Research programme on: Ischia post caldera magmatic plumbing system evolution, throughout melt and fluid inclusions, for shallower eruptible magmas.

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Ischia is a large volcanic complex that together with Campi Flegrei (CF), Procida and Mt. Somma Vesuvius (SV) forms a Quaternary volcanic field in the Mediterranean, along the Tyrrhenian Sea margin of the Apennines, in the graben of the Campanian Plain. At Ischia, volcanism probably started 150 ka BP alternating eruptive and quiescent periods. The last eruption occurred in AD 1302. Between 73 and 56 ka Ischia experienced a period of intense explosive volcanic activity by numerous trachytic Plinian and ignimbrite-forming eruptions. The Monte Epomeo Green Tuff (MEGT) eruption at c. 55 ka, has been the most voluminous and devastating eruptions of the island that for several scientists induced to the caldera formation. The MEGT caldera floor was later affected by resurgence that generated uplift of about 900 m, probably in the time interval 56–33 ka, and tilting of differentially displaced blocks; the most uplifted one is Monte Epomeo. The last episode of resurgence of Mt. Epomeo triggered large-scale debris avalanches (between 8 and 5 ka) that are found up to 40 km from the island. At present, Ischia does not show any significant uplift but only stable and subsiding areas, the maximum subsidence values (> 5 mm/yr) is located on the southern slope of Mt. Epomeo. The volcanic products of Ischia are strongly differentiated, highly alkaline (Na_2O+K_2O up to 15 wt%) and erupted in forms of lava flows, domes and pyroclastic deposits of trachytic composition. Crystalline syenitic xenoliths are abundant in all the pyroclastic units. Even if Ischia has been the object of several geological, volcanological, geophysical and geochemical studies in the past decades (Paoletti et a., 2013) there are still many uncertainties about the caldera limits, the depth of the feeding system and also the role of hydrothermal fluids that are exceptionally abundant on the whole island. The recent deflation movements have not been fully understood as well.

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, initially independent, magma pockets. Eruptible magmas typically lie at 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 > 10^6 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 plumbing systems and their development on timescales of hours to years. These

studies (Kennedy et al., 2018) commonly reveal aseismic, low-velocity zones at low depths, as happen at Ischia. The exact nature or these shallower zones is unclear, but interpretations often include shallow sills and laccoliths, and hydrothermal circulation is likely a key process as well. 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.
The objectives of this project are to study the post collapse evolution of Ischia subvolcanic plumbing system throughout fluid and melt inclusions in xenoliths and volcanics bearing mineralogical phases, to clarify the exact nature or the low-velocity shallower zones highlighted by geophysical surveys (Paoletti et al., 2013) and to assess if eruptible magmas lie at shallower depths as well.

Melt and fluid inclusions (MI/FI) are aliquots of silicatic fluid or simply fluids 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 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 MI study are:
- Petrographic analysis of MI
- Microthermometric investigations of MI (with the use of Linkam and Vernadsky heating / freezing tables)
- Microanalysis - EMPA, SIMS, Raman and LA -ICPMS

Proposal for a PhD position
The candidate for this position must have an excellent knowledge of mineralogy, petrology, magmatology, geochemistry and volcanology. He must know how to recognize minerals at a macroscopic and microscopic level, perform samplings of volcanic products and have strong aptitudes for laboratory activities that are essential for the study of FI and MI. Knowledge of the main microanalysis techniques are also required.

Funding
Although not funded, the project falls within the context of a collaboration with international research groups (i.d., Prof. R.J. Bodnar, Virginia Tech; Prof. C. Cannatelli University of Chile) consolidated over time. Between our University and these foreign universities are formally opened Conventions financed for exchanges of both teachers and students / doctoral students (MoU, responsible Prof. A. Lima). Thanks to these collaborations, the candidate PhD student will have access to cutting-edge equipment for his own research at no cost. The doctoral student will be able to decide whether to become a student of the foreign institution, thus obtaining

a joint international doctorate. This would serve to give a more complete preparation to the doctorate in a future key to open or further consolidate the collaboration between our research group (and therefore our Department) and research groups abroad.