Ancient Ashes: New methodology to effectively capture and analyze crypto-tephra in ice cores

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Abstract: By improving ice core sampling methodology, novel analysis of super fine volcanic ash (cryptotephra) from large, tropical volcanic eruptions became possible. Cryptotephra has been elusive in ice core records for several decades; probably due to both physical and instrumental limitations. However, with new techniques, tropical cryptotephra that is essential for refining ice core chronology can be both found and analyzed.

Project Description

Previous methods for mounting tephra particles include liquid adhesive, carbon planchets, filters, carbon adhesive, double-sided tape, and epoxy. While these materials are effective for capturing large (visible) tephra particles, few have managed to both capture and successfully analyze glass shards smaller than 10 µm. Because the majority of tephra deposited from tropical volcanic events is smaller than 10 µm, our new method will help further refine timescales across multiple ice cores.

Summary of Methods

Some of the most common methods are highlighted by Kuehn and Froese (2010), most of which involve mounting the particles on a carbon planchet, which eliminates the need for applying conductive coating to the sample, a process which is necessary for analysis in multiple instruments, such as the Scanning Electron Microscope (SEM).

Fig. 1. Single-opening epoxy mounts, polished on each side for flatness, adhered to specially formulated tape and a super flat hard drive surface.

While Kuehn and Froese (2010) and Hall and Hayward (2014) outline several effective methods for capturing particles in the 3-5 µm range, there are multiple steps involved that can be eliminated with newer products and simpler, more efficient methodology. Instead of filling pores of a carbon planchet with epoxy, or evaporating meltwater directly onto the carbon planchet, the multiple products and steps involved in the mounting process can be replaced with Kapton Double Sided Polyimide Tape (KT) and used computer hard drive disks (see Fig. 1).

Both expensive and difficult to use, carbon planchets are no longer necessary since the hard drives are flat enough to ensure a smooth mounting surface, and the use of the temperature resistant tape can guarantee both a sealed area to prevent leaks during heating/evaporation and a smooth enough surface to keep particles in place for backfilling the sample hole with epoxy.

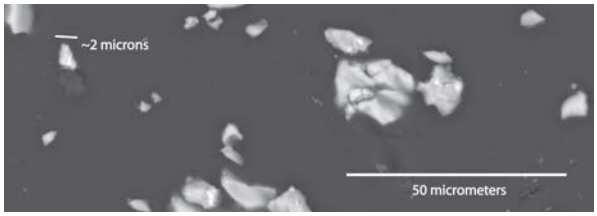

Fig. 2. View of an unpolished epoxy mount and tephra particles viewed under the SEM at 20 kV and 10 probe current in a high vacuum. Note the sub-micron particles mounted alongside the 20 µm particles.

New methods allow for effective capture of over 99% of tephra smaller than 5 µm from ice core samples, as well as the ability to view and analyze the particles under the SEM (see Fig. 2).

Acknowledgements: NSF Grant # PLR-1142007. CCI graduate scholarship. Donna Kalteyer and Natasha McWalters for laboratory assistance.

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