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INVESTIGATING NON-FICKIAN BROMIDE TRANSPORT IN THE SOIL COLUMNS

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Abstract

Integrating laboratory column experiments with theoretical models greatly improves our foundational understanding and realistic depiction of contaminant movement in porous environments. This study utilized both the Fickian convection-dispersion equation (CDE) and the non-Fickian continuous time random walk (CTRW) model to simulate bromide transport in saturated and unsaturated forest soils. The transport parameters of these models for individual breakthrough curves (BTCs) were determined using a curve fitting program, CXTFIT, and the CTRW Matlab toolbox. All the models showed acceptable fitness to the transport process of bromide, but the CTRW fitted best. The CTRW could fully describe the detector-BTC, especially for late-time tailing, while the CDE could not. The values of the spreading parameter ($1<\beta<2$), which served as an indicator for distinguishing between Fickian and non-Fickian transport, revealed that bromide transport in these columns was anomalous, or non-Fickian. Therefore, the non-Fickian CTRW model proved to be more appropriate and effective than the Fickian CDE model. The better fit of the CTRW model to the breakthrough curves (BTCs) shows its higher coefficient of determination (R^2) and lower root mean square error (RMSE) values compared to the convection-dispersion equation (CDE). This confirms its effectiveness in simulating bromide transport in both forest and rangeland soil columns.

Key words: anomalous transport, breakthrough curve, CDE model, CTRW model, Fickian-transport

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