Title Clinopyroxene Diffusion Chronometry of the Scaup Lake Rhyolite, Yellowstone Caldera, WY

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Abstract

Eruption of the Scaup Lake flow (SCL) ended ~220,000 years of dormancy and began the youngest sequence of eruptions at Yellowstone caldera [*Christiansen et al.*, USGS, 2007]. Quantification of the time intervals between magmatic events and eruption recorded in SCL is critical to interpreting signs of unrest at modern-day Yellowstone. SCL rhyolite includes zoned phenocrysts and accessory phases that indicate multiple rejuvenation events occurred shortly before eruption; previous studies focused on feldspar and zircon crystal records [e.g. *Bindeman et al.*, J.Pet, 2008; *Till et al.*, Geology, 2015]. Here we exploit zoned clinopyroxene (cpx)—one of the earliest-crystalized minerals in SCL as indicated by petrographic relationships—as a diffusion dating tool and utilize elements with different diffusivities to more precisely resolve rejuvenation-eruption timescales. Using NanoSIMS concentration profiles with 300–900 nanometer spacing, we employ the slower-diffusing REE Ce as a proxy for the initial profile shape of faster-diffusing Fe to calculate diffusive timescales. The outermost resolvable zone boundary in SCL cpx yields a rejuvenation-eruption timescale of 166 ± 80 yrs (1 SD). In comparison, modeling relaxation of Fe from a step function initial condition at the same temperature (920°C) yields a less precise timescale of 488 +9000 -300 yrs. Examination of our results, in concert with observed petrographic relationships, indicates SCL cpx may record an older, separate rejuvenation event than those recorded in feldspar rims at < 10 months and 10–40 years prior to eruption [*Till et al.*, Geology, 2015]. The difference in the youngest recorded event between feldspar and cpx may be due to different crystallization intervals for these phases and/or slower crystal growth rates for cpx relative to feldspar. Our diffusion modeling results reinforce that intracrystalline zoning timescales modeled using a step function initial condition should be considered maxima, especially in viscous rhyolitic magmas, and that different phases may not record the same series of pre-eruptive events due to differences in crystallization behavior.