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Groundwater remediation using reactive barriers: development of a reactive transport model

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Remediation of point-source groundwater pollution has traditionally been achieved by energy-intensive and drastic methods such as pump and treat systems. Recently, more economically viable and less invasive methods such as monitored natural attenuation and permeable reactive barriers (PRB) have been used to clean up a wide variety of groundwater pollutants. These latter techniques rely on in-situ biogeochemical transformations of the pollutants into less harmful components. However, effective application of these techniques requires a solid understanding of the site-specific hydrogeological and geochemical conditions, as well as a predictive assessment of long-term remediation efficiency. For example, secondary mineral precipitation in PRBs has been shown in some cases to reduce reactivity and efficiency over time. In order to quantify these processes, we develop a reactive transport model that simulates VOC degradation (TCE) and geochemical reactions in a zero-valent iron PRB. The purpose is to predict the long-term remediation efficiency of the PRB as a function of inorganic groundwater composition, hydrogeological conditions, and design parameters (e.g. barrier thickness). A main feature is that the model accounts for the effect of mineral precipitation on barrier porosity and reactivity. This is accomplished by coupling a saturated flow and transport model with a geochemical model that simulates the various chemical reactions in the PRB. The coupling accounts for the effect of mass transport on chemical reactions (such as mineral precipitation), which in turn affects flow and transport through the resulting simulated changes in porosity and hydraulic conductivity within the PRB. The model is currently being tested using field and laboratory data.