Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.10156

Correlation of Ba-zonation and corresponding diffusion timescales indicate a heat pulse-dominated storage regime: A study of sanidines from the 33 ka eruption of Taapaca volcano (Central Andes)

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Taapaca volcano in Chile is a long-lived (~1.5 My) dome complex that erupted uniform dacites containing sanidine megacrysts (1 – 12 cm). Based on their Ba-zonation and geothermometry, Rout et al. (2021)[1] proposed 3 magmatic stages: (i) long-term storage and temperature cycling, (ii) slow "mobilization", and (iii) rapid mixing with mafic recharge and eruption. As opposed to (iii), during (i) and (ii), magma recharges end up as heat pulses without compositional mixing. The transition between the stages is controlled by the frequency of the recharges/pulses estimated by diffusion modelling.

In this follow-up study, we analyze 20 sanidine megacrysts from one single eruption (33±3.9 ka) from Taapaca. Amphibole and plagioclase inclusions constrain growth-zone-specific temperatures between 720 and 820 °C. Non-isothermal diffusion modelling across individual resorption-regrowth boundaries gave diffusion times of 0.5 – 40 ky between heat pulses. The total crystal residence times sum up to 200 ky. Based on the texture, Ba-content and boundary-specific diffusion timescales, we correlate individual growth zones between different crystals, thereby identifying the sequence of specific heat pulses affecting these megacrysts. This confirms that all the crystals from a single erupted magma batch had undergone the same thermal history and thus, must have been spatially closely associated.

The megacryst sets from other eruptions are similar in terms of overall zonation-style but do not share the exact same pattern. This suggests that although they share similar thermal history comprising of the 3 stages (see above), they likely belong to different reservoirs with individual pre-eruptive thermal histories with a common pattern of recharge frequencies repeated for each erupted magma batch throughout the history of this volcano. Differences are likely due to different reservoir size, location and variations in individual recharges.

[1]Rout SS, Blum-Oeste M, Wörner G (2021) Long-Term Temperature Cycling in a Shallow Magma Reservoir: Insights from Sanidine Megacrysts at Taápaca Volcano, Central Andes, Journal of Petrology 62:egab010