Describing Gas Distribution in the Desert Unsaturated Zone

Chemical and radioactive waste facilities are often located in remote desert environments because deep water tables and low rainfall minimize contaminant mobility and groundwater vulnerability. The potential for gas phase contaminant transport, however, is far from negligible.

In an article recently published in Vadose Zone Journal, researchers report on a multi-year study focusing on CO$_2$ and CH$_4$ to improve characterization of subsurface migration and contaminant fate in arid regions. The study was done at the U.S. Geological Survey’s Amargosa Desert Research Site, which includes the low-level radioactive waste (LLRW) facility near Beatty, NV.

The team found that CO$_2$ carbon isotopic composition can be used to identify distinct natural and LLRW CO$_2$ sources, the influence of root-zone moisture changes on shallow CO$_2$ and CH$_4$ dynamics, and how pore water interactions explain differences in CO$_2$ and CH$_4$ in the deep unsaturated zone.

The results highlight the utility of using CH$_4$ and CO$_2$ as tracers of contaminant gases and to understand distributions of contaminants at the site, which include radiocarbon and volatile organic compounds. The role of the root zone and soil moisture in CO$_2$ and CH$_4$ biogeochemistry has substantial transfer value to similar arid sites.


Calibrated Parameters More Important than Two Dimensions for Phosphorus Modeling

Phosphorus and N are critical nutrients for agriculture but are also responsible for surface water enrichment that leads to toxic algal growth. Although P loading to surface waters has traditionally been thought to occur primarily in surface runoff, contributions from subsurface transport can also be significant. Phosphorus has been observed to leach through silt loam soils to gravelly aquifers that are connected to nearby streams.

In an article recently published in Vadose Zone Journal, researchers evaluated several methods of representing macropore flow and transport in a numerical model using data from field experiments on infiltration and P leaching. The dual-porosity model with heterogeneous hydraulic conductivity best matched experimental data, with dual porosity being more important than heterogeneity. Long-term (nine-year) P leaching to the water table at the field site showed little difference between analogous one-dimensional and two-dimensional models, suggesting that a one-dimensional model may be sufficient to simulate long-term P leaching.

Overall, the most important elements for accurate simulations in this silt loam and gravel soil profile were found to be (i) field-measured hydraulic conductivity of the limiting soil layer, (ii) calibrated dispersivity, and (iii) dual porosity, in some circumstances. Modelers should evaluate their particular situation to determine whether the increased effort of two-dimensional heterogeneity and/or dual-porosity models is needed.