Combined numerical and experimental study of microstructure and permeability in porous granular media

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Fluid flow on different scales is of interest for several Earth science disciplines like petrophysics, hydrogeology and volcanology. To parameterize fluid flow in large-scale numerical simulations (e.g. groundwater and volcanic systems), flow properties on the microscale need to be considered. For this purpose experimental and numerical investigations of flow through porous media over a wide range of porosities are necessary. In the present study we sinter glass bead media with various porosities, representing shallow depth crustal sediments. The microstructure, namely effective porosity and effective specific surface, is investigated using image processing. We furthermore determine flow properties like hydraulic tortuosity and permeability using both experimental measurements and numerical simulations. By fitting microstructural and flow properties to porosity, we obtain a modified Kozeny-Carman equation for isotropic low-porosity media, that can be used to simulate permeability in large-scale numerical models. To verify the modified Kozeny-Carman equation we compare it to the numerically computed and experimentally measured permeability values.