STUDY OF MICROSTRUCTURE AND HYDRAULIC PROPERTIES OF GEOLOGICAL SAMPLES BY MEANS OF MICROFOCUS X-RAY COMPUTED TOMOGRAPHY AND LATTICE BOLTZMANN METHOD.

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Microfocus X-ray computed tomography (μCT) has been recently effectively applied to geological research as a non-destructive imaging technique which reveals the internal structure of investigated objects determined by variations in density and atomic composition. Microfocus X-ray computed tomography emerged as an important and powerful tool due to relatively easy experimental application and fine spatial resolution. Rapid development of modern computational techniques and numerical methods over the last few decades caused that computational fluid dynamics (CFD) techniques have now been widely used in various environmental problems. Combination of the μCT method with numerical calculations of fluid dynamics enables to obtain complex information on investigated media with great importance for oil research industry and waste disposal systems.

In this work, the study of microstructure (porosity, specific surface area) of geological porous media has been presented. The measurements have been carried out using the X-ray microprobe at the IFJ PAN (Krakow, Poland). The facility consists of a microfocusing x-ray source (Hamamatsu L9191) with exchangeable targets (Ti, Mo, W, Ag) and small focal spot (~3um) [1], a high resolution x-ray sensitive CCD camera and a precise specimen's positioning system. A comparison of the results obtained with μCT technique and with helium or mercury porosimetry shows reasonable agreement. Moreover, microtomographic images obtained with the use of the laboratory microfocusing source have been compared with images of the same samples obtained with the use of synchrotron radiation facility ANKA at Karlsruhe Institute of Technology (Karlsruhe, Germany). Comparison and discussion of images spatial resolution, quality and artefacts appearance have been presented in the paper.

Numerical techniques have been used in order to obtain complementary information on investigated media. Simulations of the fluid flow in void pore space have been carried out with the use of Lattice Boltzmann method (LBM) in order to obtain the permeability tensors of investigated media. Large scale computations based on 3DQ19 geometrical model have been performed with the use of modern grid infrastructure [2]. Furthermore, random walk simulation technique has been employed in order to obtain diffusive tortuosity factor of the investigated media. The knowledge of the media properties mentioned above additionally enables to verify semi-empirical Kozeny-Carman equation which is the most famous permeability-porosity relation and is widely used in the field of flow in porous media [3]. The results of LBM method application and verification of Kozeny-Carman equation have been also discussed and presented in the manuscript.

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