Thermal analysis, as defined by the International Confederation for Thermal Analysis, is "a group of techniques in which a physical property of a substance and/or its reaction products is measured as a function of temperature whilst the substance is subjected to a controlled-temperature program" (Wendlandt, 1986). Much has been published on the topic of thermal analysis, including book chapters devoted specifically to soil mineral applications (Mackenzie & Mitchell, 1970; Mackenzie & Calliere, 1975; Tan et al., 1986). This chapter emphasizes the quantitative applications of thermal analysis to soil minerals. Specifically, the objectives are to: (i) review the principles and instrumentation of thermal-analysis techniques which have potential quantitative applications to soils, (ii) discuss applications and limitations of various techniques in the quantification of specific soil minerals and their properties, and (iii) describe recent advances and project future developments.

Thermal-analysis systems have advanced in recent decades from "home-made" (hybridized) devices to sophisticated computer-controlled systems. Computerization has streamlined calibration, data storage, data analysis, and graphics capabilities. It has even improved the quality of the data by permitting greater precision in the control of the instrument. Recently, thermal analysis has been coupled with spectroscopic techniques to obtain complementary information about the mineral reaction of interest. In short, the traditional thermal-analysis techniques used for soil-mineral analysis have improved in versatility and precision, and several nontraditional techniques emerging with the potential to further improve soil-mineral quantification.

Several traditional thermal-analysis techniques, measuring different physical properties, have quantitative application to soil minerals. These include thermogravimetry (TG), differential thermal analysis (DTA), and differential scanning calorimetry (DSC), and measure changes in mass, temperature, and enthalpy, respectively (Wendlandt, 1986). Other less common techniques have the potential for quantitative measurement of soil mineral properties include thermodilatometry (TD) and thermomechanical analysis (TMA), and measure dimensions and mechanical characteristics, respectively. A brief account of the principles and instrumentation employed by these techniques is given next to provide a background for subsequent discussion of quantitative measurements using thermal analysis.

PRINCIPLES AND INSTRUMENTATION