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Strategies for Applying Reagents into Low Permeability and Fractured Media: Lessons Learned, Specific Challenges, and Best Practices

Josephine Molin (josephine.molin@peroxychem.com), Brant Smith, and Fayaz Lakhwala, (PeroxyChem, LLC, Philadelphia, PA, USA)

Background/Objectives. Success of most in situ remedial strategies is largely based on effective subsurface distribution of reagents to establish contact between contaminants and reagents. The ability to establish successful contact can be hindered when working with low permeability or heterogeneous lithologies because of specific challenges including:

- Low hydraulic conductivity media such as clays and bedrock with small fractures limit the rate, mass and volume of reagents that can be delivered using conventional injection methods.
- Fractured media, including fractured clays and bedrock, may have significant hydraulic conductivity but presents challenges with uneven distribution of impacts and in understanding flow paths and predicting fracture connectivity.

Approach/Activities. Benefits and limitations of different application strategies and how they can be best applied to treat low permeable or fractured media will be discussed. Experience from a number of different field projects will be presented with specific attention to lessons learned and best practices as it comes to dealing with challenges presented by low permeability soils and bedrocks sites. Field data and case studies will be used to illustrate key points and lessons learned. Installation strategies including low pressure injection of liquids into existing fracture networks, hydraulic and pneumatic fracturing of solid reagents, and soil mixing will be reviewed during the presentation.

Results/Lessons Learned. Application of liquid reagents into fractured media typically involve a smaller more concentrated injection volume where the fluids will primarily distribute in to more permeable zones along preferred pathways. It is therefore important to map impacted zones and isolate those during injection. Injection over large screen intervals or infiltration galleries often results in uneven performance and inefficient use of reagents. Application of granular reagents via hydraulic or pneumatic fracturing involves opening up new fractures with the goal to interconnect with existing fractures. This approach has been successfully applied to both clay and bedrock sites. Soil mixing has proven successful in establishing more uniform distribution in low permeability and heterogeneous soils, achieving high contaminant removal rates and more efficient use of reagents. The applicability and efficacy of either approach is dictated by the lithology and depth and requires an understanding of the distribution of impacts, fracture locations and connectivity, and groundwater flow paths. Contact could occur directly upon substrate placement or occur over time via diffusion of reagents and/or contaminants, making substrate longevity and distribution properties key substrate features to consider.