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# Dispersivity under partially-saturated conditions; pore-scale processes

Amir Raoof and Majid Hassanizadeh
Department of Earth Sciences, Utrecht University, The Netherlands

It is known that in unsaturated porous media, the dispersion coefficient depends on the Darcy velocity and soil water saturation. It is commonly assumed that the dispersion coefficient is a function of velocity through the dispersivity. However, there is not much known about this dependence on saturation.
The purpose of this study is to investigate how the longitudinal dispersivity varied with saturation using a pore network model. We schematize the porous medium as a network of pore bodies and pore throats of finite volumes. The pore space is modeled using a Multi-Directional Pore-Network (MDPN) which allows a distribution of coordination number ranging between zero and 26. This topological property together with geometrical distributions is used to mimic the microstructure of real porous media. After the construction of the pore network, dispersivity was calculated by solving the mass balance equations for solute concentration in all network elements and averaging the concentrations over large number of pores.
We have introduced a new formulation of solute transport within pore network which helps to capture the effect of limited mixing under partially-saturated conditions. This formulation allows a very detailed description of pore-scale solute transport processes by accounting for limitations in mixing within drained pore bodies and pore throats as a result of reduced water content. This allows us to scale up and quantify the effect of different pore-scale processes contributing to dispersion under different saturations. The numerically computed dispersivities are compared with the results obtained through experimental studies. The agreement between the results demonstrates the capability of this formulation to capture solute dispersion under partially-saturated conditions.