Transp Porous Med (2017) 117:103–123
DOI 10.1007/s11242-017-0822-3

Influence of Macro-pores on DNAPL Migration in Double-Porosity Soil Using Light Transmission Visualization Method

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Received: 25 June 2016 / Accepted: 1 January 2017 / Published online: 31 January 2017

Abstract Double porosity is a substantial microstructure characteristic in a wide range of geomaterials. It is a natural phenomenon that can be found in many types of soil, and it can result from biological, chemical or mechanical damage. In this paper, the influence of macro-pores on dense non-aqueous phase liquid (DNAPL) migration in double-porosity medium was investigated using light transmission visualization technique. Three experiments were carried out in two-dimensional flow chambers filled with a double-porosity medium composed of a mixture of local sand and sintered kaolin clay spheres arranged in a periodic manner. In each experiment, a different volumetric fraction of macro-pores and micropores was used. Tetrachloroethylene (PCE) was used to simulate DNAPL, and it was dyed using Oil-Red-O for better visualization. A predetermined amount of PCE was injected into the flow chambers and this amount was re-calculated using image analysis. A very strong correlation was found between the PCE amount injected and the amount calculated from image analysis in each experiment. The experiment was repeated by filling the flow chamber with silica sand to represent single-porosity medium. The results show that the macro-pores have a considerable effect on the PCE migration in double-porosity soil as the PCE movement was the fastest in the third experiment which contained the largest macro-pores volume. The accuracy of the method was validated using statistical analysis. The results show a slight difference between the means of the three experiments, indicating that the method is viable for monitoring NAPL

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