Selective chemical dissolution (SCD) is a commonly employed means to use a range of chemical reagents to selectively extract mineral components from soils or sediments for the purposes of quantifying, separating, concentrating, or pre-cleaning of materials for analysis. It is often essential to remove cementing agents (e.g., carbonates, Al and Fe oxides, poorly crystalline aluminosilicates, organic matter) present within soil aggregates before a soil is dispersed for size fractionation (Jackson, 1979). Isolating clays is the primary step for studying layer aluminosilicates by physical methods such as X-ray diffraction (XRD), infrared spectroscopy (IR), thermal analysis, and others (Amonette and Zelazny, 1994). Better resolution can often be obtained if surface coatings and selected mineral components or impurities are removed from samples (Zelazny and Qureshi, 1972; Wang et al., 1981). Although the soil components removed by SCD are often minor in terms of mass distribution (except carbonates in calcareous soils), they may control or dominate a property or properties of a soil. Selective chemical dissolution may be a better choice for quantification of a component when physical methods are either not available, too expensive, or have poor resolution due to interferences or interpretive difficulties. Selective chemical dissolution can also be used together with physical methods for quantification (e.g., determination of soil ferrihydrite by differential X-ray diffraction) or for the confirmation of other physical methods (e.g., determining soil allophane or imogolite by infrared spectroscopy). In this chapter, we emphasize the SCD methods that are used for quantitative determination of selectively dissolved components in soils and sediments.

The assumption underlying the SCD approach is that a targeted soil fraction, which may contain one or more compounds (e.g., gypsum is a single compound, while soluble salts contain multiple compounds), has a unique, distinctive solubility and can be selectively dissolved by an appropriate solvent at a set of desirable experimental conditions (i.e., reagent concentration, pH, temperature, reaction time, solution/solid ratio). This assumption largely holds true in extracting gypsum and soluble salts—both fractions are soluble in water, but gypsum has a lower solubility with limited dissolution at a low solution/soil ratio whereas soluble salts are highly extractable. Carbonates can be dissolved stoichiometrically in an acid. Amorphous and poorly crystalline oxides and hydroxides of Al, Fe and Si, because of larger specific surfaces, have higher solubility than their crystalline counterparts. However, the specificity of SCD is not as satisfactory when the fraction to be extracted does not have a unique, distinctive solubility, which is common for polymineralic samples like soils and sediments. In a polymineralic sample, several minerals or mineral