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# Effects of time-dependent velocity fields on the dynamics of chemical transport in porous media

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The dynamics of a migrating chemical plume in a porous medium can be affected by different chemical processes (e.g., sorption, retention, precipitation and dissolution, complexation, reaction), as well as by the physical properties of the medium and flow field (heterogeneity of the medium, porosity and permeability, fluid velocity). Groundwater input in natural systems can vary over a wide range of time scales, due to different natural phenomena (e.g., day and night cycles, season variability, long term climate changes) and anthropogenic activities (e.g., groundwater extraction and injection, irrigation, construction). These variations in input give rise to a time-dependent (TD) velocity field, which in turn may influence the dynamics, mixing, and reaction rates of a migrating chemical plume. Anomalous transport, which is ubiquitous in many groundwater systems and has been shown to yield longer than expected (non-Fickian) tails of migrating chemical plumes, is of particular interest in this context. In this study, macroscopically 1D transport of a conservative chemical species through sand columns was quantified by tracer measurement at the column outlet. Transport in these columns is known to display distinct, non-Fickian tailing of the breakthrough curves. Different TD velocity field conditions were compared to study how the transient water input affects the resulting tracer breakthrough curves. A stochastic-based numerical model was employed to interpret the results. The analysis shows that different TD conditions, which retain the average discharge of a comparable constant-velocity system, yield similar, long-tailed breakthrough curves to those of the constant-velocity case. These breakthrough curves can be interpreted in terms of the continuous time random walk (CTRW) framework. We then analyze the sensitivity of the CTRW to the occurrence of abrupt velocity changes, by addressing the choice of particle transition times and distances at the moment of velocity change, and show that the CTRW matches the experimental results obtained in the column experiments.

## Participation

In-Person

## References

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