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The influence of different geotechnically relevant amendments on the reductive degradation of TCE by nZVI

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Trichloroethylene (TCE) was widely used as a cleaning and degreasing agent. Companies needing these agents were often situated in or close to built up areas, so spillage led to contaminated sites which now can only be remediated using in situ techniques. The situation is compounded by the fact that TCE tends to seep through ground water bodies forming pools at the bottom of the aquifer.
When reacting with TCE, nanoscale zero valent iron (nZVI) is known to reduce it into non-toxic substances. The difficulty is to bring it in contact with the pollutant. Attempts using passive insertion into the groundwater via wells yielded mixed results. Reasons for this are that ZVI tends to coagulate, to sediment and to adsorb on the matrix of the aquifer. Also, in inhomogeneous aquifers a passive application of nZVI can be difficult and might not bring the desired results, due to existence of preferential flow paths.
A possible solution to this problem is the physical in situ mixing of ZVI into the contaminant source. This can, in principle, be done by adapting jet grouting – a method that uses a high pressure slurry jet, consisting of water and geotechnical additives („binders“), to mix and compact zones („columns“) in soil. These columns are commonly used to solve foundation problems but can also be used to solve the problem of delivering nZVI to TCE source zones.
This paper examines the influence binders have on the degradation reaction between TCE and nZVI. The necessity of these binders is explained by the fact that the subsoil structure is rearranged during the jetting process leading to subsidence on the surface. These subsidences could result in damage to neighbouring structures.
A series of batch experiments was conducted in this study. Contaminated groundwater was brought into contact with samples of slurries commonly used in geotechnical applications. We tested the effects of concresole, bentonite, zeolithe, fly ash, slag sand and cement on the kinetics of TCE degradation by nZVI. The degradation of TCE was measured using GC Headspace samples. Furthermore, additional experiments were conducted to investigate the interaction between binders and TCE as well as binders and nZVI.
The results of these experiments led to the conclusion that jet grouting could be well suited for the delivery of nZVI to TCE contaminated source zones. Currently, soil column experiments and large-scale experiments in test facilities are performed to confirm the batch testing results.