



# Quantitative imaging of contaminant distributions in heterogeneous porous media laboratory experiments

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## Abstract

Intermediate-scale laboratory experiments on heterogeneous porous media have been increasingly used for the study of saturated and unsaturated ground water systems. While the ability to reproduce field-scale heterogeneity in these experiments has advanced, the use of visualization or image analysis methods to characterize the spatial distribution of solute concentrations has largely remained at the homogeneous media level. To advance these imaging techniques we developed a generic image analysis package that, for the first time, automatically segments regions in photographic images that require unique concentration calibration curves due to varying porous media properties or lighting nonuniformities. As a robust test, our image analysis package was applied to an intermediate-scale flow tank experiment characterized by a correlated random permeability field with unprecedented resolution. Twenty-five distinct classes of porous media were developed and binned to the synthetic permeability field, creating an experimental field of 3456 rectangular cells and thereby ensuring the emplaced field closely matched the statistics of the original continuous distribution. Concentration distributions were determined for an experimental tracer run and the corresponding dispersion parameters were calculated. The closeness of the experimental, image-processed longitudinal dispersivity ( $4.6 \times 10^{-2}$  m) to that obtained from the field statistics ( $9.1 \times 10^{-2}$  m) verifies our image analysis technique.

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