Session for submission:
5b - Dynamics and timescales in magmatic reservoirs, conduits and dikes

Title:
Can we relate diffusion timescales to magmatic flux and crustal permeability? The case of Villarrica and Osorno volcanoes (Chile)

Authors:
Sri Budhi Utami[1], Jacqueline Vander Auwera[1], Olivier Namur[2], Tonin Bechon[1], Paul Fugmann[1]

Affiliation:
1. Département de Géologie, Université de Liège, Belgium
2. Aards- en omgevingwetenschappen, Katholieke Universiteit Leuven, Belgium

Abstract
Villarrica and Osorno are two active stratovolcanoes in the Central Southern Volcanic Zone of the Andes with similar near-primary, tholeiitic parent magmas that produced overlapping major/trace element differentiation trends at comparable storage conditions (Hickey-Vargas et al., 2004; Morgado et al., 2015; Pizarro et al., 2019; Bechon et al., 2022). Yet Villarrica is an open-vent volcano that hosts an active lava lake and produced ~100 moderate-intensity, Strombolian eruptions since 1579; Osorno is a closed-vent, glacier-capped volcano with 10x less eruptions for the same period. We hypothesize the differences in eruptive style and frequency could be because of the higher crustal permeability under Villarrica relative to Osorno, either due to the higher permeability of conduit walls and/or complex fracture network. These factors would promote magma ascent to the surface, leading to short timescales and fast magma ascent rates. To test this hypothesis we compared the textures, compositions, and model diffusion timescales (Mg-Fe) in olivine, a mineral that is abundant at both volcanoes. Profiles of olivine crystals from Villarrica display reverse, normal, and no zoning and/or resorption. Osorno olivine crystals are highly resorbed and fragmented, with some crystals displaying only normal zoning. Villarrica olivine population have an overall higher Fo content (Fo_{72-87}) compared to Osorno (Fo_{66-82}) but share the same compositional range and multimodal distributions. We attribute the observed olivine textures and compositions at Villarrica to the magmatic processes occurring within its reservoir, which included magma recharge and cryptic mixing (Morgado et al., 2019; Romero et al., 2022). In Osorno, the magmatic processes are likely dominated by fractional crystallization, mush disaggregation, and crystal entrainment (Bechon et al., 2022). We will present results on diffusion timescales of the zoned olivine crystal populations to evaluate how differences in crustal permeability may be reflected in the diffusion timescales and magma ascent rates. Our findings can aid in improving current understanding of the influence of regional-scale crustal features on subduction zone magmatism and provide complementary information to support hazard mitigation efforts at active volcanoes.

References:
Bechon et al. (2022); Hickey-Vargas et al. (2004); Morgado et al. (2019); Morgado et al. (2015) JVGR, 306 : 1-16 ; Pizarro et al (2019), JVGR, 384 :48-63 ; Romero et al. (2022) Turner et al. (2017)