Model of Diffusion and Reaction of Strongly-Sorbed Solutes in Soil and Their Uptake by Plant Roots

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Minisymposium: Mathematical and Computational Problems in Life Sciences

Abstract: For solving the problem of micronutrient malnutrition and food shortage, it is important to understand the processes that control crop growth. One of the key influencing factors is the soil nutrient status.

Here we derive a model for the transport of strongly-sorbed solutes in a soil taking into account both the diffusion in the soil fluid phase and within the soil particles. The adsorption on surfaces inside and outside soil particles is described by a nonlinear reaction. Using homogenization techniques we derive effective macroscopic equations for the solute movement in the soil. We use the homogenized model to estimate what effect the dynamics within particle can have on plant phosphate uptake.

It was observed experimentally that certain plant species are particularly good at extracting strongly-sorbed solutes from soils. One of the main mechanisms behind this is the ability of roots to excrete solubilizing organic anions. We generalize the model for transport of strongly-sorbed solute in the soil by considering the interaction between adsorbed solutes and organic anions. The influence of the presence of organic anions on zinc uptake by rice roots is calculated numerically.

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