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Numerical modelling based saturation conductivity estimation uncertainty – influence of the quality of the pore space geometry representation based on X-ray CT images

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X-ray computational tomography (CT) is becoming more and more popular research tool in geosciences. Estimation of the saturated conductivity of the porous media based on X-ray CT images is an example of its application. In case of simulations for the pore media, which are approximated by the very complicated meshes, problems might arise when mesh does not follow the shape of pore-space ideally, which may happen due to limitations imposed (e.g. due to some technical constraints) on minimum mesh cell size which usually is bigger than CT scan resolution used for determination of the pore space. If this is the case, the mesh can't be generated properly in the narrow regions of the pore-space.

The work tries to quantify the impact of the limited mesh quality on estimation of the saturated conductivity coefficient. Four mesh generation parameters, resulting in different sizes of the minimum mesh cell size, were compared. For comparison five different pore media (three sandpacks prepared from different sand fractions and two types of sandstones) were used, all of them were used in two repetitions which resulted in 10 studied samples in total. First samples were X-ray CT scanned with resolution 2um. Than images were thresholded to obtain information about pore-space. In the next step, for all of 10 3D images of pore-space, mesh was generated in four repetitions differing with minimum mesh cell size: 2.56, 3.41, 5.12 and 10.25 times greater than voxel size used for CT scanning.

Saturated conductivity was simulated based on prepared meshes using finite volume based solver of the Navier-Stokes equations. Estimated for each sample saturated conductivity differed from 12% for coarse media to 200% for fine grain media for different numerical meshes representing with different accuracy pore space geometry.

Based on samples studied, one may conclude that for optimal results of saturated conductivity numerical estimation, the smallest numerical mesh's cell size should be of the level of pore media CT scan resolution.

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