Enigmatic evolution of rhyolitic magma, the Bishop, Calif. Tuff

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For starters, the Bishop Tuff, although an exemplary, eutectoid high-silica rhyolite, is far from being a monolith. Wilson and Hildreth documented its stratigraphy in detail, establishing coeruption of a range of pumice types from at least two migrating vent systems with syndeposition of plinian pumice falls and pyroclastic flows. Some features of the Bishop Tuff remain enigmatic: 1) The earliest deposited pumice was plausibly the earliest erupted pumice and it probably derived from the uppermost and coolest part of the magma body. The enigma is that the earliest-deposited pumice is, in general, relatively poor in crystals, although both decompression and cooling promote crystallization. 2) Phenocrysts are reversely zoned: Sanidine phenocrysts have Ba-rich rims, Ba and CO2-rich melt inclusions are located in the outer zones of quartz phenocrysts, magnetite inclusions in some late-erupted quartz phenocrysts preserve compositions of magnetite in early-erupted pumice. The enigma is that reverse zoning of phenocrysts is commonly ascribed to a late influx of hotter, less differentiated magma, yet Bishop melt inclusion trace element compositions follow an exponential trend that is inconsistent with magma mixing. 3) Phenocrysts and melt inclusion compositions in a single pumice clast vary much less than for the whole deposit. The enigma is that a thick body of magma would tend to convect and thereby mix crystals and melts so as to form a uniform rather than stratified body. The solution? Crystal sinking, but would it not also cause mixing? Just what is the extent of crystal mixing within individual pumice clasts?

New isotopic measurements of zircon and feldspar constrain the magmatic evolution at Long Valley Caldera

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The age and isotopic composition of crystals contained in rhyolites provide insight into the duration of magma residence timescales, the petrogenetic relationships between magmas that erupt, and the evolution of magma systems. At Long Valley (LV) we use the populations of U-Pb zircon ages and feldspar Pb isotope compositions to address the relationship of the 0.8 to 2.1 Ma precaldera Glass Mountain (GM) rhyolites to the magma that erupted as the 0.76 Ma caldera-related Bishop Tuff (BT). We measured absolute U-Pb zircon crystallization ages by SIMS for 6 GM rhyolites and for the compositional end-members of the BT. We also developed a high precision method for *in situ* Pb isotopic analyses (±0.0003, 2 s.d. for the $^{207}Pb/^{206}Pb$ ratio) of feldspar by laser ablation MC-ICPMS in order to obtain a more complete crystallization record of the LV magmas and to gain insights into the secular Pb isotopic composition changes of the system. The zircon age populations of the LV rhyolites indicate that their crystallization occurred 90 to 235 k.y. before eruption. In particular, zircons contained in both the early and late erupted BT crystallized between 0 and ~100 k.y. before caldera collapse. This relatively narrow pre-eruptive time span lacks a significant portion of the ages found in the youngest GM rhyolites. From the zircon data we also infer that differentiation of the compositionally zoned BT occurred within 10's of k.y. Lead isotopic differences between the feldspars from older rhyolites ($^{207}Pb/^{206}Pb_o$= 0.81856) and younger rhyolites, including the BT ($^{207}Pb/^{206}Pb_o$= 0.81745), are found. These distinct Pb isotope signatures indicate that BT feldspars grew from magma different from older GM-like magmas, corroborating results from our zircon studies. They also support existing Nd and O isotope crystal data that suggest a progressively greater mantle contribution to the magmas over time. Collectively, our data indicate that LV volcanism tapped a number of transient and distinct magma bodies rather than a single long-lived magma chamber. Previous Sr isotope results for the precaldera magma system can be reconciled with these observations if radiogenic crystals grew from melts that are more radiogenic than the hosts in which they are found.