

Ba(r)ing It All: A Novel Approach to Deciphering the Lava Creek Tuff, Yellowstone, using Sanidine Geochemistry

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Large caldera-forming eruptions offer many challenges to understanding how their melt-dominant magma bodies are assembled, stored, become eruptible, and the timescales over which they erupt. Such information is of great importance to mitigating hazards in the event of future unrest. Earlier studies of these systems have utilized glass and mineral geochemistry to outline new ideas about such eruptions; however, some deposits are glass-limited and require different approaches. The 1000 km³ Lava Creek Tuff (LCT; 0.631 Ma), Yellowstone, USA is one such deposit, containing very little fresh glass and pumice. To document the nature of the magma system feeding the Lava Creek eruption requires an alternative approach. Here we use textural information and the associated concentration of Ba in sanidine to assess how the LCT can be physically and geochemically defined. Due to its abundance throughout the LCT, Ba in sanidine offers a way of compensating for the lack of glass in determining the magma body composition(s) and to link between different field sites.

We first compare sanidines from two locations where the host ignimbrite contains pumice, allowing validation that bulk ignimbrite sanidine are comparable to discrete magma batches. Discrete pumices have mean Ba in sanidine concentrations (118–183 and 414–867 ppm) that fall within the means observed from the bulk ignimbrite (135 ppm and 654 ppm), indicating that ignimbrites are representing discrete magma sources. Moving stratigraphically upward at both locations we find that Ba in sanidine shifts to higher concentrations (1212 and 916 ppm), suggesting that both sites are now tapping less-evolved magma sources. Assessment of Ba in sanidine from seven more samples from four sites highlights a sample and location dependency of ignimbrite around the caldera boundary, suggesting that multiple magmas were tapped during this eruption. These results are mirrored in the range of textural complexity viewed in sanidine, where some locations consist of primarily unzoned crystals, while others preserve evidence for multiple magma recharge events. Importantly, this view of the LCT pre-eruptive magma configuration mirrors the multiple distributed melt lenses currently imaged beneath Yellowstone today.