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Experimental evaluation of connectivity influence on dispersivity under confined and unconfined radial convergent flow conditions

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Heterogeneity and connectivity have a significant impact on the fate and transport of contaminants due to the occurrence of formations with largest permeability than the surrounding geological materials, which can originate preferential pathways in groundwater system. These issues are usually addressed by tracer tests and a radial convergent (RC) flow setting is typically selected for convenience but more complicated for model interpretation than uniform flow transport. An experimental investigation was performed using RC tracer tests in a 3D intermediate scale physical model to illustrate the role of connected features on the estimation of dispersivity using the classical Sauty solution and the method of moments, under confined and unconfined aquifer conditions. The physical model consists of 26 piezometers located at difference distances from a constant-discharge central pumping well. The box is filled with gravel channels embedded in a sandy matrix and organized in different layers. Materials have been well characterized before and after the test. For the confined configuration, a silt layer was placed above the previous layers. Tracer tests were performed using potassium iodide solutions with concentration of 3•10-3 M and under a constant pumping flow rate of 0.05 L/s. To mimic a pulse injection in each piezometer we used syringes and pipes, whereas a probe allowed continuous measuring of tracer concentration. Average velocity and longitudinal dispersion coefficient were defined from the first and second central moment of the observed breakthrough curves for each piezometer (integrated over the outflow boundary of the domain) and using the classical curve matching from the Sauty's solution at different Péclet numbers. Results reveal in some cases that estimates of hydrodynamic parameters from the Sauty solution and the method of moments seem to be different. This is related to the different basic assumptions of the two methods applied, and especially because of the presence of preferential flow paths which have been found to strongly control the highest values of the average velocity at the source and affect the resulting longitudinal dispersion coefficient. This study showed additional lights on the impact of connectivity on transport and its role to obtain effective measurements of macrodispersion throughout the aquifer under RC transport.

Reference:
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