Geophysical Research Abstracts
Vol. 19, EGU2017-18835, 2017
EGU General Assembly 2017

Degassing vs. eruptive styles at Mt. Etna volcano (Sicily, Italy): Volatile stocking, gas fluxing, and the shift from low-energy to highly-explosive basaltic eruptions

Roberto Moretti (1), Nicole Métrich (2), Valeria Di Renzo (1), Alessandro Aiuppa (3), Patrick Allard (2), and Ilenia Arienzo (4)

(1) DIcDEA, Università degli Studi della Campania "Luigi Vanvitelli", Aversa (CE), Italy (roberto.moretti@unina2.it), (2) Institut de Physique du Globe, 1 rue Jussieu, Paris, France, (3) DiSTeM, Università di Palermo, Via Archirafi 36, Palermo, Italy, (4) Istituto Nazionale di Geofisica e Vulcanologia sezione Osservatorio Vesuviano, Via Diocleziano 328, Napoli, Italy

Basaltic magmas can transport and release large amounts of volatiles into the atmosphere, especially in subduction zones, where slab-derived fluids enrich the mantle wedge. Depending on magma volatile content, basaltic volcanoes thus display a wide spectrum of eruptive styles, from common Strombolian-type activity to Plinian events. Mt. Etna in Sicily, is a typical basaltic volcano where the volatile control on such a variable activity can be investigated. Based on a melt inclusion study in products from Strombolian or lava-fountain activity to Plinian eruptions, here we show that for the same initial volatile content, different eruptive styles reflect variable degassing paths throughout the composite Etnean plumbing system. The combined influence of i) crystallization, ii) deep degassing and iii) CO_2 gas fluxing can explain the evolution of H_2O, CO_2, S and Cl in products from such a spectrum of activity. Deep crystallization produces the CO_2-rich gas fluxing the upward magma portions, which will become buoyant and easily mobilized in small gas-rich batches stored within the plumbing system. When reaching gas dominated conditions (i.e. a gas/melt mass ratio of $\sim$ 0.3 and CO_2,gas/H_2Ogas molar ratio $\sim$ 5), these will erupt effusively or mildly explosively, whilst in case of the 122 BC Plinian eruption, open-system degassing conditions took place within the plumbing system, such that continuous CO_2-fluxing determined gas accumulation on top of the magmatic system. The emission of such a cap in the early eruptive phase triggered the arrival of deep H_2O-rich whose fast decompression and bubble nucleation lead to the highly explosive character, enhanced by abundant microlite crystallization and consequent increase of magma effective viscosity. This could explain why open system basaltic systems like Etna may experience highly explosive or even Plinian episodes during eruptions that start with effusive to mildly explosive phases. The proposed mechanism also determines a depression of chlorine contents in CO_2-fluxed (and less explosive) magmas with respect to those feeding Plinian events like 122 BC one. The opposite is seen for sulfur: low to mild-explosive fluxed magmas are S-enriched, whereas the 122 BC Plinian products are relatively S-poor, likely because of early sulfide separation accompanying magma crystallization. The proposed mechanism involving CO_2 separation and fluxing may suggest a subordinate role for variable mixing of different sources having different degrees of K-enrichment. However, such a mechanism requires further experimental studies about the effects on S and Cl dissolution and does not exclude self-mixing between degassed and undegassed batches within the Etna plumbing system. Finally, our findings may represent a new interpretative tool for the geochemical and petrological monitoring of plume gas discharges and melt inclusions, and allow tracking the switch from mild-explosive to highly explosive or even Plinian events at Etna.