

Tephra layers in the Siple Dome and Taylor Dome ice cores, Antarctica: Sources and correlations

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[1] Volcanic ash, or tephra layers, are found in the Taylor Dome, Siple Dome A, and Siple Dome B ice cores. Significant shard concentrations are found at a number of depths in all three cores. Electron and ion microprobe analyses indicate that the geochemical composition of most layers is basaltic, basanitic, or trachytic, and the geochemical signatures of the layers suggest derivation from the Pleiades volcanic center, Mt. Melbourne volcano, or small mafic centers, probably in the Royal Society Range area. Presence of tephra layers suggests an episode of previously unrecognized Antarctic volcanic activity between 1776 and 1805 A.D., from at least two volcanic centers. A strong geochemical correlation ($D = 3.49$ and 3.97 with a value of 4 considered identical) is observed between tephra layers at depth of 79.2 m in the Taylor Dome ice core, and layers between 97.2 and 97.7 m depth in the Siple B core. This correlation, and the highly accurate depth-age scale of the Siple B core suggest that the age of this horizon in the Taylor Dome ice core presented by *Steig et al.* [1998a, 2000] should be revised downward, to the younger age of 675 ± 25 years before 1995. This revised chronology is consistent with vertical strain measurements presented by *Hawley et al.* [2003]. **INDEX TERMS:** 1827 Hydrology: Glaciology (1863); 9310 Information Related to Geographic Region: Antarctica; 8404 Volcanology: Ash deposits

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1. Introduction

[2] Ice cores collected in polar regions offer unique records of past climate and volcanism. Deep ice cores collected in Greenland (GISP2 and GRIP) and in Antarctica (e.g., Vostok, Byrd, Siple Dome, and Taylor Dome) provide climate records for as much as 100,000–400,000 years of Earth's history at annual to decadal to multidecadal resolution. However, deciphering the chronology of ice cores, particularly the age of ice at a given depth, can be difficult in areas of low accumulation, and particularly in the deeper parts of cores. The interpretation of the global climate record is critically dependent on correct chronology. For some types of ice cores, particularly shallow cores in areas of high accumulation rates, the chronology of a core can be determined by counting annual layers [*Hammer et al.*, 1986; *Alley et al.*, 1993]. However, for many ice cores, particularly in the interior of Antarctica, the accumulation rate of snow is too low for annual accumulation layers to be visible

[e.g., *Steig et al.*, 1998b]. When this is the case, other techniques must be used to determine the chronology of the cored ice. These techniques include modeling of annual layer thickness versus depth [*Nereson et al.*, 1996], using measurements of the sunspot-cycle-dependent isotope ^{10}Be [*Steig et al.*, 1998b], or analysis of large-scale variations in the oxygen isotopic and methane or other gas concentrations in the ice [*Bender et al.*, 1997; *Steig et al.*, 1998a, 2000]. The volcanically produced sulfate record from known eruptions can also provide time lines in the ice cores as well as providing information about the atmospheric impact of some of these events [*Zielinski*, 1995; *Zielinski et al.*, 1996, 1997; *Wolff et al.*, 1999].

[3] In addition to preserving volcanic aerosols, ice cores can contain a record of volcanism by containing volcanic ash, or tephra, produced during the eruption. During volcanic eruptions, volcanic ash and aerosols are widely distributed away from the volcanic source. The ash shards and aerosol gasses are dispersed by local winds, and fall out onto the snow surface of ice sheets. The material is then covered by snow, and becomes incorporated into the section that will later, following burial and compaction to ice,