How can chaotic advection improve the emerging pollutants degradation during Managed Aquifer Recharge?

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The coupling of Managed Aquifer Recharge (MAR) with soil aquifer remediation (SAR) through a reactive layer placed at the bottom of the infiltration pond is a promising technology to improve the quality of both recharged water and groundwater. As the reactive layer is made up of organic matter, all the redox processes are enhanced, improving the degradation of emerging pollutants. The success of the MAR-SAR coupling is based on the assumption that recharged water and groundwater are well mixed. Nevertheless, it is well known that mixing process in aquifers are sometimes the limiting processes to redox reactions. Recently, it has been demonstrated that mixing can be improved by inducing chaotic advection through extraction-injection engineering (EIE). Although the emerging pollutant degradation is not well understood, it has been observed that some compounds are preferably degraded either in oxic or in reduced conditions, depending on the nature of each compound. Then, promoting different redox conditions will result in an enhancement in the actual degree of degradation expected for any given compound. Considering all of this, our work is aimed to evaluate how caothic advection can improve mixing during MAR-SAR operations, and thus, capable of enhancing the spreading of redox conditions with the final aim of improving emerging pollutants degradation. To achieve this, we have developed a reactive transport model that describes how recharged water (rich in organic matter coming from a reactive layer) is mixed with groundwater, and how this organic matter is oxidized by different electron acceptors. The model has been tested in different scenarios of recharge and injection-extraction sequences, both in homogenous and in heterogenous media. The preliminary results show that EIE improves the mixing between the recharged water and groundwater and increase the spreading of the plume. Consequently, the redox zonation is found to be spread spatially, with the coexistance of different redox conditions at the same time, facilitating emergent pollutants degradation.

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