Minerals make up about one-half of the volume of most soils. They provide physical support for plants and create the water- and air-filled pores that make plant growth possible. Mineral weathering releases plant nutrients that are retained by other minerals through adsorption, cation exchange, and precipitation. Minerals are indicators of the amount of weathering that has taken place and the presence or absence of particular minerals gives clues to how soils formed. The physical and chemical characteristics of soil minerals are important considerations in planning, constructing, and maintaining buildings, roads, and airports. Soil minerals can adsorb many organic and inorganic environmental pollutants, promoting their degradation to nontoxic forms, attenuating their movement through the soil, or preventing their uptake by plants and their introduction into the food chain. Some minerals are themselves pollutants and can cause serious environmental problems when they are exposed to weathering at the soil surface by human activities. An understanding of soil mineralogy is central to understanding virtually all facets of humanity’s use and misuse of soils and is often the key to solving specific environmental problems.

This chapter develops a core of concepts and terminology needed for understanding soil minerals. The chemical composition of the Earth’s crust is discussed first to show that the most abundant elements in the crust are, not surprisingly, the ones most likely to be encountered in soil minerals. Then the chemical and structural classification of minerals is discussed, and the major minerals represented in soils are mentioned. The phyllosilicate minerals are covered separately because of their major role in soils. Basic structural concepts common to all minerals are covered at this point to provide the background for the discussion of the phyllosilicate structures. The overall structural theme of the phyllosilicates is then presented, along with a very brief summary of their most important properties. The chapter concludes with a treatment of some crystallographic and x-ray diffraction concepts important in identifying and characterizing soil minerals.

I. CHEMICAL AND STRUCTURAL CLASSIFICATION OF MINERALS

A. Composition of the Earth’s Crust

Most of the weight and volume of the Earth’s crust is made up of only a few elements (Table 1–1). Oxygen and Si make up most of the weight, while oxygen