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Is breakthrough of solute impacted by the edges of the columns in the case of macropored systems?

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In natural systems, preferential flow is the rule rather than the exception. Non-uniform and preferential flows significantly impact mass transport, and by this way most of geochemical processes and pollutant dispersion in the environment. Laboratory columns are experimental devices used for the monitoring of solute transfer through porous. In particular, several studies used such experimental devices for characterizing mass transfer through heterogeneous systems and macropored systems. However, the design of these devices and its impacts on the experimental results has never been investigated in depth so far. In particular, the edge effect is rarely questioned and the transfer is always hypothesized to correspond to a fully developed flow (i.e., flow in an equivalent infinite system). In this study, we question this hypothesis both experimentally and numerically for the case of a macropored system. Tracer elutions, magnetic resonance imaging (MRI), and modeling using multiphysics approaches (Comsol) are conducted to demonstrate that flow is affected by edge effects close to the inlet and the outlet of the column, and that the presence of filters (used to prevent particles from exiting the system and clogging the outlet) do impact the flow and transfer breakthrough. Consequently, these edge effects should be considered when analyzing the results and concluding on the involved processes, in particular for the case of soils and systems with macropores.