Digital Rock Model based on nCT images as an input to Deep Learning for permeability simulation

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Abstract. Computed nanotomography, nCT is one of the modern, non-destructive research methods allowing to investigate the object using X-rays and present the pore space image of the examined sample. Research material at this work constituted samples of low porosity and low permeability (shales, tight sandstones and carbonates). The 3D visualization presents qualitative interpretation including irregularity of the pore space distribution. Pore distribution graphs allow to quantitative characteristics of the rock samples and their comparison. Processing of the 3D image provides with the information about the porosity, the number and length of the pore channels, their connections, directions and structure and also possibility of permeability modelling. One of the most important petrophysical parameters is a tortuosity. Tortuosity is determined as the ratio of the capillary length measured in the flow direction to the capillary length measured in pressure gradient direction. Using modified by authors algorithm in software poROSE, tortuosity is calculated using different approaches (standard and novel approach). Using new algorithms for nCT data interpretation is possible to enhanced the correctness of the permeability calculations. In this paper the main object of the study was to simulate permeability based on the parameters obtained from nCT images processing. For permeability calculation the Deep Learning techniques, especially Artificial Neural Network (MLP and RGB) were used. As a results relation between quantitative parameters from nCT parameters and permeability was found. Results were compared to the lab measurements data. In the second step permeability obtained using Artificial Neural Networks was compared to the fluid flow simulation results. It can be concluded that the use of new CT image processing algorithms and the use of high-resolution measurements allow for a better estimation of the permeability. The use of Deep Learning is an effective tool for permeability simulation.