Title: The structure and evolution of faults triggered by magma migration in active volcanic areas

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Research program

Over the last few decades, several studies have addressed the question of how underground magma movements (i.e., horizontal or vertical migrations) influence the surficial and deep strains, structurally expressed as developing fracture and fault systems. As an example, is has been proposed that the collapse of the roof of a magma chamber during magma and associated fluids migration can results in the development of fault systems displaying a "ring" configuration around the active volcano. The development of these volcanic activity-induced fault systems is often associated with low-magnitude seismic events and, therefore, the understanding of their structure and evolution can have critical implications for seismic hazard mitigation in active volcanic areas. Although these faults typically do not release a significant amount of seismic energy, they are often very shallow and may consequently cause important damages to infrastructures located within or around the volcanic area. However, the vast majority of models proposed for the structure and development of faults in these geological settings is derived from modelling approaches which includes, among others, mathematical, numerical and analogue studies, at a resolution which is often lower than that can be derived from direct field observations.

Proposal for a PhD position

In this PhD Project, the candidate will study in details fault systems developed in active volcanic areas, with a focus on caldera volcanoes and an initial emphasis on that of the Campi Flegrei area (Italy). In this area, exceptional exposure of volcanic activity-related fault systems will permit the candidate to address their characteristics by means of detailed structural field observations. Generally, faults develop in active volcanic areas due to the superposition of both tectonic and local strain fields (the latter often changing over time), rather than due to a nearly constant one such as those in which normal, reverse, and strike-slip faults typically form. Furthermore, they often develop nearly instantaneously, at relative shallow crustal depths, and under strong underlying structural controls (i.e., location and size of magmatic reservoirs such as magma chambers, conduits, dykes, and sills). As a consequence, faults developed in active volcanic settings are likely to be associated with peculiar and unique structural and kinematic styles. The PhD Project may slightly vary based on the candidate's scientific propensities and interests. However, some of the fundamental questions that will be addressed by analyzing data collected in the field will be, among other possible ones: how does the size and distribution of fault systems developed in active volcanic settings correlate with the size and location of the magmatic reservoirs? How do these fault properties change over time with the progression of magma migration? What are their fault plane dips and trajectories? What are their characteristic throw gradients? What are their displacement-length relationships? How and how often are they segmented? How do they evolve with increasing shear strain? What are the links between this evolution and the spatio-temporal

magma migration? Are they more likely to be associated with discontinuous or continuous deformation? How do faults with possibly contrasting slip vectors interact with one another?

In order to address the aforementioned scientific questions, the PhD candidate will follow a work schedule articulated as follows:
1st year - Bibliographic research on the structure of faults triggered by magma migration in active volcanic areas. Extensive field work in the Campi Flegrei area and fault data analysis;
2nd year - Completion of field work activity in the Campi Flegrei area and visits to other areas worldwide with similar characteristics. 5-month external stay. Results presentation at international conferences and in peer-reviewed papers;
3rd year - Completion of analyses of the data collected in the previous years. Results presentation at international conferences and in peer-reviewed papers. Thesis writing.

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