Geophysical Research Abstracts
Vol. 16, EGU2014-15364, 2014
EGU General Assembly 2014

Modeling the enhanced removal of emerging organic contaminants during MAR through a reactive barrier.

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Artificial recharge of reclaimed water is often proposed as a way of increasing water resources while improving quality. However, it is also feared that recalcitrant organic contaminants (i.e. those that are not completely removed during wastewater treatment) may reach the aquifer. Specifically, emerging organic contaminants (EOCs) have been increasingly detected in surface and ground waters and are becoming a worldwide problem. Most EOCs exhibit higher concentrations in reclaimed water used for artificial recharge than in produced groundwater, indicating that these compounds are retained and/or degraded during infiltration. Removal may be the result of sorption, which depends on organic matter and inorganic surfaces contained in the sediments, and degradation, which depends on redox conditions (some EOCs are preferentially removed under specific redox conditions). To enhance removal and retention processes, we designed a reactive barrier, which consists of compost, sand, clay and is covered by iron oxide. The role of compost is to favor sorption of neutral compounds and to release easily degradable organic carbon, so as to generate diverse redox condition, thus increasing the range of degraded EOCs. The role of iron oxides and clay is to favor sorption of anionic and cationic compounds, respectively. The barrier has been tested in the field proving its ability in promoting diverse redox conditions and indeed improving EOCs removal. However, experimental data do not allow separating sorption from degradation. To do so, we have built a flow and transport model representing the infiltration system and the aquifer beneath. The model has been calibrated against head data, collected during three years that include recharge and natural flow periods, and concentration, collected during a conservative tracer test. The calibrated model was then used to predict the fate of EOCs using sorption and half-lives from the literature. Results confirm that retention and degradation processes are greatly enhanced by the addition of the reactive layer. However, a significant portion of recharge occurs through preferential flow paths with short residence times in the reactive layer.