Residence times of eruptible rhyolites at Yellowstone caldera: Insights from zircon and sanidine

MARK E. STELTEN[1]*, KARI M. COOPER[1], JORGE A. VAZQUEZ[2], ANDREW CALVERT[2] AND JUSTIN J.G. GLESSNER[1]

[1]University of California – Davis, Davis, CA, USA (*correspondance: mestelten@ucdavis.edu)
[2]U.S. Geological Survey, Menlo Park, CA, USA

Yellowstone caldera has generated three caldera-forming eruptions at ca. 2.1 Ma, ca. 1.3 Ma, and ca. 0.64 Ma [1], and is a prime example of a long-lived, intracontinental silicic magmatic system. Although the petrogenesis of Yellowstone rhyolites has been studied in detail, the residence time of eruptible magma bodies is poorly constrained due to the lack of sufficiently precise geochronologic data. We focus our geochronologic investigation on rhyolites from the most recent post-caldera eruptive episode at Yellowstone, which generated the ca. 170-70 ka Central Plateau Member (CPM) rhyolites, because their young age allows for high precision ^{238}U-^{230}Th dating of their constituent mineral phases. We present new constraints on the residence times of eruptible magma bodies by comparing (1) ^{238}U-^{230}Th crystallization ages and trace-element compositions of the interiors and surfaces of individual zircons with (2) bulk ^{238}U-^{230}Th crystallization ages and *in situ* Ba concentrations and Pb isotope data for sanidines from three CPM rhyolites.

Comparing zircon surface and interior ages from CPM rhyolites of varying eruption age demonstrates that zircon interiors are antecrysts inherited from previous episodes of Yellowstone magmatism, whereas the zircon surfaces crystallized at (or within a few kyr of) eruption. Conversely, linking sanidine ^{238}U-^{230}Th ages, Pb isotopic compositions, and Ba concentrations demonstrates that CPM sanidines crystallized shortly before eruption from their host melts and lack a significant antecrystic component. The paucity of antecrystic sanidine relative to antecrystic zircon suggests that CPM rhyolites were generated by extracting melt (and antecrystic zircon) from a long-lived crystal mush, while the larger sanidine crystals remained trapped in the locked crystal network. In this model, crystallization of the sanidine observed in each rhyolite must have occurred after extraction of melt from the crystal mush. Because sanidine would have been saturated in the extracted melt, crystallization of the observed sanidines likely began immediately after extraction, and therefore the timing of sanidine crystallization constrains the residence time of eruptible melts to conservatively < 9 ka.

[1] Lanphere *et al* (2002), *Geol Soc Am Bull*, **114**, 559-568.