CHAPTER 2

SOLID AND FLUID PROPERTIES
OF THE SOIL-WATER SYSTEM

The Solid Framework

The solid phase of the soil-water system consists of mineral particles of many sizes and shapes, arranged in a multitude of ways, with a sprinkling of organic materials intermingled throughout. The thickness of mineral particles ranges from fractions of a micron to millimeters. The size, shape, and arrangement of the solid particles determine the size, shape, and distribution of pores. These, in turn, influence the amount of fluids contained in the pores and the rate of transfer of the fluids through the system. Another complicating factor is that fluids, especially water, can alter the pore geometry by dislodging and moving solid particles within the system and by causing swelling (or shrinking) of some mineral particles. Freezing and thawing of the soil and root action can also alter the pore geometry.

The theory of flow problems involving changing pore geometry is not extensive. It is an important factor in the analysis of water transfer in soils, but we are often forced to assume a constant pore geometry.

One might presume that two soils of identical pore geometries will have identical hydraulic properties. This would be true for systems having inert pore walls or walls composed of identical minerals. If the walls differ in surface charge density and specific ions absorbed, their effects will be manifested in flow. Detailed micromorphological soil studies clearly show that pore walls often consist of clay concentrations which may be significantly different in composition and structure from that of the bulk soil. The complexity of the porous media can be further complicated by the fact that in such cases the pore wall is in itself a porous body.

The chemical and mineral composition of pore walls is as varied as that of the soils in which they reside. Even minute quantities of organic constituents can affect the entry of water into pores because of their resistance to wetting (Jamison, 1945; Letey et al., 1962).

Size and Shape of Particles

It is common practice in soils work to qualitatively relate soil hydraulic properties to texture. Less frequently soil composition, e.g., muck vs. peat or kaolin vs. montmorillonite, is studied as a variable. Such diverse combinations of particles, varying in size, shape, arrangement, and composition, do not lend themselves to easy description and in the end have defied expression as simple parameters.