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Analysis of single ring infiltrometer test by direct numerical modeling

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The well field of the Lyon metropolitan area provides drinking water to approximately 1,300,000 inhabitants. It is equipped with 12 infiltration basins. These basins have two main goals: sustaining the water table in times of peak demand for water, and preventing a possible contamination from the Rhône river by inverting groundwater flow direction. The water infiltration under the basins is thus crucial for the overall hydrogeologic behavior of the site.
In order to characterize this phenomenon, a set of infiltrometer tests were performed to estimate the soil hydraulic properties. The soil is a coarse alluvial deposits. In order to deal with its sparse granulometric curve, a large single ring infiltrometer (1 meter in diameter) was used. A constant hydraulic head (=0.07 m) was imposed during the test. Two kinds of data are recorded: the amount of water infiltrated over time and the extension of the moisture stain around the ring. The main hydraulic properties are estimated using Richard's equation in a 2D axi-symmetric configuration. Simulations are performed using a finite element commercial software package (Comsol Multiphysics 5.1).
According to simplified numerical models, an average homogeneous saturated permeability of the alluvial deposits is estimated at 5.0 10-6 m.s-1. However, such a simple model is not able to represent accurately the moisture stain at the soil surface. More complex models introduce anisotropy of permeability in the alluvium layer, with mono or bi-layer domain. In these cases, experimental and modeling results are consistent, both for the amount of water infiltrated over time and the extension of the moisture stain around the ring. The hydraulic anisotropy in the soil could be due to the stratified nature of alluvial deposits and to soil compaction during the construction of infiltration basins.

Keywords: Single ring infiltrometer test, artificial aquifer recharge, numerical modeling.