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The Vadose Zone Observatory: Dynamical Characterization of Liquid- and Gas-Phase Contaminant Transport in a Heterogeneous Soil Regime

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The transport of contaminants to the water table is influenced by diffusion, buoyancy forces, capillarity and barometric pressure variations. With support from the DOE Environmental Management Science Program, we are developing an improved understanding of vadose-zone transport processes by means of field experiments carried out at a highly characterized and instrumented site called the Vadose Zone Observatory (VZO). The results of the observations obtained from infiltration experiments are then evaluated with models of 3-D multiphase flow and transport using the NUFT program. At the VZO we can monitor liquid saturation changes with electric resistance tomography (ERT) and gypsum blocks. Vadose zone liquid samples can be obtained from absorbent pads that are part of a borehole flexible liner system as well as from lysimeter/tensiometer tools that will soon be installed at the site. The gas phase is monitored by drawing samples from different levels in the vadose zone following the release of a plume containing dissolved noble gas tracers. In addition barometric pressure is continuously monitored at the surface and at numerous depths within the vadose regime. A recent point-source infiltration experiment carried out at the VZO illustrates the need to understand the importance of preferential pathways resulting from soil heterogeneity. We found liquid transported over 50 feet to the water table within a day or two in a seemingly "tight" clay-silt soil regime while predictive models, based on borehole samples and assuming a layered structure, showed this regime to be a strong barrier to transport. Stochastic models suggest that flow paths with permeabilities in the darcy range control the speed with which contaminants will be transported to the water table in this clay-silt system. Gas-phase tracer measurements also suggest chemical transport at rates that far exceed those of an almost-saturated clay-silt regime.

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