

VOLCANIC ASH RECORD IN THE SIPLE DOME ICE CORE

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Volcanic ashes, or tephra, are present at a number of depths in the Siple Dome Ice Core. These tephra, composed mainly of volcanic glass shards, were located using a several different methods. The most prominent tephra layers can be located by visual observation of the core, and in the Siple Dome Ice Core nine ashes were located by this method. A second method of finding tephra layers is to locate high sulfate concentrations in the ice core, then to search these intervals for glass. This method allowed us to locate a number of additional tephra layers but was less consistently successful than the visual observation method. A third method involved use of a dust logger consisting of a downward-pointing phototube, ~1 m below side-directed light-emitting diodes (LEDs), attached to a cable that can lower the device down a 3-in. (7.5-cm) borehole filled with butyl acetate. The dust logger allowed identification of 30 “dusty” horizons, of which 23 yielded coherent populations of volcanic ash. Of the 7 non-ash bearing intervals, there may have been sampling depth errors in 5, accounting for the lack of volcanic ash in the sampled ice.

Geochemical analyses demonstrated significant concentrations of volcanic ash at a total of 40 separate depths in the Siple Dome Ice Core, ranging from 33.4 to 986.2 meters. The geochemical composition of shards was determined by electron microprobe analysis of polished samples of ash derived from filtered water from a given horizon of the core. We consider a concentration of volcanic ash in an ice core to be a significant time-stratigraphic marker, or a deposit related to a distinct eruptive events, if the layer contains at least 4-6 glass shards of similar, or geochemically-related composition. The grain size of the glass shards of the significant tephra layers typically ranges from 5 to 15 microns (Figure 1), and a

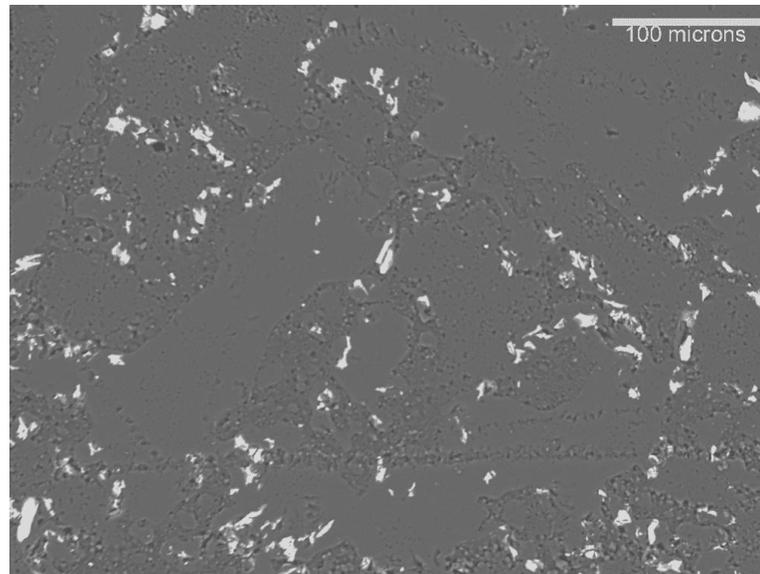


Figure 1. Backscattered electron image of volcanic ash from Siple Dome Ice Core. Bright areas are glass shards, dark areas are epoxy mounting material.

single sample may yield as many as several hundred, or as few as 10, individual shards. Random glass shards are also found at many depths in the core. These are not considered to be stratigraphically meaningful, but rather a component of windblown dust, similar to the quartz, feldspar, mica and clay minerals also found in many samples.

We have geochemically tied many of the tephra layers found in the Siple Dome ice core to local volcanic sources. These include the West Antarctic volcanoes Mt. Berlin and Mt. Takahe, as well as East Antarctic volcanoes Mt. Melbourne and the Pleiades. In addition, some of the tephra layers may be derived from small volcanic centers in the Transantarctic Mountains and sub-Antarctic Islands. A few layers in the upper part of the core appear to be derived from non-Antarctic rhyolitic volcanoes, probably located in South America. Eighteen of the 40 Siple Dome tephra layers were erupted from Mt. Berlin volcano, located 500 km from the Siple Dome drill site. The chronology of eruptive event from Mt. Berlin is known from deposits on the volcano as well as from englacial tephra from Mt. Moulton. Berlin-derived tephra layers are found at depths of 550, 600, 703, 707, 733, 735, 746, 748, 749, 751, 758/760, 778, 786, 809, 812, 911, 951, and 985 meters in the Siple Dome core. Of these, the layers that correlate to the best-dated eruptions of Mt. Berlin include the layer at 550 meters which probably correlates to the last activity of Mt. Berlin at 10.3 ± 2.7 ka, the layer at 703 m depth which correlates to an eruption at 14.5 ± 3.8 ka, and the layers at 758 and 760 m which correlate to an eruption at 27 ± 2.3 ka. Several other layers in the Siple Dome Core cannot be directly tied to a dated eruption, but can be correlated to undated eruptions bracketed between dated events. The layer at 911 m geochemically correlates to an eruption stratigraphically older than 27 ± 2.3 ka and the layer at 951 m geochemically correlates an eruption stratigraphically younger than 92.5 ± 2.0 ka. The deepest tephra layer in the Siple Dome core, at 985 meters depth, also appears to be from Mt. Berlin, but a single, direct correlation to an eruptive event has proven difficult. Of the two possible corollary eruptions, one occurred close to, but slightly earlier than 118.7 ± 2.5 ka, and the other slightly after 141.6 ± 7.5 ka. Further dating of Mt. Berlin eruptions is underway, and may provide added time control. Another robust time-stratigraphic marker is provided by a tephra layer found at 503-504 m depth, which correlates an 8.2 ± 2.7 ka eruption from another West Antarctic volcano, Mt. Takahe. This tephra layer was also recognized in the Byrd Ice Core (Wilch et al., 1999). Mt. Takahe is located ~1100 km from the Siple Dome drill site, and probably contributed less tephra to the Siple Dome area because of its greater distance, and also because it was less eruptively active in the past 100,000 yrs than Mt. Berlin. The only non-Antarctic eruption that has been correlated to a tephra layer in the Siple Dome is the 11.1 ± 1.8 ka (Haberle and Lumley, 1998) eruption of Mt. Hudson, in Chile, which chemically matches a tephra layer at between 596 and 597 meters. Although few global, non-Antarctic tephra layers have been found in the Siple Dome ice core, the abundant tephra layers derived from Antarctic volcanoes are likely to be found in future Antarctic cores, and will provide time-lines and cross-correlations with existing Antarctic ice cores.