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PFAS variable transport behavior: insights from soil sorption experiments

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Per- and Polyfluoroalkyl Substances (PFAS) are extensively utilized chemicals owing to their desired physicochemical properties. Despite increasing efforts to limit their applications, they persist in the environment and pose a threat to drinking water production due to their persistence, mobility, and toxicity. Understanding their behavior in subsurface media is crucial for minimizing the risk of exposure in areas where groundwater is a significant source. Sorption is considered a pivotal mechanism in PFAS remediation. This study aims to explore the transport behavior of different PFAS groups in soil sorption experiments and establish a connection to field scenarios.

Miscible displacement experiments were conducted on a mixture of PFAS. A 50 cm long glass column filled with sand was injected with a 2.5 µg/l PFAS solution. Subsequently, the column was flushed with a PFAS-free solution to examine the desorption process. A conservative tracer test was performed to determine hydrogeological properties. Samples were analyzed using liquid chromatography-mass spectrometry. Breakthrough curves were then simulated using Hydrus 1D to obtain transport parameters.

The results revealed that different PFAS groups exhibit varying orders of magnitude of sorption. Some were conservative, while others were entirely retained. In addition to functional groups and chain length, hydrophobicity played a crucial role in PFAS behavior. The desorption process was inversely proportional to sorption; less desorption occurred with an increased sorption level.

To simulate these behaviors, different sorption modules in Hydrus were tested. Substances with higher sorption levels required more complex sorption terms and could not be accurately simulated by assuming equilibrium sorption.