Contamination of the vadose zone is a particularly difficult problem to remedy; water moves relatively slowly compared with saturated material. This problem can be localized or grow to a much larger scale when soluble contaminants migrate down to the groundwater table. This will then result in contamination of the aquifer over a much larger spatial scale and persist for a long time into the future. Removal of water from the vadose zone is complicated as the water is held by strong capillary forces specifically in low-permeability sediments.

At the Hanford Site in Washington State, past activities have led to presence of technetium-99 in low-permeability sediments at high water content. Scientists have for years sought to slow the downward migration of this contaminated water. In a recent issue of Vadose Zone Journal, researchers suggest an innovative method: sustained extraction of contaminated pore water from the low-permeability layers in the vadose zone. If successful at the field scale, this could prevent further migration to the subsurface. The authors devised a series of laboratory experiments using repacked Hanford sediments, as well as numerical experiments for pore-water extraction from the vadose zone. The pore water was then extracted using a vacuum pump and simulated using a numerical model.

The results showed that, perhaps surprisingly, presence of high-permeability layers impeded water flow because the material dried too quickly. The wetter, low-permeability layers promoted flow for longer periods of time, increasing water extraction. The predicted capillary pressure using the numerical model (with the proper initial and boundary conditions) matched the measured values from the laboratory experiments. These results offer a glimpse of the saturation gradients as a result of the extraction process, something that could potentially be designed into large-scale remedial systems.

The success of this research offers hope that this method can be used in actual field settings to reduce contamination of groundwater.

Pore-Water Extraction from Unsaturated Porous Media


Reference

