In Situ Bioremediation at FracRock Sites

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Retention of bacteria in fractured bedrock can be a challenge for bioaugmentation. The relatively low surface area in the aquifer compared to porous media sites may not retain a high enough density of bacteria for effective remediation. Recirculation can be used to retain bacteria within the area of concern, but the cost and infrastructure associated with this strategy can be prohibitive at some sites. Two case studies will be used to illustrate the passive and semi-passive application of bioaugmentation in fractured bedrock. The former Naval Air Warfare Center (NAWC) in West Trenton, NJ has high concentrations of TCE indicating the presence of DNAPL in fractured mudstones. Similarly, a site in Tennessee had DNAPL concentrations in both the clay overburden source area as well as further downgradient in a karst aquifer. Both of these sites were treated with a combination of emulsified oil substrate and KB-1® bacterial consortium. The working hypothesis is that the hydrophobic oil partitions to coat the surface of the fractures and helps to retain the hydrophobic bacteria at the surface of the fractures. Long term monitoring suggests that the oil/bacteria coating on the fractures prevents further diffusion of TCE into the groundwater from the bedrock by degrading the TCE at the rock/water interface. The combination of a long-term electron donor and a bacterial consortium that uses TCE as an electron acceptor is a remedial approach that does not require an *ex situ* operating system. Effective concentrations of the KB-1® bacterial consortium are expected to exist (and increase by growth and replication) as long as adequate electron donor and electron acceptor persists. This passive approach requires replenishment of the electron donor only on a periodic basis, but the indications are that this replenishment is needed relatively infrequently, on the order of years.