Influence of calcium and magnesium on arsenic sorption to phyllosilicate clays

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Calcium has been reported to promote As retention on phyllosilicate clays such as smectite and vermiculite. In this study, we decipher the influence of Ca and Mg on As retention and release, and we reveal the resulting surface complexation mechanisms. Further, we evaluate the influence of these mechanisms on As transport within Managed Aquifer Recharge (MAR) of Orange County, CA. In the Orange County MAR, purified wastewater of low ionic strength is discharged into recharge basins to replenish local groundwater. Smectite and vermiculite dominate the clay-size fraction of the underlying Santa Ana River-deposited shallow aquifer sediments and exert a dominant control on ion retention.

We conducted a series of batch and column experiments using recharge basin sediments. Batch experiments were used to construct As adsorption isotherms for solutions of varying ionic composition and concentrations at circumneutral pHs relevant to groundwater systems. Batch results were used to develop and calibrate a surface complexation model using PHREEQC. We subsequently analyzed As elution from columns with varying Ca and Mg concentrations. Our surface complexation model was extended to a 1D reactive transport model and applied to column results to simulate the physical and chemical conditions of infiltrating water in the Orange County aquifer.

Our results reveal that Ca and Mg have large impacts on As retention, creating ion bridging complexes to smectite/vermiculite surfaces. An understanding of these effects can dictate water treatment decisions in cases of MAR where As mobilization is a potential concern. More specifically, higher Ca and/or higher Mg concentrations can be achieved during post-treatment steps by increasing lime dosage, addition of dolomitic lime, and/or gypsum amendment.