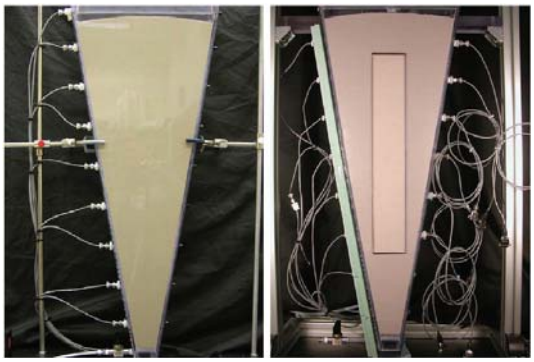
All Dried Up

EMSL resources support studies for desiccation-based remediation method

Remediating contaminated environments may be as easy as drying desert soil. Thought to be the first attempt of its kind, a soil desiccation pilot test is being prepared at the U.S. Department of Energy's Hanford Site located in the semi-arid desert of Richland, Washington. The pilot test is designed to determine if the mobility of ^{99}Tc and NO_3, both byproducts of plutonium production, can be limited via desiccation. To support the pilot test and to help demonstrate the efficacy of desiccation as a remediation treatment in the region between the ground surface and the water table, called the vadose zone, a team of researchers from Pacific Northwest National Laboratory, EMSL, and Auburn University conducted laboratory-scale experiments to study the effects of temperature and humidity in model systems. The team then validated PNNL's STOMP subsurface flow and transport simulator against their data to demonstrate its accuracy in predicting the behavior of field-scale systems.



Wedge-shaped flow cells representing homogeneous (left) and heterogeneous (right) systems with probes attached.

Remediation by desiccation is to simply inject dry air and withdraw wet air from soil, thus immobilizing contaminants by preventing their aqueous-phase transport. The technique seems straightforward, but some detailed physics must be accounted for before field-scale studies can commence – for example, the relationship between the energy required to evaporate water from the soil as well as the temperature and the water-vapor density of the system; the effects of osmosis; and the potential for rewetting to cause an initial increase in contaminant remobilization. To help resolve questions pertaining to these issues, researchers used wedge-shaped intermediate-scale flow cells at EMSL filled with either a homogeneous pack of medium-grained sand or a simple, heterogeneous pack of medium-grained sand surrounding a fine-grain sand core. The team then injected dry air into the systems and monitored the desiccation process via temperature and humidity probes attached at a range of depths in the flow cells. The data from the probes was used to validate STOMP and showed that it simulated the desiccation process effectively in both system types only if the wall and PVC insulation from the flow cells were accounted for. Ignoring those values yields predictive values for cooling greater than observed experimentally, meaning that the simulator is accounting for the physics of the system properly. Experiments are at present being conducted in larger, more complex, heterogeneous systems to further understand desiccation prior to moving to field-scale studies.

Scientific impact: New flow and transport data is used to further refine models used by the remediation research community. This work also supports EMSL's goal to rapidly link theory with experiment.

Societal impact: Studies such as this demonstrate, new, potentially more efficient and cost effective remediation methods, that may have a positive impact on environmental and human health.

Reference: Oostrom M, TW Wietsma, JH Dane, MJ Truex, and AL Ward. 2009. "Desiccation of Unsaturated Porous Media: Intermediate-Scale Experiments and Numerical Simulation." *Vadose Zone Journal* 8(3):643-650. DOI: 10.2136/vzj2008.0182

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