Geophysical Research Abstracts
Vol. 18, EGU2016-13791-1, 2016
EGU General Assembly 2016

Reconstructing the magma storage and transfer dynamics during the 1669 eruption of Mt. Etna: Inferences from the record of zoned olivine populations

Maren Kahl (1,2), Daniel Morgan (2), Teresa Ubide (3), Marco Viccaro (4), and Donald Dingwell (1)

(1) Department of Earth & Environmental Sciences, Ludwig-Maximilians-Universität München, Germany (M.Kahl@lmu.de; dingwell@lmu.de), (2) School of Earth & Environment, The University of Leeds, UK (D.J.Morgan@leeds.ac.uk), (3) School of Natural Sciences, Trinity College Dublin, Ireland (teresa.ubide@tcd.ie), (4) Department of Biological, Geological & Environmental Sciences, University of Catania, Italy (m.viccaro@unict.it)

The March-July eruption of Mt. Etna in 1669 is ranked as one of the most destructive and voluminous eruptions of Mt. Etna. In order to better understand the threats and hazards related to future flank eruptions an improved understanding of the nature and duration of the magma storage and magma transfer dynamics within the Etnean plumbing system are required.
Here we present a combined population-based approach that links the compositional and zoning record preserved in 202 olivine crystals with a time-integrated study that enables us to decipher changes in the internal plumbing dynamics prior to and during one of the most destructive flank eruptions recorded at Mt. Etna in historical times. We have studied a total of 10 lava samples (five SET1 and five SET2) plus one scoria sample (MtRs: bomb from the Monte Rossi scoria cone) that were erupted from different vents that opened progressively between 950 and 700 m a.s.l. [1].
Following up on previous work [2-4], we have classified different olivine populations based on their overall core and rim compositional record and the prevalent zoning type (i.e. normal vs. reverse). The core plateau compositions of the SET1 and SET2 olivines range from Fo70 up to Fo83 with a single peak at Fo75-76. The rims differ significantly and show a bimodal distribution of compositions. Olivine rims from the SET1 samples are generally more evolved and range from Fo50 to Fo64 with a maximum at Fo55-57. SET2 olivines and those erupted from the Monte Rossi scoria cone vary between Fo65-75 with a peak at Fo69. SET1 and SET2 olivines display normal zonation with uniform core compositions (Fo75-76) but diverging rim records (Fo55-57 and Fo65-75). MtRs olivines display rare reverse zoning with cores at Fo70-72. Using the tool of System analysis [2] we can identify diverging magmatic histories for the SET1, SET2 and MtRs samples after the formation of the olivine cores. The diverging rim compositions of the SET1, SET2 and MtRs olivines can be explained best as the result of magma evolution in different magmatic environments (MEs): M2 (=Fo69), M3 (=Fo55-57), M4 (=Fo60-65) and M5 (=Fo50-59). Application of kinetic modelling of the diffusive relaxation of compositional zoning profiles preserved in 151 olivines yield a spectrum of timescales ranging from a few days up to 1 year. We find that SET1 samples contain crystals that record slightly longer timescales (up to 1 year), whereas the majority of SET2 olivines record timescales <40 days.

[1] Branca et al. (2013). Bull Volc 75: 694; [2] Kahl et al. (2011). EPSL 308, 11-22; [3] Kahl et al. (2013). Bull Volc 75:692; [4] Kahl et al. (2015) JPet 56, 2025-2068.