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Optimal oxidant injection method investigated using a reactive transport approach for remediation of a heavy metal contaminated aquifer

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The injection of oxidizing agents in heavy metal contaminated aquifers can lead to the precipitation of metal oxides near the injection well, posing a potential risk to well integrity. To mitigate this risk and maximize remediation efficiency, we conducted a continuum-scale reactive transport modeling study using PFLOTRAN to explore different injection scenarios. Our investigation took place in the Hyeonbuk-ri area of Buyeo-gun, South Korea, where the groundwater aquifer consists of sand (5 - 12 m), gravel (12 - 18 m), and weathered soil (18 - 21 m) layers with the permeability of 8.65×10^{-12} m^2, 3.59×10^{-11} m^2, and 2.38×10^{-11} m^2, respectively. The initial and boundary conditions were constrained to replicate observed patterns of iron and manganese concentrations during the three alternative aerations and oxidant injections. The oxidized iron and manganese were assumed to precipitate respectively as $Fe(OH)_3$ and MnO_2 with the precipitation rates determined using transition state theory. With the simulation conditions constrained, a range of injection scenarios was tested using random correlation fields which honor the measured hydrogeochemical properties of each geologic layer. Our preliminary results indicate that injecting oxidant into the aquifer layer with the highest permeability at a fast rate led to more widespread oxidant distribution and homogeneous oxide precipitation, thus reducing the risk of well failure. This study highlights the usefulness of a reactive transport model for elucidating the complex interplay of hydrological and geochemical processes in heterogeneous porous media, and its potential to improve the efficiency of remediation efforts in heavy metal contaminated groundwater.