possible for a middle-eastern heterogeneous carbonate rock sample, and to define a workflow for further experiments on similar rocks.

In this study, we will mix classical segmentation of microCT samples with modern image processing routines such as machine and deep learning to automatically segregate the rock structure into the matrix, macroporous, and microporous regions. Machine and Deep Learning have a great interest to be user-independent and automated, hence producing extremely trustable outputs.

Moreover, this workflow is independent of the PC memory since all computations are run out of memory to get rid of the hardware limitation. All operations can be automatized for further replications to other samples. A 7,5 cm tall and 38mm large plug has been scanned with a high-resolution microCT at a resolution of 16 μm . The analysis shows that the pore space is not entirely resolved, hence a 10mm diameter sub-plug has been extracted and scanned at a resolution of 5 μm .

The sample being highly heterogeneous with an important micro porous region even not resolved at the resolution of 5 μm , the sub-plug has been cut and scanned with an SEM at a resolution of 2 μm , which was considered enough to resolve the smallest pores.

We have then used a process-based modeling approach to generate 3D representations of the sample from SEM image information. Excluding the macroporous regions, we obtain pore space representations of the microporous regions. This can be repeated for each realization of the process-based modeling. These realizations are then simulated using pore network modeling to obtain the upscaled flow and electrical properties. This process generates different rock types for each of the generated realizations. These rock types are then inputted in the multiscale pore network extraction model to generate hybrid pore network models. These hybrid pore network models are then used to simulate multiphase flow and query the relative permeability of the entire rock sample.

Time Block Preference

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

References

A Multiscale Imaging and Modeling Workflow for Tight Rocks, Leonardo Ruscini&Al

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Primary authors: Mr TALLEC, Gwenole; Mr ZOLFAGHARI, Arsalan

Presenters: Mr TALLEC, Gwenole; Mr ZOLFAGHARI, Arsalan

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