# Abstract

The definition of an optimal reservoir management strategy is fundamental for the primary production of oil and gas, Enhanced Oil Recovery, Underground Gas Storage, Underground Hydrogen Storage, $CO_2$ storage and geothermal systems. This definition requires a thorough analysis, characterization, description and understanding of fluid flow phenomena occurring in underground porous media. This work proposes a methodology based on geometrical analysis and hydrodynamic modeling in order to estimate microscopic and textural parameters that influence the fluid flow behavior in the pore space. Geometrical analyses and hydrodynamic simulations are run at the pore-scale directly on binary images of rocks. The geometrical analysis is implemented based on the application of the A* algorithm to find paths connecting inlet and outlet points in 2D and 3D rock images. Hydrodynamic simulation is performed using the Lattice Boltzmann Method (LBM) in 2D geometries and the Finite Volume Method (FVM) in 3D geometries. The results obtained through these analyses and simulations are compared and discussed. First of all, 2D binary images are analyzed to characterize the pore network geometry and to estimate effective porosity, pore size distribution and tortuosity. The results show that the path-finding approach can provide reasonable and reliable estimates of the parameters of interest. Then, the methodology is applied to 3D binary images of synthetic rock samples generated with the Quartet Structure Generation Set (QSGS) algorithm. Two different cases, representing an isotropic and an anisotropic porous media, are presented. In these cases, permeability was also estimated by the geometrical approach using the Kozeny-Carman equation and by hydrodynamic simulation inverting the Darcy's equation. The outcome of this investigation evidences that the geometrical analysis used in this research can provide a reliable characterization of 3D porous media.