Title: Caldera magmatic system evolution and parameters that control the triggering of explosive eruptions of active systems in the Mediterranean area, throughout melt (MI) and fluid (FI) inclusions study.

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Research program

Overall, magma plumbing systems beneath calderas develop incrementally as magma rises, intrudes and rejuvenates. Eventually accumulation and eruption of a sufficient magma volume drives subsidence of the plumbing system roof to form a caldera. The magma plumbing system may then reside relatively unchanged or continue to re-intrude on a variety of scales. Consequences include continued eruptions, crustal resurgence, or new cycles of caldera formation.

Large magma volumes characteristic of calderas may evolve as a single progressively-enlarging reservoir or through the rapid amalgamation of small magma pockets. Eruptible magmas typically lie al shallower depths as a caldera system evolves. Timescales of subcaldera magma residence reveal two remarkable concepts: (1) portions or melt within a magma may remain molten for > 106 years, and (2) melt can be created and mobilized in a few thousand years or less (Kennedy et al., 2018 and references there in).

Geophysical and geochemical data illustrate the present state or active sub-caldera plunbing systems and their development on timescales of hours to years. These studies commonly reveal aseismic, low-velocity zones at depths commonly overlain by shallower low-velocity zones linked with ground deformation. The exact nature or these shallower zones is anclear, but interpretations often include shallow sills and laccoliths, and hydrothermal circulation is likely a key process as well. Some interpretations include a link between magma movement and crustal deformation at calderas as well. Together with evidence from field studies, munerical simulations and analogue models, such data show that magma migration at calderas may involve considerable lateral transport through dykes or sills to a site of eruption. While caldera-related magma intrusions commonly exploit structures produced by caldera subsidence, they may also follow regional tectonic structures that extend well beyond the border of the caldera. The increased structural complexity that occurs as a caldera evolves increases the permeability of the crust. This may promote small volume eruptions and shallow storage of magma in the post-collapse phase.

This project aims to study through FI and MI the compositional variations of magma plumbing systems before and post caldera collapse of active systems in the Mediterranean area, the hydrothermal fluid implications and what control the triggering of explosive, high and medium energy, eruptions.

Melt inclusions (MI) are aliquots of silicatic fluid trapped within the phenocrysts during their growth. MI ideally represent the only direct way to measure the composition of magmas, including volatiles (De Vivo and Bodnar, 2003). MI and FI can also be used as geobarometer to establish the depth of magmas crystallization (Metrich and Wallace, 2008). In addition, some modifications after entrapment of MI can be used to model their residence times (Danyushevsky et al., 2002; Newcombe et al., 2014).

The analytical techniques required for FI and MI study are:

- Petrographic analysis of MI

- Microthermometric investigations of MI (with the use of Linkam and Vernadsky heating / freezing stages)
- Microanalysis - EMPA, SIMS, Raman and LA -ICPMS

Proposal for a PhD position

The proposed PhD position is aimed at the study of “Caldera magmatic system evolutions, throughout melt inclusions, to study the triggering of explosive eruptions”. Sampled volcanics have to be of different ages and representative of different eruptive styles in order to cover the complete pre and post caldera volcanic history. These data, together with others already acquired must achieve to a magmatic system model to define the possibility of explosive eruptive scenarios for the future.