EGU2020-9649
https://doi.org/10.5194/egusphere-egu2020-9649
EGU General Assembly 2020

Crystal mush formation, timescales, and unrest: a combined study of olivine crystals and their hosted melt inclusions

Helena Albert[1], Fidel Costa[2], Andrea Di Muro[3], Jason Herrin[2], Nicole Métrich[3], and Etienne Deloule[4]

[1]Central Geophysical Observatory, IGN, Madrid, Spain
[2]Earth Observatory of Singapore, Nanyang Technological University, Singapore
[3]Institut De Physique Du Globe De Paris, Sorbonne Paris-Cité, Université Paris Diderot, UMR 7154 CNRS, Paris, France
[4]CRPG, UMR 7358 CNRS-Université de Lorraine, France

Crystals and their hosted melt inclusions are key witnesses of the processes occurring in the magma plumbing systems. Crystal zoning patterns can inform us of the range of magmatic environments, magma interactions, timescales, and of the likely processes that lead to eruption. A complementary view of the plumbing system is provided by detailed studies of melt inclusions. The variability of major, trace, and volatile element concentrations of the inclusions informs us of the heterogeneity and architecture of the system (e.g. minimum depth of magma storage). Coupling of the storing depth with the times of magma movement allows us to propose links with the eruptive behavior and different phases of eruptions, and especially with the monitoring data describing the unrest preceding the eruptions. Here we report the magmatic processes associated with caldera collapse and lateral magma transport recorded in olivine crystals and their melt inclusions on selected samples from the largest historical eruption of Piton de la Fournaise (April 2007).

The olivine crystals and melt inclusions from the 2007 Piton de la Fournaise eruption record shallow storage depth and re-equilibration related to lateral magma movement towards the surface. Most crystals we have studied likely grew during the pre-eruption and eruption period (e.g. in about 3 months) from the basalt that migrated from, and was temporarily stored at shallow depths (about 0.5-1 km a.s.l.), although deformation source modeled from tilt data indicates an initially deeper magma source (ca. 3 km b.s.l.). These observations suggest that magma arrival at shallow depth pressurized the pre-existing melts and led to eruption, but we have no evidence of physical interaction between the two. The zoning and timescales derived from olivine crystals record fast crystal growth, creation of a crystal mush and subsequent lateral transport, eruption, and caldera collapse. Timescales deduced from Fe/Mg, Ni and Ca in olivine rims and towards melt inclusions are relatively short (from 3 to 60 days) and agree with the changes in monitoring data. Degassing and re-equilibration of H^+ of melt inclusions via diffusion occurred during the depressurization of the shallow system and caldera collapse and vary between a few hours to six days (depending on the crystallographic direction).