43  Solute Diffusivity

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43-1 INTRODUCTION: SOLUTES IN WATER

Molecules and ions in soil water are commonly bound to portions of the semicrystalline water lattice by dipole-dipole or charge-dipole electrical attractions. Consequently, when the semicrystalline water lattice moves in response to body forces exerted by gravity or to electrical potential gradients, the solute molecules and ions are carried or convected with the lattice (as outlined in chapter 45 in this book). When water moves, portions of the water lattice nearest the solid surfaces generally move relatively slowly and those further from solid surfaces move more quickly. This range of lattice velocities results in dispersion or mixing of solution components, which is discussed in chapter 45.

Bonding energy of solutes to the water lattice is similar in magnitude to the kinetic energy of unbound water molecules. Consequently, impacts by thermally agitated molecules often dislodge solute molecules or ions from the lattice and they move through the lattice colliding occasionally with water and other solute molecules, imparting their kinetic energy to them and eventually becoming adsorbed in new positions on the water lattice. This movement of solutes with respect to the water lattice is random for individual ions or molecules in an isothermal system. Consequently, when the initial concentration of a solute is higher in one zone than in an adjacent zone, a net flux or diffusion from the zone of higher to the zone of lower concentration will occur. Diffusion of solutes with respect to the water lattice is often slower than convection. Consequently, when measuring diffusion coefficients, elimination of convection is a primary requisite.

In porous media and particularly near solid surfaces, the velocity of the water lattice (convection) is relatively slow and diffusion is often the dominant means by which fertilizer ions move away from solution in the vicinity of solid fertilizer particles, where their concentration is high, to other portions of the soil water where their concentration is lower.

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