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Tracking the extraction of compositionally and thermally distinct rhyolite magma batches at Laguna del Maule, central Chile

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A large silicic magmatic system beneath the Laguna de Maule volcanic field (LdM) has produced a remarkable volume of rhyolite during the last ~24 kyr. Whole rock chemistry suggest rhyolite petrogenesis involves recurring episodes of magma recharge, mixing, and segregation of crystal-poor melt. Frequent seismic swarms, ongoing uplift, and a low Bouguer gravity anomaly indicate these processes remain active to this day. However, the physical structure of and processes within the magma reservoir preceding the recent rhyolite eruptions remain an open question. Here, we utilize major and trace element compositions of magnetite and plagioclase to characterize the spatial continuity of the thermo-chemical conditions preceding coeval rhyolite eruptions, their variation through time, and the pre-eruptive residence time of crystal-poor rhyolite melt. The mineral compositions define distinct groups of rhyolites erupted during the early post-glacial period (EPG; ~ 24 - 19 ka) and Holocene (~ 8 - 2 ka). The EPG rhyolites are characterized by lower concentrations of Al, Mg, and Ti in magnetite, and Ce in plagioclase. These geochemical fingerprints link rhyolites erupted from vents up to 15 km apart, indicating the segregation of several discrete rhyolite melt bodies that fed eruptions within a similar area. A complexly zoned sub-population of plagioclase records repeated extraction of evolved melt. In contrast to several well-studied silicic magma systems, LdM rhyolite feldspars do not record the intrusion of hotter, less evolved melt shortly before eruption. Instead, low An and Mg plagioclase rims grew within a rhyolite magma body. These sharp compositional gradients primarily reflect the changing crystallization conditions; however, Mg diffusion kinetics indicate pre-eruption crystal residence of as little as years to decades. If the last decade of unrest at LdM is associated with the extraction of crystal-poor melt, an eruption in the coming years would be consistent with the dynamics preceding the most recent eruptions.