E04

# Hydrological properties of preferential flow paths

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During dye staining experiments at field sites in Okaya and Mie, Japan, undisturbed core soil samples were collected and processed in the laboratory. Staining patterns of natural soil profiles revealed strong heterogeneous water percolation into and through the soil (Figure 1), suggesting the presence of preferential flow paths (PFP). Samples taken both from stained and unstained parts of the soil profile were analysed for saturated hydraulic conductivity ($K_{sat}$) and grain size (GSD) to explain why water flows into some parts of the soil mass and does not flow into another parts. Vertical samples were collected where evidence of vertical flow was clear and slope parallel samples were taken where lateral flow patterns were evident.

The stained samples did not have higher $K_{sat}$ values as expected. $K_{sat}$ data for 90 samples showed no correlation with regions where water percolated into the soil. Both stained and unstained samples exhibited a wide range of variation in $K_{sat}$.

To explain the staining patterns, 10 samples were analysed for grain size distribution to ascertain possible correlations. Analysis of variance revealed significant differences among mass percentage distributions in different sieve fractions ($p < 0.005$). Also, a test of homogeneity variance revealed significant differences amongst samples. Tanhane's test for mean separations then revealed that mean mass for only one sample differed from the other nine samples. Therefore, we conclude that analysed samples are almost homogeneous, except one sample, and their particle size distributions are similar.

For all ten samples, distribution of mass in respective sieve fractions perfectly ($R^2 > 0.99$) fit the Weibull distribution. The fitted parameters of the 4-parameter Weibull distribution differed significantly from 0 ($p < 0.05$).

Our findings reveal that $K_{sat}$ values for core samples do not always indicate an appropriate tendency of hydraulic gradient that may arise from variable PFP sizes that can be easily masked by larger core sizes. This condition may introduce errors in, for example, the van Genuchten curve in flow modeling combined with Richards equation. The Weibull fitting parameters for GSD showed no correlation with both staining and $K_{sat}$, suggesting that GSD within large soil block domains does not affect soil hydrologic properties; thus, packing of soil grains appears more important. These findings are important for subsurface flow modeling and understanding water percolation processes in soils affected by PFP.

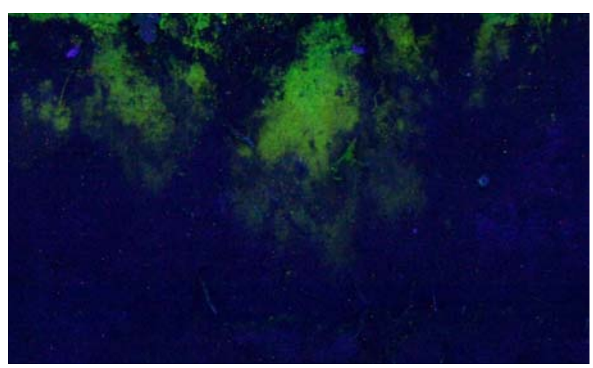

Figure 1. Staining pattern in soil profile.