Chapter 3

The Retention Process: Mechanisms

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Retention is one of the key processes affecting the fate of organic chemicals in the soil-water environment. Retention refers to the ability of the soil to hold a pesticide or other organic molecule and to prevent the molecule from moving either within or outside of the soil matrix. As such, retention refers primarily to the adsorption process, but also includes absorption into the soil matrix and soil organisms, both plants and microorganisms. Retention controls, and is subsequently controlled, by chemical and biological transformation processes. Retention strongly influences chemical transport to the atmosphere, groundwater, and surface waters. Not surprisingly, retention is a primary factor influencing the efficacy of soil-applied pesticides. The literature abounds with references on the retention of pesticides in soils (e.g., Bailey & White, 1964; Hamaker & Thompson, 1972; Green, 1974; Weed & Weber, 1974; Calvet, 1980).

Adsorption is defined as the accumulation of a pesticide or other organic molecule at either the soil-water or the soil-air interface. Adsorption is often used to refer to a reversible process involving the attraction of a chemical to the soil particle surface and retention of the chemical on the surface for a time that depends on the affinity of the chemical for the surface. The distinction between true adsorption in which molecular layers form on a soil particle surface, precipitation in which either a separate solid phase forms on solid surfaces or covalent bonding with the soil particle surface occurs, and absorption into soil particles and organisms is difficult. In practice, adsorption is usually determined only by chemical loss from solution, thus adsorption is often replaced by the more general term, sorption. Sorption refers to a general retention process with no distinction between the specific processes of adsorption, absorption, and precipitation.

The individual retention processes are highly complex. This complexity is primarily the result of soil heterogeneity and the soil’s contiguity with biological, atmospheric, and water systems. Therefore, one of the keys to understanding the mechanisms of the retention process is the composition of the soil matrix.