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Sr and Mg diffusion models on plagioclase show potential long melt residence time and complex mush structure beneath arc volcanoes

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The nature of magma storage underneath arc volcanoes has been a debate between two end member hypotheses of Cold Storage (Mt. Hood, Oregon) and Warm Storage (Soufriere, St.Lucia), which were derived from Sr-in-plagioclase diffusion and trace element geochemistry in zircon respectively. Both end-members have critical implications on the mechanisms of volcanic eruptions, and it is not clear if the documented difference in storage conditions are linked to the analytical methods used, or reflect real differences in magmatic storage systems between volcanoes. Here we revisit the conclusions of cold storage at Mt. Hood using an updated Sr and Mg in plagioclase diffusion model combined with Monte Carlo error propagation (102 plagioclase from 3 eruptive events). Our results show that Mt. Hood lavas host plagioclases with distinct thermal/storage histories, with some crystals having long (tens of thousands of years) post-rejuvenation storage timescale at temperatures of the solidus and rheological lockup (700 and 750°C), and others only briefly residing in the post rejuvenation melt (~10 – 100 years). This suggests that arc volcanic reservoirs are complex bodies with some areas retaining melt for long periods of time after rejuvenation (warm storage), and some solid parts (cold storage) that get sampled during the magma mobilization/ascent leading to the eruption. While we argue that only the post-rejuvenation timescales can be derived through plagioclase diffusion models, pre-rejuvenation storage can be assessed by combining our post-rejuvenation residence times with the timing of Hood different eruptive events. Our results suggest that at least part of Hood reservoir has experienced long term storage above the solidus (up to 27,000 years), which contradicts previous conclusions of cold storage. Thus, the presence of intracrustal melt might represents the normal state of magma storage underneath dormant arc volcanoes, holding little potential as an early warning of imminent eruption.