INTRODUCTION

Volcanic eruptions are often, although by no means always, associated with a profuse output of fine pyroclastic material, tephra. Tephra is a term used to describe all of the solid material produced from a volcano during an eruption (Thorarinsson 1944). Tephra is well known to travel great distances—even across continents—and can thus serve to link not only volcanic zones but also to bind stratigraphic provinces together internally, and with each other. While residence time in the atmosphere of the very finest of these particles can be substantial, the deposition of the bulk of volcanic ejecta can be considered instantaneous on geological timescales. Often these volcanic products can be identified by various chemical and non-chemical means and if the eruption date is known, the occurrence of tephra from a given eruption in stratigraphic sequences provides a powerful means of dating such deposits, or of refining available dating schemes. Furthermore, the occurrence of tephra from the same eruption preserved simultaneously in various types of depositional environments including glacial, terrestrial, and marine holds the potential of linking the regional causes of tectonic and stratigraphic change. In practice, tephrochronology requires tephra deposits to be characterized (or fingerprinted) using physical properties evident in the field together with those obtained from laboratory analyses. Such analyses include mineralogical and petrographic examination or geochemical analysis of glass shards or phenocrystals using an electron microprobe or other analytical tools including laser-ablation-based mass spectrometry or the ion microprobe. Tephrochronology provides the greatest utility when a numerical age obtained for a tephra is transferrable from one site to another using stratigraphy and by comparing and matching, with a high degree of likelihood, inherent compositional features of the deposits. Used this way, tephrochronology is an age-equivalent dating method that provides an exceptionally precise volcanic-event stratigraphy.

Bentonite is a clay deposit most commonly generated from the alteration of volcanic tephra, consisting predominantly of smectite minerals, usually montmorillonite. Other smectite group minerals may include hectorite, saponite, beidellite, and nontronite. Bentonite was originally known as “mineral soap” or “soap clay.” As has been reported by numerous authors (e.g., Grim and Güven 1978), Wilbur C. Knight first used the name taylorite for this material in an article in the Engineering and Mining Journal (1897). The name came from William Taylor of Rock River, Wyoming; owner of the Taylor ranch where the first mine was located. Taylor made the first commercial shipments of the clay in 1888. After Knight learned that the name taylorite had been previously used in England for another mineral he decided to rename the clay bentonite (Knight 1898) in recognition of its occurrence in the Cretaceous Fort Benton Group of the Mowry Formation. The Fort Benton Group was named after Fort Benton, Montana, in the mid-19th century by F.B. Meek and F.V. Hayden of the U.S. Geological Survey (1862, this report described the rocks of Nebraska, which at that time included Wyoming, Montana, and Dakota). As later defined by Ross and Shannon (1926), “Bentonite is a rock composed essentially of a crystalline clay-like mineral formed by the devitrification and the accompanying chemical alteration of a glassy igneous material, usually a tuff or volcanic ash.” Bentonite deposits are considered instantaneous at geologic scales, because of the briefness of volcanic explosions and the short duration over which particles are transported in the troposphere/stratosphere and finally deposited in sedimentary basins. Resulting from paroxysmal volcanic explosions (Plinian or ultra-Plinian events, co-ignimbrite), ash is deposited on