Application of Vegetable Oil-Based Substrate in Shallow Fractured Bedrock and Associated Saprolitic Clay Soils

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Successfully enhancing reductive dechlorination through the addition of vegetable oil-based substrates has been problematic due to the general inability to obtain reasonably homogeneous distribution of the substrate. While attempts to increase distribution by decreasing the emulsion particle size of kinetically stable emulsions have been successful, mostly in soils with higher hydraulic conductivities, highly fractured bedrock and soils with lower hydraulic conductivities remain problematic. This has limited the use of slowly soluble substrates such as standard emulsified vegetable oil to sites with soils with higher hydraulic conductivity. In order to conceptually prove that enhanced reductive dechlorination could be successful in shallow bedrock and saprolitic soil, a thermodynamically stable soy-based product (LactOil® soy microemulsion) was injected in a pilot test on a site in east-central Kansas.

The subject site is generally characterized as including overburden material of varying thickness ranging from several feet to about 12 feet grading to a limestone unit followed by shale bedrock. The overburden consists of about 58% silt, 40% clay, and 2% sand. The limestone unit below the overburden generally follows the general surface topography but "pinches out" near the downgradient end of the site. The limestone unit is thought to be the primary pathway for shallow groundwater. Both the limestone unit and overlying soils exhibit very low yield.

Data collected over a period of eighteen months exhibited a decrease of chlorinated ethenes in two of four monitoring wells ranging from over 1,000 ug/L to non-detectable levels. Two additional wells exhibited decreases in total ethenes ranging from 34% to 89%. A fifth well located below the intended application zone in bedrock exhibited decreases in chlorinated ethenes over eighteen months suggesting the migration of substrate vertically through the system. An evaluation of the distribution of substrate based on changes in geochemistry will be presented along with the impact on the degradation of the chlorinated ethenes at the site.

PRESENTATION OUTLINE

Enhanced Reductive Dechlorination in low conductivity saprolitic soils and bedrock

Challenge is substrate distribution

Thermodynamically stable soy microemulsion to enhance substrate distribution

Site lithology and apparent hydrogeology

Injection strategy

Results

Challenges