U.S. Environmental Protection Agency

USEPA Capabilities and Directions to Advance Innovative Remediation Technologies

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Selected Remediation Technologies of the Sustainable & Healthy Communities National Research Program

Outline

- Arsenic Remediation in Groundwater
- Geochemical Tracers for Groundwater Remediation
- Biochar-laden Vertical Wetland to Adsorb Metals
- Managing Plume Back Diffusion

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Arsenic Remediation in Groundwater

- EPA Report: Investigation of a Sustainable Approach to In-situ Remediation of Arsenic Impacted Groundwater (EPA/600/R-19/102)
- Collaborative work between ORD, EPA Region 2, and Army Corps of Engineers
- Large-scale pilot testing of air sparging in low-pH, Fe(II) groundwater – Vineland Superfund Site (NJ)

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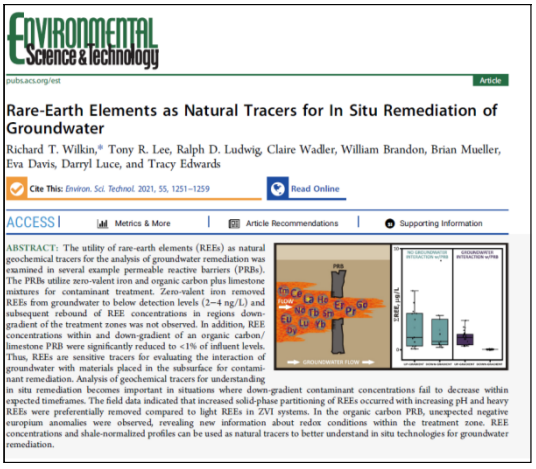
Geochemical Tracers for Groundwater Remediation

- Journal Article: Rare Earth Elements as Natural Tracers for In Situ Remediation of Groundwater
  Wilkin et al. (2021). ES&T, p. 1251-1259.
- Collaborative effort between ORD, EPA Region 1, & EPA Region 6
- Provides a tool for evaluating groundwater interaction with reactive materials and for understanding remedy failures/delays


Environmental Science & Technology

pubs.acs.org/est Article

Rare-Earth Elements as Natural Tracers for In Situ Remediation of Groundwater

Richard T. Wilkin,* Tony R. Lee, Ralph D. Ludwig, Claire Wadler, William Brandon, Brian Mueller, Eva Davis, Darryl Luce, and Tracy Edwards

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ABSTRACT: The utility of rare-earth elements (REEs) as natural geochemical tracers for the analysis of groundwater remediation was examined in several example permeable reactive barriers (PRBs). The PRBs utilize zero-valent iron and organic carbon plus limestone mixtures for contaminant treatment. Zero-valent iron removed REEs from groundwater to below detection levels (2−4 ng/L) and subsequent rebound of REE concentrations in regions down-gradient of the treatment zones was not observed. In addition, REE concentrations within and down-gradient of an organic carbon/limestone PRB were significantly reduced to <1% of influent levels. Thus, REEs are sensitive tracers for evaluating the interaction of groundwater with materials placed in the subsurface for contaminant remediation. Analysis of geochemical tracers for understanding in situ remediation becomes important in situations where down-gradient contaminant concentrations fail to decrease within expected timeframes. The field data indicated that increased solid-phase partitioning of REEs occurred with increasing pH and heavy REEs were preferentially removed compared to light REEs in ZVI systems. In the organic carbon PRB, unexpected negative europium anomalies were observed, revealing new information about redox conditions within the treatment zone. REE concentrations and shale-normalized profiles can be used as natural tracers to better understand in situ technologies for groundwater remediation.

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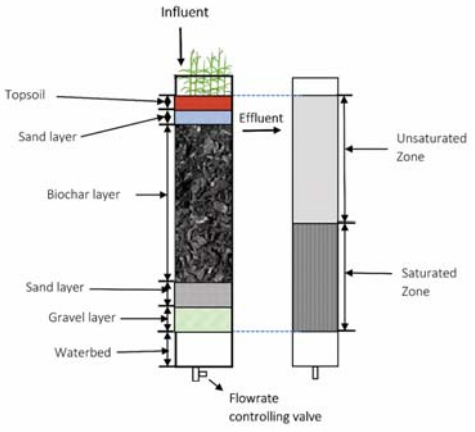
Biochar-laden Vertical Wetland to Adsorb Metals

- Passive adsorption of high metal concentrations in very acidic MIW with biochar



Vertical wetlands schematic with biochar used as a substrate

Column reactors used for MIW treatment

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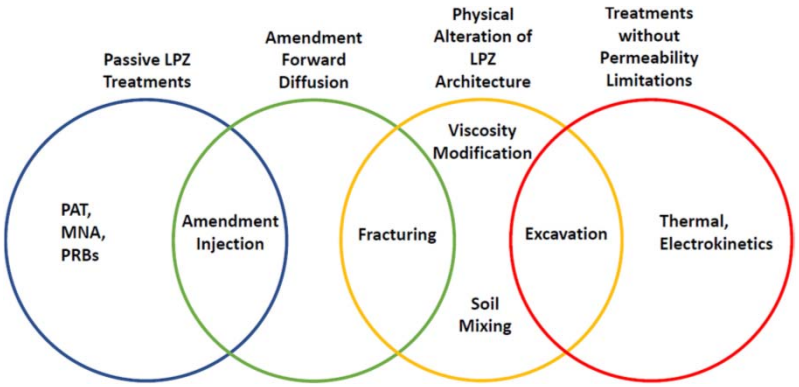
Managing Plume Back Diffusion

- Journal Article: Strategies for Managing Risk due to Back Diffusion.
  Brooks et al. (2021). GW Monitor & Remediation, p. 1-23.



Summary of strategies and treatments to address plume persistence due to back diffusion. Implementation cost/difficulty and remedial performance, generally increases from left to right.

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References

- North, T., Sehayek, L., Wilkin, R., Cutt, D., Klaber, N., and Young, H. (2019). Investigation of a sustainable approach to in-situ remediation of arsenic impacted groundwater, EPA Report, EPA/600/R-19/102, 59 pp.
- Brooks, M.C., Yarney, E., and Huang, J. (2021). Strategies for Managing Risk due to Back Diffusion. Groundwater Monitoring and Remediation, v. 41(1), p. 76-98.
- Wilkin, R.T., Lee, T.R., Ludwig, R.D., Wadler, C., Brandon, W., Mueller, B., Davis, E., Luce, D., Edwards, T. (2021). Rare-earth elements as natural tracers for in-situ remediation of groundwater. Environmental Science and Technology, v. 55, p. 1251-1259.

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